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The Bright and Dark Sides of Exercise Behaviour: Untangling the Paradox

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A dissertation submitted for the title of Doctor of the Hungarian Academy of Sciences

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To my academic mentors,

Peter Seraganian, Sylvia Ruby, François Péronnet, Lise Gauvin, Robert Frenkl

Psychology, unlike chemistry, unlike algebra, unlike literature, is an owner's manual for your own mind. It's a guide to life. What could be more important than grounding young people in the scientific information that they need to live happy, healthy, productive lives? To have good relationships?

Daniel Goldstein

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Acknowledgements

To write a thesis at this level, one had to have outstanding mentors, so I must thank them first. My keen interest in the psychology of physical activity was sparked by the inspiring lectures by Peter Seraganian at Concordia University in Montreal. I was so devoted to studying the subject that I asked Pete to accept me as a volunteer student research assistant in his Psychophysiology laboratory. He did. So, from 1983, as a first year undergraduate, I started to work in Peter's research team that also included his graduate students, Tom Brown and David Sinyor. These three gentlemen taught me the basics of strict and meticulous research work for which I am the most indebted to them.

I wish to express my sincere gratitude to Sylvia Ruby, who convinced me that psychology is more interesting if I understand its biological basis. When I told her that I am ready to do my MSc in biology with her, she was very supportive. As a Master's student, I worked on the neurotoxicity in the fish brain that may not be too close to human psychology, but later it helped me to understand the physiological, biological, and chemical writings related to my psychology research. Sylvia is also thanked for providing me the first opportunity to teach as a laboratory demonstrator in one of her courses. The two years spent in the biology laboratory were different from the rest of my academic path. During this time, I have learned about a new dimension of the scientific inquiry that allowed me to look at things from a 'more scientific' or rather multidisciplinary perspective. This is Sylvia's merit and I must acknowledge it as a milestone in shaping my thinking and academic career.

The most disciplined and the most organized scholar who I met during my higher education was François Péronnet. Initially, we worked together on a collaborative project in Peter Seraganian's laboratory. Later, when I went to his University of Montreal office and told him that I would like to do my PhD with him in exercise psychophysiology all he said: "no problem". From that moment a very fruitful collaboration has started. François was down to the point. He never said an extra word. "*Focus"* was his slogan. Without his support, it would have been impossible to publish five papers and a book chapter on the psychological effects of exercise during the three years of my PhD studies. I learned from François to be effective, parsimonious, and organized. These skills are very useful in my academic work today. François Péronnet is an academic role model for me even today.

I have completed my first year of postdoctoral research at Concordia University with Lise Gauvin. She encouraged me to apply for a postdoctoral grant and if I get it then she would hire me as a postdoctoral fellow. Lise inspired me in grant writing even before actually doing research together. Since I was successful and obtained the grant, I became her department's first postdoctoral fellow. We worked on the implementation of the experience sampling method in exercise psychology that resulted in a peer reviewed publication. Lise taught me a different approach in scientific investigation and made me a part of a pioneering research approach in the field. I am also very thankful to her for showing me flexibility in planning and goal setting while keeping up with the schedules of research.

My last "official" mentor was Robert Frenkl. I wrote to him from Canada indicating that I have a grant for postdoctoral research that I would like to use for working with him in an area that integrates psychology and medicine in sport. He cordially invited me to Hungary. When I first met him in his 2nd floor Alkotás street office, he was very welcoming. We drunk coffee every morning, while he answered about five incoming calls. Listening to his conversations with others was already a great learning experience. We spoke about the Internet a lot and I told him that soon we can use the web for research. Robert was a visionary, instead of laughing at me he said "let's do it then". And we did it, thanks to Rob's open minded attitude. We published the very first guidelines - in the whole world - for Internet research, presented the topic at several conferences, and collected the first set of data (in psychology) over the Internet between 1996-1997. Without Robert's encouragement, positive attitude, and multidisciplinary orientation this giant first step would not have happened. I remember Robert as a polyhistor and a great mentor in the academic and everyday life as well.

I am also indebted to my colleagues and research collaborators in the United Kingdom. Nigel Hunt is the bravest psychologist, I ever met, who studied war trauma in real war settings in Kosovo and Bosnia. He also helped me in my first successful PhD supervision in his role of co-supervisor to Ester Mataija (Cerin). Professor Mark Griffiths is acknowledged for the inspiration and continuous help in writing scholastic articles as well as for sharing his knowledge and experience in behavioural addictions. Pro Vice-Chancellor, of the Nottingham Trent University, Professor Nigel Hastings is acknowledged for his help and support in his role as my second Master's Thesis (MA) supervisor. He provided motivation for my work and continuous encouragement. His supportive attitude resulted in my best cited publication (>200) that is co-authored by him. He praised me for that work, but the real praise should be his for the continuous support and motivation of a junior colleague.

Manuel Calvo from the Universidad de La Laguna in Tenerife is thanked for involving me in an intervention study on the psychological effects of training. Alexei Egorov is thanked for his ideas and input in the development of the interactional model for exercise addiction. He is also thanked for supplying case studies in exercise addiction. Roberto Ruíz and Ricardo de la Vega are thanked for their past and still ongoing research support, data collection in Spain, and supplying difficult-to-get literature through their interlibrary order at Universidad Autonoma de Madrid. Konrad Morgan is thanked for helping me on several aspects of the advancement of my professional career. Edward Chow is thanked for the Hong Kong connection that not only resulted in several publications, a PhD student completion, and consultancy work for the Hong Kong Institute of Education, but also in a much appreciated familiarity with the South-East Asian and Chinese way of life, including the academic, social, and philosophical mentality. Eric Tsang, my PhD student who was eight years older than me, showed me new ways on how to live life wiser and that it is never too late to do anything.

Since my move to Hungary in 2005, I have received enormous support from many people. Tamás Szabo is thanked for giving me a challenging psychology post at the National Institute for Sport Talent Care. Prof. György Hunyady is thanked for bringing me to ELTE. Prof. György Bárdos is thanked for professional and personal support in the past years and for being the most democratic superior that I ever had. Zsolt Demetrovics is sincerely thanked for the many research and publication opportunities and for his support and motivation in my career advancement. In fact, this dissertation probably would not have been written without Zsolt's motivation and encouragement. I also would like to thank my research collaborators, Ferenc Köteles, Márk Bérdi, Attila Velenczei, Árpád Kovács, István Soós, Bernadett Kun, Kata Mónok, Zoltán Gáspár, Anikó Maráz, Barbara Mervó, and Róbert Urbán for the many new things that I have learned from them. Special thanks to Ágnes Hardi for her support, patience, and understanding, as well as for her help in the editing of this dissertation.

Last, but not least, I am thankful to my family and all my beloved ones, for their support and understanding in my often exaggerated time devoted to the work that is also my hobby, which often resulted in not paying enough attention to them or even neglecting them.

Budapest, 30 March, 2015

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List of Abbreviations

A-B-A	- Training-Deprivation-Training
ACSM	- American College of Sports Medicine
ADACL	- Activation-Deactivation Adjective Check List
AE	- Aerobic Exercise
AHA	- American Heart Association
ANG	- Anger
ANOVA	- Analysis of Variance
ANS	- Autonomic Nervous System
APA	- American Psychological Association
ASAM	- American Society of Addiction Medicine
BBB	- Blood Brain Barrier
BDI	- Beck Depression Inventory
BDS	- Bodybuilding Dependency Scale
BHR	- Baseline Heart Rate
BMI	- Body Mass Index
BS	- Between Subjects
BW	- Bowling
CNS	- Central Nervous System
CPA	- Commitment to Physical Activity
CRS	- Commitment to Running Scale
CS	- Case Study
CSAQ	- Cognitive-Somatic Anxiety Questionnaire
CSPA	- Center for Support and Prevention of Athletes
CT	- Cross-Training
CX	- Cross-Sectional
DIFFTMD	- Difference in Total Mood Disturbance
DIR	- Direct
DISTRE	- Distress
DN	- Dance
DPS	- Depression
DSM IV	- Diagnostic and Statistical Manual of Mental Disorders (4th Ed.)
DSM V	- Diagnostic and Statistical Manual of Mental Disorders (5th Ed.)
DSS	- Deprivation Sensation Scale
EA	- Exercise Addiction
EAI	- Exercise Addiction Inventory
EBQ	- Exercise Beliefs Questionnaire
ED	- Exercise Dependence
EDS	- Exercise Dependence Scale
EDQ	- Exercise Dependence Questionnaire
EE	- Excessive Exercise
EFI	- Exercise-Induced Feeling Inventory

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EPI	- Eysenck Personality Inventory
ES	- Effect Sizes
ESM	- Experience Sampling Methodology
EXH	- Exhaustion
EXINT	- Exercise Intensity
EXP	- Experimental
FATIG	- Fatigue
FC	- Fitness Conditioning
FE	- Fencing
fMRI	- Functional Magnetic Resonance Imaging
FS	- Feeling Scale
G-G	- Greenhouse-Geisser
GEP	- General Exercising Population
GHQ	- General Health Questionnaire
HRR	- Heart Rate Reserve
hrs	- Hours
HRV	- Heart Rate Variability
HSD	- Honestly Significant Difference
IL-6	- Interleukin six
IND	- Indirect
JSEP	- Journal of Sport and Exercise Psychology
KMO	- Kaiser-Meyer-Olkin
MA	- Martial Arts
MANOVA	- Multivariate Analysis of Variance
MET	- Metabolic Equivalent of Task
MFI	- Multidimensional Fatigue Inventory
MHR	- Maximal Heart Rate
MHRR	- Maximal Heart Rate Reserve
mi	- Miles
MMPI	- Minnesota Multiphasic Personality Inventory
MRM-ANOVA	- Multivariate Repeated Measures Analysis of Variance
MT	- Method or Test development
n	- Number of subjects / number of observations
NA	- Negative Affect
NAS	- Negative Addiction Scale
NS	- Statistically Not Significant
OE	- Obligatory Exercise
OEQ	- Obligatory Exercise Questionnaire
ORQ	- Obligatory Running Questionnaire
Other	- Other QTRs than the EDS or EAI
PA	- Positive Affect
PACE	- Pragmatics, Attraction, Communication, Expectation
PANAS	- Positive Affect Negative Affect Schedule

PC	- Personal Computer
PET	- Positron Emission Tomography
PMA	- Primary Mental Abilities
POE	- Positive Engagement
POMS	- Profile of Mood States
PSE	- Psychology of Sport and Exercise
QTR	- Questionnaire
RAS	- Running Addiction Scale
REV	- Revitalization
RPE	- Rated Perceived Exertion
RPES	- Rated Perceived Exertion Scale
SD	- Standard Deviation
SDT	- Self-Determination Theory
SEES	- Subjective Exercise Experience Scale
Sex: m	- male
Sex: f	- female
SPSS	- Statistical Package for Social Sciences
SSAI	- Spielberger State Anxiety Inventory
SSS	- Sport Science Students
ST	- Survey Type
STAI	- Spielberger Trait Anxiety Inventory
SW	- Swimming
SWL	- Satisfaction With Life Scale
TMD	- Total Mood Disturbance
TNS	- Tension
TR	- Triathlon
TRQ	- Tranquillity
UK	- United Kingdom
USA	- United States of America
VGR	- Vigour
VO_2	- Volume of maximum oxygen uptake
WB	- Well-Being
WBQ	- Well-Being Questionnaire
wk	- Week
WS	- Within Subjects
WT	- Weight-Training
yrs	- years
?	- not clear or not known

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List of the Author's Works, on which the Dissertation is Based (in order of discussion)

1. **Szabo, A.,** Griffiths, M. D. & Demetrovics, Zs. (2013). Psychology and exercise. In D. Bagchi, S. Nair & C. K. Sen (Eds.), *Nutrition and Enhanced Sports Performance* (Chapter 6, pp. 65-73;). New York, NY: Academic Press. ISBN: 978-0-12-396454-0

2. **Szabo, A.,** Meskó, A., Caputo, A., & Gill, É. (1998). Examination of exercise-induced feeling states in four modes of exercise. *International Journal of Sport Psychology, 29*, 376-390.

3. **Szabo, A.,** Frenkl, R., Janek, Gy., Kálmán, L., & Lászay, D. (1998). Runners anxiety and mood on running and non-running days: An in-situ daily monitoring study. *Psychology, Health & Medicine, 3*(2), 193-199. doi: 10.1080/13548509808402235

4. **Szabo, A.** (2003). Acute psychological effects of exercise performed at self-selected workloads: Implications for theory and practice. *Journal of Sport Science and Medicine, 2*, 77-87. PMCID: PMC3942640

5. **Szabo, A.** & Ábrahám, J. (2013). The psychological benefits of recreational running: A field study. *Psychology, Health & Medicine, 18*(3), 251-261. doi: 10.1080/13548506.2012.701755

6. **Szabo, A.** (2013). Acute psychological benefits of exercise: Reconsideration of the placebo effect. *Journal of Mental Health, 22*(5), 449-455. doi: 10.3109/09638237.2012.734657

7. **Szabo, A.,** Gáspár, Z., & Ábrahám, J. (2013). Acute effects of light exercise on subjectively experienced well-being: Benefits in only three minutes. *Baltic Journal of Health and Physical Activity, 5*(4), 261-266. doi: 10.2478/bjha-2013-0024

8. Calvo, M. G., **Szabo, A.**, & Capafons, J. (1996). Anxiety and heart rate under psychological stress: The effects of exercise-training. *Anxiety, Stress, and Coping, 9*, 321-337. doi: 10.1080/10615809608249409

9. **Szabo, A.,** Frenkl, R., & Caputo, A. (1996). Deprivation feelings, anxiety, and commitment to various forms of physical activity: A cross-sectional study on the Internet. *Psychologia, 39*, 223-230.

10. **Szabo, A.,** Frenkl, R., & Caputo, A. (1997). Relationships between addiction to running, commitment to running and deprivation from running: A study on the Internet. *European Yearbook of Sport Psychology, 1*, 130-147. ISBN 3-88345-740-X

11. **Szabo, A.** (1997). Cross sectional research on the Internet; Trait anxiety, deprivation feelings, and commitment in five modes of physical activity; instituting sport-science research on a public-across computer network (Internet^{TM}). *Journal of Physical Education and Sport Sciences, 10*(1), 14-22. ISSN 2319-9946

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12. **<u>Szabo, A.,</u>** & Parkin, A. M. (2001). The Psychological Impact of Training Deprivation in Martial Artists. *Psychology of Sport & Exercise, 2*, 187-199. doi:10.1016/S1469-0292(01)00004-8

13. **<u>Szabo, A.</u>** (1995). The impact of exercise deprivation on well-being of habitual exercisers. *The Australian Journal of Science and Medicine in Sport, 27*(3), 68-75.

14. **<u>Szabo, A.</u>** (1998). Studying the psychological impact of exercise deprivation: Are experimental studies hopeless? *Journal of Sport Behavior*, *21*(2), 139-147.

15. **<u>Szabo, A</u>.** (2010) *Exercise Addiction: A Symptom or a Disorder?* Hauppauge, NY: Nova Science Publishers. ISBN: 978-1-60876-789-2

16. Egorov, A. Y., & **<u>Szabo, A.</u>** (2013). The exercise paradox: An interactional model for a clearer conceptualization of exercise addiction. *Journal of Behavioral Addictions,* 2(4), 199-208. doi: 10.1556/JBA.2.2013.4.2

17. Griffiths, M. D., **<u>Szabo, A.,</u>** & Terry, A. (2005). The exercise addiction inventory: a quick and easy screening tool for health practitioners. *British Journal of Sports Medicine, 39*, e30. doi:10.1136/bjsm.2004.017020

18. **<u>Szabo, A.,</u>** & Griffiths, M. D. (2007). Exercise addiction in British sport science students. *International Journal of Mental Health and Addiction, 5*(1), 25-28. doi: 10.1007/s11469-006-9050-8

19. **<u>Szabo, A.,</u>** de la Vega, R., Ruiz-Barquín, R., & Rivera, O. (2013). Exercise addiction in Spanish athletes: Investigation of the roles of gender, social context and level of involvement. *Journal of Behavioral Addictions, 2*(4), 249-252. doi: 10.1556/JBA.2.2013.4.9

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List of the Author's Further Publications Cited in the Dissertation (in alphabetical order)

1. Ábrahám, J., Velenczei, A., & **Szabo, A**. (2012). Perceived determinants of well-being and enjoyment level of leisure activities. *Leisure Sciences, 34*(3), 199-216. doi: 10.1080/01490400.2012.669677

2. Berczik, K., Griffiths, M. D., **Szabo, A**., Kurimay, T., Kökönyei, Gy., Urbán, R., & Demetrovics, Zs. (2014). Exercise addiction - the emergence of a new disorder. *Australasian Epidemiologist, 21*(2), 36-40.

3. Berczik, K., **Szabo, A**., Griffiths, M. D., Kurimay, T., Kun, B., Urbán, R., & Demetrovics, Zs. (2012). Exercise addiction: symptoms, diagnosis, epidemiology, and etiology. *Substance Use & Misuse, 47*(4), 403-417. doi: 10.3109/10826084.2011.639120

4. Dagrou, E., & **Szabo, A**. (1998). Daily assessment of state anxiety and mood in African athletes: Psychological effects of training from a life-quality perspective. *Ife Psychologia, 6*(2), 1-12. doi: 10.4314/ifep.v6i2.23530

5. Gauvin, L., & **Szabo, A**. (1992). Application of the experience sampling method to the study of the effects of exercise withdrawal on well-being. *Journal of Sport and Exercise Psychology, 14*(4), 361-374.

6. Michalak, E. E., & **Szabo, A**. (1998). Guidelines for Internet research: An update. *European Psychologist, 3*(1), 70-75. doi: 10.1027//1016-9040.3.1.70

7. Mónok, K., Berczik, K., Urbán, R., **Szabo, A**, Griffiths, M. D., Farkas, J.,…Demetrovics, Zs. (2012). Psychometric properties and concurrent validity of two exercise addiction measures: A population wide study. *Psychology of Sport and Exercise, 13*(6), 739-746. doi: 10.1016/j.psychsport.2012.06.003

8. Péronnet, F., & **Szabo, A**. (1993). Sympathetic response to psychosocial stressors in humans: Linkage to physical exercise and training. In P. Seraganian (Ed.), *Exercise Psychology: The Influence of Physical Exercise On Psychological Processes.* (Chapter 7, pp. 172-217; peer-reviewed book chapter). New York: John Wiley & Sons. ISBN: 978-0-471-52701-5

9. Snowball, J., & **Szabo, A**. (1999). Anxiety, affect and exercise: Preliminary evidence lends support to the Distraction Hypothesis. *Journal of Sport Sciences, 17,* 67-68.

10. **Szabo, A**. (1992). Habitual exercise participation and personality. *Perceptual and Motor Skills, 74,* 978. doi: 10.2466/pms.1992.74.3.978. Retrieved January 2, 2015 from: http://www.amsciepub.com/doi/abs/10.2466/pms.1992.74.3.978

11. **Szabo, A**. (1993). The combined effects of orthostatic and mental stress on heart rate, T-wave amplitude, and pulse transit time. *European Journal of Applied Physiology and Occupational Physiology, 67*(6), 540-544. doi: 10.1007/BF00241651

12. **Szabo, A**. (2000). Physical activity as a source of psychological dysfunction. In S. J. H. Biddle, K. R. Fox & S. H. Boutcher (Eds.), *Physical activity and psychological well-being* (pp. 130-153). London: Routlegde.

13. **Szabo, A**. (2003). The acute effects of humor and exercise on mood and anxiety. *Journal of Leisure Research, 35*(2), 152-162.

14. **Szabo, A**. (2006). Comparison of the Psychological Effects of Exercise and Humor. In M. L. Andrew (Ed.), *Mood and Human Performance: Conceptual, Measurement, and Applied Issues*, (pp. 201-216). New York, NY: Nova Science Publishers.

15. **Szabo, A**. (2014). Sport and exercise psychology research and Olympic success: An analytical and correlational investigation. *European Journal of Sport Science, 14*(3), 273-278. doi: 10.1080/17461391.2013.827241

16. **Szabo, A**., Ainsworth, S. E., & Danks, P. K. (2005). Experimental comparison of the psychological benefits of aerobic exercise, humor, and music. *Humor, 18*(3), 235-246. doi: 10.1515/humr.2005.18.3.235

17. **Szabo, A**., Billett, E., & Turner, J. (2001). Phenylethylamine, a possible link to the antidepressant effects of exercise?. *British Journal of Sports Medicine, 35*(5), 342-343. doi: 10.1136/bjsm.35.5.342

18. **Szabo, A**., Brown, T. G., Gauvin, L., & Seraganian, P. (1993). Aerobic fitness does not influence directly heart rate reactivity to mental challenge. *Acta Physiologica Hungarica, 81*(3), 229-237.

19. **Szabo, A**., & Frenkl, R. (1996). Consideration of research on Internet: Guidelines and implications for human movement studies. *Clinical Kinesiology, 50(*3), 58-65.

20. **Szabo, A**., & Gauvin, L. (1992). Reactivity to written mental arithmetic: Effects of exercise lay-off and habituation. *Physiology and Behavior, 51*, 501-506. doi: 10.1016/0031-9384(92)90171-W

21. **Szabo, A**., Péronnet, F., Boudreau, G., Côté, L., Gauvin, L., & Seraganian, P. (1993). Psychophysiological profiles in response to various challenges during recovery from acute aerobic exercise. *International Journal of Psychophysiology, 14*, 285-294. doi: 10.1016/0167-8760(93)90042-N

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22. **Szabo, A**., Péronnet, F., Frenkl, R., Farkas, A., Petrekanits, M., Mészáros, J.,…Szabó, T. (1994). Blood pressure and heart rate reactivity to mental strain in adolescent judo athletes. *Physiology & Behavior, 56*(2), 219-224. doi: 10.1016/0031-9384(94)90187-2

23. **Szabo, A**., & Tsang, T. C. E., (2003). Motivation for increased self-selected exercise intensity following psychological distress: Laboratory based evidence for catharsis. *Journal of Psychosomatic Research, 55*(2), 133, Abstract. doi: 10.1016/S0022-3999(03)00308-8

24. Trembath, E. M., **Szabo, A**., & Baxter, M. J. (2002). Participation motives in leisure center physical activities. *Athletic Insight: The Online Journal of Sports Psychology, 4*(3), 28-41.

1.0 Background and Aims

The industrial revolution and technological advancement brought substantial changes to human life. The biological laws of evolution were suddenly challenged by major lifestyle changes, making human life increasingly sedentary. To counteract the accumulating health risks and ill effects of sedentary behaviour, regular physical exercise become a recommended component of the daily life. Scientists have realized that only sports and exercise can compensate for the lost physical activity that was previously performed for survival activities (Péronnet & Szabo, 1993). Consequently, a progressively increasing number of people have started to exercise, which slowly became a lifestyle habit, especially among Western white collar workers. While studies in sport psychology, with a view on performance enhancement, have started early in the past century, an increased attention devoted to the effects recreational or leisure exercise could be noticed only in the second part of the 20th century. Initial studies focused on the physiological effects of exercise, like its stress-buffering capacity (Michael Jr., 1957). The psychological work has started later. Martens (1970) wrote about the social psychology of exercise. From this point on, research effort in health and exercise psychology has gradually increased. At the same time, Baekeland (1970) noticed that those accustomed to exercise exhibit severe withdrawal effects at times when exercise is prevented. Glasser (1976) wrote about a positive addiction in the context of exercise, whereas five years later Sachs (1981) recognized a negative and addictive facet of running. Soon it became clear that the much praised exercise behaviour that could save human health, it may also destroy it. These scholastic observations generated an unresolved paradox in exercise behaviour.

The aim of this dissertation is to present, critically evaluate and synthesize the positive and negative facets of exercise behaviour in light of two decades of my personal research. Therefore, the dissertation is organized into three parts. Part one examines mainly the acute psychological effects of exercise by looking at the most widely studied psychological variables, such as affect, mood and anxiety. The acute or the instant effects of exercise are important and rewarding aspects of the behaviour. The instant reward is what plays an important role in motivation and adherence to exercise. While the cumulative effects may play role in a better-equilibrated lifestyle, the acute, or the instant effects are the ones linked to addiction by yielding psychological gratification that is badly missed when the need for exercise cannot be fulfilled. Such feelings of deprivation occur in all regular exercisers, but if they are severe - resulting in psychological hardship - they are known as 'withdrawal symptoms', which are components of addiction. I present a set of studies examining feelings of exercise deprivation, at least three of which were pioneering studies conducted on the Internet, marking the first cross-sectional research in psychology on the Word Wide Web. These studies, focusing on exercise deprivation, are covered in Part two of the dissertation. I show that feelings of deprivation occur on a spectrum, ranging from mild to severe. The former mirrors the commitment to habitual exercise, while the other end of the spectrum may reflect a maladaptive exercise behaviour. In this context, it is another major objective of this dissertation to separate healthy *commitment* to exercise from a pathogenic behaviour, known as *exercise addiction*.

Part three of the dissertation examines exercise addiction, which is a pathogenic behaviour exhibited by only a few exercisers (Mónok et al., 2012; Szabo, 2000, 2010). This scholastic area is perhaps the most misunderstood aspect of exercise psychology. It is the aim of this work to show that studies in exercise addiction, in fact do not assess a pathology. The belief that more and more exercise leads to exercise addiction is simply wrong, because elite athletes demonstrate extreme volumes of training without being addicted to exercise. I highlight that even the 'at risk' categories on questionnaires may not turn into maladaptive forms of exercise. In this context, I present several models for exercise addiction, among which is an interactional model that my colleague and I have recently developed (Egorov & Szabo, 2013). The discussion of the model, in light of several case studies, prompts me to conclude that exercise addiction is a form of *coping* with life stress that cannot be controlled, which is adopted by only a small fraction of the regular exercisers.

I also highlight in the dissertation that excessive exercise behaviour can be observed in a relatively high proportion of the individuals suffering from eating disorders, that is referred to as secondary exercise addiction. However, the addictive aspects of exercise are absent in most eating disorders and exercise is merely used as a means for *weight loss* in addition to dieting and purging, Therefore, excessive volumes of exercise, accompanying eating disorders, are not manifestations of an addiction. Consequently, this dissertation discusses only primary or actual exercise addiction that is defined as a behaviour containing all six components of behavioural addictions, based on the Components Model of Addiction (Griffiths, 2005), that results in significant loss or *negative consequences* to the individual. In lack of negative personal, health, or social consequences, one cannot talk about maladaptive exercise behaviour, regardless of the volume of habitual exercise.

Another major aim of the dissertation is to review and highlight the inconsistencies in the study area of exercise addiction. It is pointed out that research efforts are not focused and that in lack of clinical interviews, supplementing questionnaire-based data, exercise addiction cannot be presumed. The diagnosis of exercise addiction can only be symptom-based, because the DSM V does not contain a unique entry for the disorder within its 'behavioural addictions' category that only encompasses disordered gambling at this time. It is highlighted, that exercise addiction may be a symptom of another psychological disorder augmented by stress or life events that are out of the control of the individual. It is also stressed that a predisposition, as based a research evidence, may facilitate the manifestation of pathology in some people accustomed to regular exercise.

Finally, the dissertation attempts to clarify the paradox about elite athletes' scores, on exercise addiction questionnaires, that are significantly higher than that observed in the general exercising population. It is illustrated that the assessment tools contain statements intended to the measuring of exercise addiction that could be interpreted differently by elite athletes in contrast to the recreational exercisers. Different meanings, complemented by a reflection of commitment and motivation, may raise the scores of elite athletes leading to the erroneous conclusion that they are 'at risk' for exercise addiction. An argument in this context, is intended to reshape the thinking about exaggerated maladaptive behaviour, especially among the elites of the athletic population.

Overall, in this dissertation, I show that even a light and easy short-duration exercise may change the subjective well-being of the person. I present evidence, based on my own and others' research, that exercise intensity (workload) does not play an instrumental role in yielding positive psychological effects. I also differentiate, as clearly as possible, between healthy commitment to exercise and maladaptive exercise behaviour to show that they are two different constructs and to avoid any further confound in the literature. Finally, I stress the point, based on several theoretical models and case illustrations, that exercise addiction as a *psychopathology* cannot be studied with the traditional nomothetic approach, but only through idiographic case studies.

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1.1 Organization of the Dissertation

Due to its highest academic esteem, a dissertation for the title of Doctor of the Hungarian Academy of Sciences, should provide undisputed *evidence* for the significant advancement of the knowledge in the field resulting from the candidate's scholastic contributions. In my view, this objective can be best achieved through a clear focus on the specific subjects within the area of research of the academic person. Therefore, instead of the usual chronological organization and section-based discussion of the research programme, I have organized this dissertation in exercise psychology *thematically* to reflect both the positive and negative psychological facets of exercise behaviour, as well as the critical paradox in a socially valued human behaviour.

The dissertation contains three parts, which are based on 19 publications and 24 other supporting research reports. They are discussing the transition from healthy to morbid exercise behaviour on a continuum. In each of these parts, my studies are embedded within the context of the discussion of the relevant issues, as well as the new questions, emerging from the previous work or a relevant topic. Therefore, more recent research may precede older research. Briefly, a chronological order of presentation is *not* adopted in any of the three parts of this work.

Highlights and case reports that are not directly linked to the main topic, but were carried out in its context, are incorporated in the pertinent section with the aim to present a parallel and/or unique scholastic contribution. An example of such a highlight, is the discussion of the origin of the Internet-based scholastic research, that was initiated in my research program within the field of exercise psychology, specifically, in the subject area of exercise deprivation and addiction. By using such an approach, I do not intend to depart from the main issue(s) under scrutiny, nor do I bifurcate the writing. Instead, I simply emphasize through a case-note that the today so widely adopted Internet-based data collection has originated - at least in part - from my research effort in the understanding of exercise deprivation. Consequently, this highlight simply describes a novel and a feasible means of research in the field Psychology, substantiating an important contribution in the context of my scientific career.

I have adopted this writing organization to match the title of the dissertation as closely as possible and to make the reader aware of the exercise paradox. Of course, where I present early research, the new knowledge emerging in the area is incorporated in the discussion of the actual work. For example, an article that was published in 1996 is complemented with the newly emerging information since that period and the results obtained, then are discussed in relation the current or most up to date knowledge. I sincerely believe, that this logical and thematic structure of writing makes the reading of the dissertation not only easier, but more pleasurable as well.

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Part I.

The Bright Side: Psychological Benefits of Exercise

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2.0 Psychological Effects of Exercise

The bulk of research reveals that physical activity yields numerous health benefits (Bellocco, Jia, Ye, & Lagerros, 2010; Lee et al., 2011; Blair, Kohl, & Barlow, 1993; Powell & Blair, 1994). There is also scholastic evidence linking regular exercise and/or sport with positive mental well-being (Biddle, 1995; Biddle, Fox, & Boutcher, 2000; Biddle & Mutrie, 2001; Brown, Mishra, Lee, & Bauman, 2000; Tseng, Gau, & Lou, 2011) as well as lower psychophysiological reactivity to psychosocial stress (Norris, Carroll, & Cochrane, 1990, 1992; Rosenfeldt et al., 2011; Stein & Boutcher, 1992). The acute psychological benefits of exercise on various measures of affect and state anxiety are consistently demonstrated in the literature (Anderson & Brice, 2011; Berger & Motl, 2000; Biddle & Mutrie, 2001; Dasilva et al., 2011; Fontaine, 2000; Hoffman & Hoffman, 2008; O'Connor, Raglin, & Martinsen, 2000; Paluska & Schwenk, 2000; Raglin, 1990; Szabo, 2003a,b). Since even a single bout of acute exercise yields instant psychological benefits, it may be conceived as a suitable non-pharmaceutical antidote to life-stress and various mood dysfunctions, in addition to other physical health benefits. It is not surprising then that the American College of Sports Medicine (ACSM) has launched the "Exercise is Medicine" program initiative (Jonas & Phillips, 2012) to make physical exercise part of both prevention and treatment of various morbidities. The mental benefits of chronic and acute exercise are the most prominent on various measures of affect and anxiety (Asmundson et al., 2013; Berger & Motl, 2000; Biddle & Mutrie, 2001; Fontaine, 2000; O'Connor et al., 2000; Paluska & Schwenk, 2000; Raglin, 1990; Scully, Kremer, Meade, Graham, & Dudgeon, 1998). Affect is an expression of emotion attached to ideas or mental representations of events (Russell, 2003). Acute improvements in affect and perceived well-being are evident even after only three minutes of very light exercise (Szabo, Gaspar, & Abraham, 2013a). Consequently, a single bout of physical exercise may be considered as a potential buffer of the hassles and challenges experienced in the everyday life. All the psychological benefits take place in addition to overcoming the ill physical effects of the increasingly sedentary contemporary lifestyle.

2.1 Theories and Models Accounting for the Psychological Benefits of Exercise[1]

There are several explanations for the psychological benefits of physical exercise. Clearly, the models and theories forwarded for this purpose may not be independent of each other. Based on the current knowledge, it is most plausible that in function of the dynamic interaction between various individual characteristics and environmental factors, a combination of the theories may jointly account for the most valid explanation. The theories known to date may be segregated into physiological and psychological models. The first is often based on a dose-response relationship serving a common denominator for these models, while the latter is more divergent. Below, I present a brief summary of the known popular explanations forwarded for the psychological benefits of physical exercise.

[1] *Based on: **Szabo, A.,** Griffiths, M.D. & Demetrovics, Zs. (2013c). Psychology and exercise. In Bagchi, D, Nair, S. & Sen, C.K. (Eds.) Nutrition and Enhanced Sports Performance (Chapter 6, pp. 65-73;). New York, NY: Academic Press. ISBN: 978-0-12-396454-0*

2.1.1 Physiological models

2.1.1.1 The "Sympathetic Arousal Hypothesis"

Nearly thirty years ago, Thompson and Blanton (1987) proposed a "Sympathetic Arousal Hypothesis" on the basis of physiological knowledge that habitual or regular physical exercise, especially aerobic exercises like running, if performed for a sustained period, results heightened sympathetic nervous system activity. This activated state causes a rise in the concentration of various neurochemicals, like norepinephrine and serotonin, and possibly the secretion of beta-endorphins yielding a pleasant cognitive feeling state that is analogous to euphoria. Experimental evidence supports this hypothesis, especially in consideration of changes in heart rate measures. While heart rate is only a crude measure of the body's sympathetic activity (which is directed by the autonomic nervous system), it is, nevertheless, a sensitive measure and it is often used to mirror sympathetic activity. A lower resting heart rate after training results from the adaptation of the body to exercise (Rahnama, Nouri, Rahmaninia, Damirchi, & Emami, 2010). With repeated exercise the person develops a more efficient cardiovascular system characterized by a lower resting heart rate, lower sympathetic activity in general, and lower arousal at rest. This new state of arousal may induce relaxation, a sense of tranquility, and positive engagement in the exerciser (Gauvin & Rejeski, 1993). It is also common sense that after sustained effortful contraction of the muscles the halt of the exercise results in physical relief that is accompanied by mental relief too.

2.1.1.2 The "Thermogenic Regulation Hypothesis"

A thermogenic model is based on physiological evidence that physical exercise increases body temperature. A warm body temperature induces a relaxing state with concomitant reduction in anxiety (similar to sun tanning, Turkish or Haman bath, or any warm bath, and sauna effects). Therefore, physical exercise reduces anxiety (De Vries, 1981; Morgan & O'Connor, 1988) via an increased state of physical relaxation. Lower levels of anxiety and states of relaxation are positive reinforcers in exercise behaviour. A relaxed body relaxes the mind and yields a positive psychological feeling state. A certain "dose" (workload) of exercise may be necessary to induce a sufficient increase in body temperature that could generate a relaxation effect after exercise.

2.1.1.3 The "Cardiovascular Fitness Hypothesis"

The Cardiovascular Fitness Hypothesis suggests that adaptations are taking place in the vascular system and the heart in response to repeated habitual exercise, which results in a more efficient cardio-respiratory system. This adaptation is manifested in a decreased cardiovascular response to physical exertion, that also translates into a decreased cardiovascular response to psychosocial stress (Péronnet & Szabo, 1993). Moreover, greater physical fitness may yield better overall mood as well. This hypothesis is supported by limited research evidence showing that relative increases in cardiovascular or aerobic fitness and regular exercise are dose-dependently linked to increased psychological well-being, more positive mood, and even lower depressive symptoms in both genders (Silverman & Deuster, 2014).

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2.1.1.4 The "Monoamine Hypothesis"

This hypothesis is derived from the early observation that exercise triggers an increase in the levels of catecholamines in the peripheral blood circulation (Cousineau et al., 1977). Later, Szabo, Billett and Turner (2001) showed that a 30 minute bout of moderate to high intensity aerobic exercise could increase uric phenylacetic acid levels - reflecting phenylethylamine concentration - in healthy males who were habituated to exercise. While catecholamines, among other functions, are involved in the stress response, phenylethylamine is more closely linked to changes in mood. In light of the monoamine hypothesis, it is speculated that in addition to a notable increase in monoamines in the peripheral circulation, the central aminergic activity may be simultaneously and pararelly altered by exercise. Because central monoamine levels are involved in the regulation of mood and affect, while they also play an important role in mental dysfunctions like depression, the alteration of monoamines by exercise seems to be an attractive explanation. To date, however, there is inconclusive evidence to this surmise. Indeed, it is unclear whether the peripheral changes in monoamines have an effect on the brain's aminergic activity or vice versa. Furthermore, changes in brain monoamine levels during exercise in humans are unknown, because direct measurement in the human brain is not possible.

2.1.1.5 The "Endorphin Hypothesis"

This model is attractive and relatively popular in the literature, because it is connected to the “runner’s high” phenomenon (discussed later in this section). The surmise behind the model is that exercise leads to increased levels of beta-endorphins in the brain, which act as internal psychoactive agents yielding a feeling of euphoria. In fact, this hypothesis may be analogous to substance or recreational drug addiction (e.g., heroin, morphine, etc.) with the exception that the psychoactive agent (beta-endorphin) is generated internally during exercise instead of being administered from the outside. Endogenous opioids are involved in modulating several of the sensory, motivational, emotional, and mental functions (McNally & Akil, 2002). Recent evidence lends tentative support to the opioid hypothesis. A novel investigation, using positron emission tomography (PET), found that acute exercise - performed between aerobic and anaerobic threshold for 60 minutes - has resulted in an increase in the availability of μ-opioid receptors in anterior cingulate cortex, prefrontal-, and temporal cortex of young healthy recreational exercising men (Saanijoki et al., 2014). While further research is this area is definitely needed, the opioid response to exercise is likely to be workload- or dose-dependent in addition to individual variability.

2.1.2 Psychological models

2.1.2.1 The "Cognitive Appraisal Hypothesis"

I have proposed an early psychological model based on the "Appraisal Theory" (Lazarus & Folkman, 1984) two decades ago (Szabo, 1995). According to this explanation, in concordance with behaviouristic theories, habitual exercisers workout to *gain something* positive and to be rewarded as a result of their physical effort, or alternatively, to *avoid something* that is unpleasant, like stress or any other form of psychological hardship (Morris, 1989). People engage in exercise in accord with the interpretation of their life conditions, and emerging motivations, at any given time. The pleasant psychological feeling after exercise is interpreted as: "exercise is good for me". (This interpretation is reinforced by both the popular and the scientific media.) At times of stress, this explanation may be adopted to deal with the hardship. Indeed, the positive effects of exercise may be perceived as a buffer for life-stress. Therefore, using cognitive strategies, exercise initially used for gaining fitness- or health-benefits may turn into a means of coping with adversity when the life circumstances induce changes in the cognitive (subjective) strategies and motivations.

2.1.2.2 The "Affect Regulation Hypothesis"

The Affect Regulation Hypothesis posits that exercise has a dual effect on mood and well-being. First, it increases positive affect (also defined as a momentary psychological feeling state of somewhat longer duration than a momentary emotion) and, therefore, contributes to an improved general mood state (defined as prolonged psychological feeling state lasting for several hours or even days). Second, exercise decreases negative affect and, therefore, contributes to the improved general mood state (Hamer & Karageorghis, 2007). There are several additional aspects to affect-regulation during exercise. For example, outdoor stimuli, music, an exercising partner or social setting all could modify the subjective state of affect. Negative factors could impede the expected positive regulation. Bad or unavailable equipment, weather, unpleasant instructor or co-exercisers, technical problems and the like, may act as inhibitors of the desired positive state of affect.

2.1.2.3 The placebo model

Not long ago, I have proposed a role for the placebo effect in triggering the psychological benefits of exercise (Szabo, 2013). I have pinpointed that there is now growing evidence that the acute psychological effects of exercise cannot be explained solely by physiological mechanisms. Perhaps a strongly plausible mechanism, that may explain the benefits reported even after a very short duration of exercise (Szabo et al., 2013a), may be linked to the placebo effect. I have also admitted that physiological adaptations and placebo effects may jointly contribute to the acute mental benefits of exercise. The latter, based on the strength of expectancy- and/or conditioning-effects due to past exercise experience and learning, may vary among individuals. Consequently, the mediators of the psychological benefits of exercise, in addition to the physical effects, may involve one's expectation and past conditioning. Accordingly, the placebo effect may be, at least in part, responsible for psychological improvements observed after a single bout of exercise.

2.1.2.4 The "Distraction Hypothesis"

The Distraction Hypothesis suggests that physical exercise or similar recreational activities serve as a time-out from the core activities of the everyday life (Leith, 1994; Snowball & Szabo, 1999). More precisely, the model suggests that distracting activities may represent a means of coping either with adversity, stress, and depression, or simply yield a pleasant and reliving change from the survival activities and the routuine in the daily life. This is a recreational or leisure model subscribing to the idea that a positive break brings about positive psychological changes.

2.1.2.5 The "Self-efficacy Hypothesis"

It is known that regular physical exercise improves self-efficacy (McAuley, Courneya, & Lettunich, 1991). Self-efficacy is defined as the belief that a person possesses the necessary skills and abilities to complete a given task or to deal with an imposed demand. It also incorporates the knowledge, appraisal, or level of confidence that the task or the challenge can be addressed in such a way that a positive or a targeted result could be achieved. Physical exercise is viewed as an effective way through which self-efficacy can be improved. Its effectiveness is ascribed to the mastery experience resulting from learning and practice. The psychological feelings associated with self-efficacy are positively linked to people's psychological well-being (Strobel, Tumasjan, & Spörrle, 2011).

2.2 The "Runners' High" Phenomenon; A Link to the Psychological Effects of Exercise

> *"I believe in the runner's high, and I believe that those who are passionate about running are the ones who experience it to the fullest degree possible. To me, the runner's high is a sensational reaction to a great run! It's an exhilarating feeling of satisfaction and achievement. It's like being on top of the world, and truthfully... there's nothing else quite like it!"*

Sasha Azevedo source: http://www.lazyrunner.com/motivational-running-quotes
(The quotation is on the bottom of the web page; retrieved January 12, 2015)

For many years, marathon runners, long distance joggers, and even recreational runners reported a subjective feeling state of strong euphoria buffering the fatigue and pain of physical exertion caused by very long sessions of exercise. This euphoria triggers a sensation of almost "flying", automatic and effortless movements, and has become a target referred to as "the zone" (Goldberg, 1988). The genuine existence of the runner's high is subject of heated debate in the scholastic circles. The question is whether a biochemical explanation for the runner's high exists, or it is an anecdotal - folks-conceptualized and popularized - terminology. Runners (and most, if not all, habitual exercisers) experience a sort of deprivation sensation or withdrawal symptoms when their exercise is prevented. The symptoms include guilt, irritability, anxiety, and other unpleasant feelings (Szabo, 1995). Research showed that the human body produces its own opiate-like peptides, called endorphins, and having a chemical structure similar to morphine, these peptides could cause dependence (Farrell, Gates, Maksud, & Morgan, 1982) and, consequently, may be at the route of withdrawal symptoms. In general, endorphins are known to be responsible for pain and pleasure responses in the central nervous system. Morphine and other exogenous opiates bind to the receptors of the endogenous opioids or endorphins. Since morphine's analgesic

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and euphoric effects are well documented in the literature, a comparable effect resulting from endogenous endorphins could be anticipated (Sforzo, 1988).

Research was conducted to examine the effects of aerobic fitness levels, gender, and exercise intensity on endogenous opioid – mainly beta-endorphin – production during cycling, running on a treadmill, participating in aerobic dance, and running marathons. Biddle and Mutrie (1991) reported research results showing that aerobic exercise could cause beta-endorphin levels to increase fivefold as compared to pre-exercise baseline levels. Fitness levels of the research participants appear to be irrelevant as both trained and untrained individuals experience an increase in beta-endorphin levels, although the metabolism of beta-endorphins appears to be more efficient in the trained athletes (Goldfarb & Jamurtas, 1997).

Goldfarb et al. (1998) researched gender-related responses in beta-endorphin production during exercise. Their results could not reveal gender-differences in beta-endorphin response to exercise. Other studies have demonstrated that both exercise intensity and duration are factors in increasing beta-endorphin concentrations. For example, the exercise needs to be performed at above 60% of the individual's maximal oxygen uptake (VO_2 max; Goldfarb & Jamurtas 1997) and for at least three minutes (Kjaer & Dela, 1996) to detect changes in endogenous opioids.

The researchers have further explored these findings by looking at the correlation between the exercise-induced increase in beta-endorphin levels and mood changes using the Profile of Mood States (POMS) inventory (Farrell et al., 1982). The POMS was administered to all participants before and after their exercise session. Respondents gave numerical ratings to five negative categories of mood (tension, depression, anger, fatigue and confusion) and one positive category (vigour). Adding the five negative affect scores and then subtracting from the total the vigour score yields a "total mood disturbance" (TMD) score. In Farrell's study the TMD scores improved by 15 and 16 raw score units from the baseline, after subjects exercised at 60% and 80% VO_2 max. Quantitatively, mood improved around 50%, that corresponds to clinical observations in which people's moods are elevated after vigorous exercise workouts. Farrell et al. (1982) using radioimmunoassay also observed two- to fivefold increase in peripheral plasma beta-endorphin concentrations from pre- to post-exercise.

However, Farrell et al.'s research is inconclusive. First, only six well-trained endurance athletes were studied and the six showed large individual variations in beta-endorphin response to submaximal treadmill exercise. Second, the exercise-induced changes in mood scores were not statistically significantly different between pre- and post-exercises scores. Third, no significant relationship between mood measures, obtained with the POMS inventory, and plasma beta-endorphin levels were found. Therefore, the obtained results cannot prove conclusively that beta-endorphins cause mood elevations. A more questionable issue, however, also recognized by Farrell et al., is that the beta-endorphin measures in the experiment come from plasma - which means that this type of beta-endorphin is generated in the peripheral circulation. Because of its chemical makeup, beta-endorphin cannot cross the Blood Brain Barrier (BBB). Hence, plasma beta-endorphin fluctuations do not reflect beta-endorphin fluctuations in the brain. Some researchers have speculated that endogenous opiates in the plasma may act centrally and, therefore, can be used to trace CNS activity (Biddle & Mutrie, 1991). At this time, such a model concerning beta-endorphins could only rely on circumstantial evidence that met-enkephalin and dynorphin, two opioids, which show a modification mechanism that could possibly transport them

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across the BBB (Sforzo, 1988). Unfortunately, direct measurement of changes in brain beta-endorphins involves cutting open the brain and doing radioimmunoassay on brain slices. However, a novel study, using positron emission tomography (PET), provides promising evidence for adaptation in the opioid receptors during exercise. Saanijoki et al. (2014) found that acute cycling exercise - performed between aerobic and anaerobic threshold for 60 minutes - triggered an increase in the availability of μ-opioid receptors in anterior cingulate cortex, prefrontal- and temporal cortex of young healthy recreational exercisers. Further, earlier animal studies, using rats, have shown an increase in opioid receptor binding following physical exercise (Sforzo, Seeger, Pert, Pert, & Dotsen, 1986).

In humans, to work around this problem, scholars proposed that naloxone could be useful in testing whether beta-endorphins played a role in CNS-mediated responses like euphoria and analgesia. Since naloxone is a strong opioid receptor antagonist, it competes with beta-endorphin to bind the same receptor. Thus, injection of naloxone into humans should negate the euphoric and analgesic effects produced by exercise, if beta-endorphin perpetrates such effects indeed. It was found that naloxone decreased the analgesic effect reportedly caused by runner's high, but other researchers who conducted similar experiments remain divided in opinion about these results. As for naloxone's effects on mood elevation, Markoff, Ryan and Young (1982) observed that naloxone *did not* reverse the positive changes in mood induced by exercise.

Mounting evidence demonstrates that beta-endorphins are not necessary for the euphoria experienced by exercisers. Harte, Eifert and Smith (1995) noted that although exercise produces both positive emotions and a rise in beta-endorphin levels, the two are not necessarily connected. Indeed, physically undemanding activities like watching humour or listening to music produce identical elevations in mood to exercise (Szabo, 2006; Szabo, Aisnsworth, & Danks, 2005), although accompanying elevations in beta-endorphins could not be observed after humour (Berk et al., 1989) or music (McKinney, Tims, Kumar, & Kumar, 1997). Similarly, Harte et al. (1995) found that both running and meditation resulted in significant positive changes in mood. In addition to taking mood measures, Harte et al. (1995) have also measured plasma beta-endorphin levels of the participants. As expected, those in the meditation group did not show a rise in beta-endorphin levels in spite of reported elevations in mood. Such results seem to further question the link between mood improvement and changes in beta-endorphin levels after exercise.

Answering the improved mood and increased beta-endorphin level connection question inversely, experiments were carried out in which beta-endorphin was directly injected into the bloodstream of healthy participants. The results failed to show any changes in mood (Biddle & Mutrie, 1991). On the other hand, beta-endorphin injections had a positive effect on clinically depressed patients (Biddle & Mutrie, 1991). Further, electroconvulsive therapy, used to treat patients with depression, also increased plasma b-endorphin levels.

The lack of beta-endorphin release during meditation and the lack of mood alteration after beta-endorphin injection, call for attention on factors that influence beta-endorphin levels. In an effort to consolidate peripheral beta-endorphin data with the central nervous effects, researchers have realized that the peripheral opioid system requires further investigation. Taylor et al. (1994) proposed that exercise-induced acidosis is the actual trigger of beta-endorphin secretion in the bloodstream. Their results showed that blood pH level strongly correlated with the beta-endorphin levels (acidic conditions raise the concentration of b-endorphin, buffering the blood attenuates this response). The explanation behind such observations is that acidosis increases respiration and stimulates a feedback inhibition mechanism through beta-endorphins. The latter interacts with neurons responsible for respiratory control, and beta-endorphin, therefore, serves the purpose of preventing hyperventilation (Taylor et al., 1994). How then is this physiological mechanism connected to CNS-mediated emotional responses? Sforzo (1988) noted that since opioids have inhibitory functions in the CNS, if a system is to be activated through opioids at least one other neural pathway must be involved. Thus, instead of trying to establish how peripheral amounts of beta-endorphin act on the CNS, researchers could develop an alternate physiological model demonstrating how the emotional effects of opioids may be activated through the inhibition of the peripheral sympathetic activity (Sforzo, 1988).

While the "runner's high" phenomenon may hardly be empirically established as a fact and beta-endorphins' role in this event is questionable, other studies have shown how peripheral beta-endorphins affect centrally-mediated behaviour. Electro-acupuncture used to treat morphine addiction by diminishing cravings and relieving withdrawal symptoms, caused β-endorphin levels to rise (McLachlan, Hay, & Coleman, 1994). Since exercise also increases beta-endorphin levels in the plasma, McLachlan et al. (1994) investigated whether exercise could lower exogenous opiate intake. Rats were fed morphine and methadone for several days and then randomly divided into two groups of exercisers and non-exercisers. At that time, voluntary exogenous opiate intake was recorded to see if the exercise would affect the consumption of opiate in exercising rats. The results showed that while opiate consumption has increased in both groups, exercising rats did not consume as much as non-exercising animals and the difference was statistically significant (McLachlan et al., 1994). These findings suggested that exercise decreases craving.

In conclusion, the connection between beta-endorphins and runner's high is an elegant explanation without sufficient empirical support at this time. It is likely that the intense positive emotional experience, to which athletes, runners, and scientists refer as runner's high, is evoked by several mechanisms acting jointly. In a study carried out about ten years ago, I have shown that while exercise and humour are equally effective in decreasing negative mood and increasing positive mood, the effects of exercise last longer than that of humour (Szabo, 2006). These results may serve as evidence for the involvement of more than one mechanism in mood alteration after physically active and inactive, or relatively passive, interventions.

2.3 Investigation of the Psychological Effects of a Single Bout of Exercise

2.3.1 Investigating the affective benefits generated by different forms of exercise[2]

While numerous studies have examined the acute or immediate psychological benefits of physical exercise, early research results were largely equivocal (Tuson & Sinyor, 1993). The main reason for the controversy was linked to highly heterogeneous exercise characteristics manifested in different exercise modalities, intensities and durations. Further, it was speculated that the used instruments could not gauge reliably the effects of a single bout of physical exercise on subjective

[2]*Based on: **Szabo, A**., Meskó, A., Caputo, A., & Gill, É. (1998b). Examination of exercise-induced feeling states in four modes of exercise. International Journal of Sport Psychology, 29, 376-390.*

feeling states (Gauvin & Rejeski, 1993), because they were not specific to exercise behaviour. In response to this dilemma, two questionnaires aimed at the assessment of subjective feeling states specifically attributable to acute exercise, were developed simultaneously by two independent groups of researchers. The first instrument is the Exercise-Induced Feeling scale (EFI), developed by Gauvin and Rejeski (1993), and the second tool is the Subjective Exercise Experience Scale (SEES), developed by McAuley and Courneya (1994). These instruments were claimed to be highly specific to exercise, because they were generated on the basis of a broad spectrum of subjective reports describing psychological states associated with physical activity.

Having two psychometrically validated instruments at hand, it was of interest to examine the psychological effects of exercise in various forms of exercise. Previous reports suggested that the psychological benefits of acute exercise may vary across different modes of exercise (Berger & Owen, 1992; Berger & Owen, 1988; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991) despite of the fact that mainly runners (Bahrke & Morgan, 1978; Morgan, 1979) and general aerobic exercisers (LaFontaine et al., 1992) were studied. Therefore, given that earlier studies investigated primarily the psychological effects of aerobic forms of exercise (Tuson & Sinyor, 1993), there was a significant theoretical and applied-research incentive to investigate how other forms of exercise compare with aerobic workouts.

To address the issue, my colleagues and I have devised a study to investigate the role of the mode (form) of exercise. We tested the affective benefits - using the relatively new exercise-specific tools - in four different forms of exercises and a control group: 1) aerobic (aerobic dance), 2) anaerobic (weight training), 3) mixed aerobic and anaerobic (martial arts), and 4) low-physical-exertion (tai-chi and Hatha yoga). A no-exercise control group, engaged in music appreciation, was also tested. Given that the characteristics of these exercises differed, we hypothesized that the groups will exhibit different psychological outcomes following their workout. This cross-sectional field study was the first to address the acute exercise-specific psychological feeling states after four different forms of exercise, and not only immediately following exercise, but also three hours after the exercise, because we were interested in the persistence of the positive changes (if any) in context of the exercise modality.

2.3.1.1 Materials and methods

2.3.1.1.1 Participants. We recruited regularly exercising individuals from athletic facilities serving primarily college communities in Montreal metropolitan area. The potential participants were approached only after obtaining consent for support and collaboration from the respective exercise or sporting authority of the targeted facilities. All participants were volunteers. Incentive for participation, was the provision of individual feedback for those who were interested in their personal results. Participating volunteers were from aerobic (dance-exercise), anaerobic (weight training), mixed aerobic and anaerobic (martial arts), and low-physical-exertion (tai-chi and Hatha yoga) exercise classes. All physical activities were performed at moderate levels of effort to accommodate both beginner and advanced practitioners. A control group was also tested. Initially 195 individuals (104 males, mean age = 28 years (standard deviation (SD) = 9.1), and 91 females, mean age = 29.9 years (SD = 11.9)) volunteered for the study. They completed the EFI and SEES on two occasions (immediately before and after exercise). A total of 128 participants, forming the

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final sample, completed the scales on a third occasion as well (three hours after the exercise; a return rate of 66%). Characteristics of the final sample are presented in Table 2.1.

2.3.1.1.2 Materials. The Exercise-Induced Feeling Inventory (EFI; Appendix A - Gauvin & Rejeski, 1993) is based on 12 adjectives. The items are rated on a 5-point scale from zero (0) to four (4), where zero stands for "do not feel at all" and four stands for "feel very strongly". The 12 items capture four, presumably distinct, feeling states: revitalization, tranquillity, positive engagement, and physical exhaustion (Gauvin & Rejeski, 1993). Revitalization includes items like "refreshed" or "revived" and refers to psychobiological changes stemming from exercise that produce some invigorating effects. Tranquillity refers to post-exercise calmness, lessened anxiety, peace of mind and contains items like "peaceful" or "relaxed". Positive engagement contains adjectives like "happy" or "enthusiastic" and it is aimed at measuring positive changes in affect. Physical exhaustion is aimed at measuring sensations of fatigue related to exercise and contains adjectives like "tired" or "worn-out" (for a more thorough description of the conceptualization of the subscales refer to Gauvin and Rejeski (1993)). The internal consistencies of the items forming the subscales range from .72 to .91 and the concurrent and discriminant validity of the EFI was reported to be good in relation to the Positive Affect and Negative Affect Schedule (PANAS - Watson, Clark, & Telegan, 1988) and the Activation Deactivation Adjective Check List (ADACL - Thayer, 1989).

The Subjective Exercise Experience Scale (SEES; Appendix B - McAuley & Courneya, 1994) is also a 12 item rating scale. In contrast to EFI, the SEES is rated on a 7-point scale, ranging from one (1) to seven (7), where one is "not at all", four is "moderately" and seven is "very much so". Another distinction from EFI is that SEES has only three subscales aimed at gauging of positive well-being, psychological distress, and fatigue. Positive well-being is meant to trap positive states of affect in relation to exercise and contains items like "great" or "terrific". The psychological distress subscale is aimed at gauging negative mental states and includes items like "crummy" or miserable". The fatigue subscale is intended to measure feelings of exhaustion, similar to the exhaustion subscale of the EFI, and contains items like "tired" or "exhausted" (a comprehensive description of the subscales' conceptualisation can be found in McAuley and Courneya (1994)). The internal consistencies of the three subscales were ranging from .84 to .92. Concurrent and discriminant validity of the SEES was good in relation to PANAS, Spielberger State Anxiety Inventory (SSAI), and the Feeling Scale (FS - Hardy & Rejeski, 1989).

We used the Rate of Perceived Exertion Scale (RPES - Borg, 1983) to assess perceived physical work reported after exercise by subjects in the four exercise groups. This instrument was used only to ascertain that the so designated low- and no-physical-exertion groups were indeed different from the other three exercise groups. However, assessment of perceived exertion was also useful in determining whether changes in subjective feeling states, following exercise, may be related to the perceived intensity of the exercise bout.

2.3.1.1.3 Procedure. All testing was performed in the winter season in the subjects' usual activity setting. To reduce the effects of circadian fluctuations in affect, samplings were performed in the afternoon and early evening when affect is relatively stable (Clark, Watson, & Leeka, 1989). Participants were tested on three occasions: 1) within five minutes before exercise, 2) within five minutes after exercise, and 3) three hours after exercise. Subjects in the music appreciation group listened to classical or new age music in a concert hall. All the activities, including music

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appreciation, were performed on an individual basis in a social setting (i.e., all participants in all five activities were doing the same thing alone but simultaneously with others). The field activities were comparable in duration, ranging from 60 to 75 minute workouts or music listening.

Prior to their activity, consenting volunteers were given the EFI and SEES on the same form, but in a counterbalanced order. Consequently, half of the subjects completed the EFI first and SEES second, while the other half completed the scales in the reverse order. After exercise or music, participants completed the EFI and SEES again. Only at this time, subjects also completed the RPES. After this stage, subjects were given a pre-addressed stamped envelope, containing the EFI and the SEES, and were asked to complete the scales, once again, three hours later and return them by mail. Reminder tips were provided to subjects, including the request to set their alarm wrist-watch (if wearing one) for the opted time, to maximize the return rate of the questionnaires. Participants were told that they should not complete the scales if they forgot to complete them within the ten minutes of the targeted three hours post-exercise period.

2.3.1.1.4 Data analysis. All data analyses were performed with the Statistical Package for Social Sciences (SPSS) software using a personal computer (PC). Initially the data were manually coded, verified and then entered into a Microsof Excel file, which was imported in the SPSS program and subsequently saved as an SPSS data file. Univariate - group by period - repeated measures analyses of variances (ANOVA) were used. For these analyses the Greenhouse-Geisser (G-G) corrected probability level was adopted and their alpha (α) level was corrected according to the Bonferroni method (i.e., $\alpha = .05$ was divided by 7 (number of univariate tests) which called for a new α level of .007). Where applicable, Tukey's Honestly Significant Difference (HSD) post-hoc test was also employed. Within group differences between the various means were assessed with dependent t-tests. Although these tests were pre-planned, their α level was corrected by using the Bonferroni method for multiple tests (Wilkinson, 1989) and set to $\alpha = .003$. Effect sizes (ES = (d) - Cohen, 1969) were also calculated according to the pooled standard deviation method (Hedges & Olkin, 1985). According to Cohen (1969) an effect size that is around 0.2 reflects negligible or very minor differences. An effect size around the value of 0.5 divulges moderate differences. Effects sizes reaching the value of 0.8 or over represent large differences between the compared data sets.

2.3.1.2 Results

2.3.1.2.1 Subject characteristics. An ANOVA revealed that the five groups differed in age ($F(4,121) = 5.0$, $p < .01$), and in the amount of reported weekly exercise ($F(4,118) = 5.7$, $p < .01$). Tukey's HSD tests revealed that subjects in the martial arts group (Table 2.1) were younger than subjects in the music appreciation group (HSD = 11.5, $p < .01$), and than subjects in the tai-chi and Hatha yoga group (HSD = 8.6, p <. 05). Subjects in the aerobic group were significantly younger than subjects in the music appreciation group (HSD = 8.8, $p < .05$). In terms of the reported weekly exercise, subjects in the martial arts group reported exercising more hours per week than subjects in the aerobic group (HSD = 3.1, $p < .05$), and participants in the music appreciation (HSD = 4.8, $p < .01$) group.

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Table 2.1. Subject characteristics (means and standard deviations in parenthesis).

Group	Gender	n	Age (yrs)	Height (cm)	Weight (kg)	Exercise (hr/wk)
Aerobic	Males	3	33.3(8.4)	177.0(1.7)	71.3(11)	4.2(0.3)
(aerobic dance)	Females	24	26.4(9.4)	158.1(35.2)	59.3(9.5)	5.1(3.4)
Anaerobic	Males	18	31.2(9.7)	176.3(7.2)	73.5(10.4)	6.1(3.4)
(body-building)	Females	10	25.8(9.6)	165.1(6.6)	57(5.6)	6.0(3.0)
Mixed	Males	24	24.9(4.9)	177.3(5.4)	79.9(9.7)	8.7(4.6)
(martial arts)	Females	4	22.0(3.6)	169.5(6.7)	63.5(5.5)	4.1(1.3)
Low-Exertion	Males	4	29.3(7.4)	181.5(4.4)	83.0(18.7)	8.0(3.6)
(tai-chi/yoga)	Females	17	33.9(11.4)	168.0(6.3)	62.9(14.5)	5.0(4.2)
Control	Males	14	29.8(12.3)	178.1(9.7)	67.2(8.1)	2.8(2.2)
(music listening)	Females	10	44.6(14.2)	160.4(7.7)	62.1(7.4)	4.4(2.2)
All groups	Males	63	28.5(8.9)	177.4(6.9)	75.1(11.3)	6.4(4.3)
(final sample)	Females	65	30.1(12.5)	162.9(22.2)	60.7(10.3)	5.1(3.3)

2.3.1.2.2 Rate of Perceived Exertion Following Exercise. An ANOVA on RPES showed that the four exercise groups were different in terms of perceived exertion ($F(3,95) = 10.4$, $p < .001$). As conceived in the design, participants in the low-physical-exertion exercise group, who performed either tai-chi or Hatha yoga, reported less physical exertion during exercise than subjects in the other three groups (HSD = 1.44, $p < .001$, vs. the aerobic group; HSD = 1.67, $p < .001$, vs. the anaerobic group; and HSD = 1.89, $p < .001$, vs. the martial arts group).

2.3.1.2.3 Exercise-Induced Feeling Inventory. For positive engagement (POE), the ANOVA yielded a significant "period" main effect ($F(2,242) = 16.9$, G-G $p < .001$), but no interaction. t-tests showed that the increase in PE from pre- to five minutes post-exercise was significant ($t(19) = -5.5$, $p < .001$) in the tai-chi/Hatha yoga group only (Table 2.2 and ESs are shown in Table 2.3). Three hours after exercise PE scores of the latter group were still higher than pre-exercise, but they did not reach corrected level of significance ($t(19) = -3.3$, $p < .004$; Bonferroni correction: α=.003).

The repeated measures ANOVA for the revitalization (REV) yielded a significant main effect for the period ($F(2,246) = 42.7$, G-G $p < .001$) and a group by period interaction ($F(8,246) = 2.9$, G-G $p < .005$). The analysis of the interaction revealed that before exercise subjects in the tai-

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chi and yoga group scored lower on the REV subscale than participants in the music appreciation group (HSD = .86, $p < .05$). At five minutes and 3 h after exercise group differences were absent. Increases on the REV subscale scores, from pre- to post-exercise, were observed in all four exercise groups ($t(26) = -4.2$, $p < .001$, aerobic; $t(27) = -4.1$, $p < .001$, weight training; $t(27) = -3.2$, $p < .003$, martial arts; $t(20) = -10.3$, $p < .001$, tai-chi and yoga), but not in the music appreciation group (Tables 2.2 & 2.3). While REV scores in the tai-chi and yoga group decreased from five minutes post-exercise to 3 h post-exercise ($t(20) = 4.0$, $p < .001$), at 3 h post-exercise their REV values were still higher than before exercise ($t(20) = -5.0$, $p < .001$).

Table 2.2. Means and standard deviations reflecting data obtained on the various subscales of the EFI and SEES under three sampling conditions: 1) before exercise (Pre-), 2) five minutes after exercise (5-min), and 3) three hours after exercise (3-h).

GROUP		PE[1]	REV[1]	WB[2]	EXH[1]	FATIG[2]	DISTRE[2]	TRQ[1]
Aerobic	Pre-	2.2(1.2)	1.7(1.3)	4.3(1.5)	1.9(1.2)	3.1(1.9)	2.4(1.4)	2.2(1.0)
	5-min	2.9(1.0)	2.8(1.0)	5.2(1.4)	1.6(1.3)	3.0(1.5)	1.5(0.9)	2.6(1.0)
	3-h	2.3(1.2)	2.1(1.3)	4.5(1.5)	1.8(1.3)	3.3(1.7)	1.7(1.0)	2.6(1.0)
Anaerobic	Pre-	2.3(1.1)	1.8(1.3)	4.4(1.4)	1.6(1.2)	2.8(1.6)	2.2(1.4)	2.2(1.2)
	5-min	2.8(0.9)	2.9(0.8)	5.4(1.1)	1.3(0.9)	2.7(1.2)	1.4(0.6)	2.5(1.0)
	3-h	2.4(0.8)	2.5(1.0)	4.8(1.0)	1.7(1.1)	3.1(1.6)	1.7(0.8)	3.1(0.9)
Martial	Pre-	2.6(0.8)	2.0(0.8)	4.6(1.2)	1.3(1.1)	2.3(1.3)	1.7(0.9)	2.7(0.9)
Arts	5-min	2.8(0.9)	2.5(0.8)	5.2(1.3)	1.7(1.0)	3.2(1.5)	1.7(1.1)	2.6)1.0)
	3-h	2.6(0.9)	2.2(0.8)	4.9(1.2)	1.7(1.0)	3.2(1.5)	1.7(0.8)	3.0(0.8)
Tai-chi/	Pre-	1.5(0.7)	1.2(0.8)	3.8(1.0)	2.0(1.1)	3.5(1.5)	2.3(1.1)	2.0(0.8)
Yoga	5-min	2.3(0.8)	2.9(0.6)	4.9(1.3)	0.9(0.7)	2.0(0.8)	1.3(0.5)	3.4(0.5)
	3-h	2.0(0.9)	2.1(1.1)	4.1(1.6)	1.1(0.9)	2.1(1.1)	1.4(0.8)	2.7(0.7)
Music	Pre-	2.4(1.0)	2.0(1.0)	4.6(1.3)	0.9(0.8)	2.2(1.2)	1.6(0.9)	2.5(0.7)
Appraisal	5-min	2.7(0.9)	2.3(0.9)	4.8(1.2)	1.2(0.9)	2.3(1.0)	1.4(0.7)	2.7(0.8)
	3-h	2.2(0.9)	1.9(1.0)	4.3(1.1)	1.4(1.2)	2.7(1.3)	1.5(0.7)	2.6(0.9)

NOTE: For statistically significant differences (Bonferroni corrected) between the means and ESs refer to Table 3. The values shown in this Table are rounded to one decimal place. [1]=EFI subscale and [2]= SEES subscale.

The group by period repeated measures ANOVA for exhaustion (EXH) subscale of the EFI yielded a significant group by period interaction ($F(2,246) = 3.3$, G-G $p < .005$). Participants

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in the music appreciation group reported lesser feelings of EXH, before exercise, than subjects in the tai-chi/Hatha yoga group (HSD = 1.03, $p < .05$) and aerobic group (HSD = .94, $p < .05$). Five minutes following exercise participants in the tai-chi/Hatha yoga group reported less exhaustion than subjects in the martial arts group (HSD = .84, $p < .05$). Group differences were absent 3 h after exercise. As shown in Tables 2.2 & 2.3, only subjects in the tai-chi/Hatha yoga group reported significantly lower feelings of EXH five minutes ($t(20) = 5.8$, $p < .001$) and 3 h after exercise ($t(20) = 3.8$, $p < .001$) in comparison to pre-exercise values.

Table 2.3. Effect sizes (ESs) reflecting mean differences, reported on the seven subscales of the EFI and SEES, between three sampling conditions: 1) between five minutes post exercise and before exercise (P1-BE), 2) between 3 h post-exercise and pre-exercise (P3-BE), and 3) between 3 h post-exercise and five minutes post-exercise (P2-P1).

GROUP		PE[1]	REV[1]	WB[2]	EXH[1]	FATIG[2]	DISTRE[2]	TRQ[1]
Aerobic	P1-BE	.59	1.0*	.58*	-.26	-.09	-.75*	.34
	P2-BE	.09	.36	.12	-.09	.12	-.57*	.43
	P2-P1	-.49	-.58	-.46	.17	.23	.20	.07
Anaerobic	P1-BE	.47	1.1*	.83*	-.31	-.12	-.70	.31
	P2-BE	.05	.57	.35	.05	.18	-.40	.83*
	P2-P1	-.44	-.48	-.56	.38	.33	.41	.53
Martial Arts	P1-BE	.27	.70*	.47	.39	.61	.06	-.11
	P2-BE	-.01	.35	.20	.38	.69	.01	.32
	P2-P1	-.28	-.32	-.27	-.01	.06	-.06	.42
Tai-chi/ Yoga	P1-BE	1.0*	2.3*	.96*	-1.2*	-1.3*	-1.2*	2.3*
	P2-BE	.59	1.0*	.24	-.84*	-1.1*	-.91*	.99*
	P2-P1	-.36	-.82*	-.55*	.33	.12	.22	-1.1*
Music Appraisal	P1-BE	.30	.35	.13	.25	.06	-.29	.23
	P2-BE	-.16	-.15	-.26	.44	.36	-.10	.13
	P2-P1	-.48	-.50	-.41	.24	.34	.22	-.08

NOTE: * Significant difference at Bonferroni corrected probability level for multiple t-tests.
[1]=EFI subscale and [2]= SEES subscale.

The repeated measures ANOVA for the tranquillity (TRQ) subscale of the EFI yielded a significant main effect for period ($F(2,246) = 17.3$, G-G $p < .001$) and a group by period interaction ($F(8,246) = 5.1$, G-G $p < .001$). Before exercise, higher TRQ scores were reported by subjects in the martial arts group than in the tai-chi and yoga group (HSD = .76, $p < .05$). Five minutes after exercise, however, subjects in the tai-chi and yoga group reported greater TRQ feelings than subjects in the aerobic group (HSD = .84, $p < .01$), anaerobic group (HSD = .85, $p < .01$), and martial arts group (HSD = .79, $p < .05$). Five minutes after exercise, higher than pre-exercise TRQ scores were observed in the tai-chi and yoga group only ($t(20) = -7.8$, $p < .001$). However, 3 h post-exercise TRQ scores were higher, as contrasted to pre-exercise values, in the anaerobic ($t(27) = -3.7$, $p < .001$) and tai-chi/Hatha yoga groups ($t(20) = -3.9$, $p <.001$). While in the tai-chi and yoga group the TRQ scores decreased from five minutes to 3 h post-exercise (t(20= 4.3, $p < .001$), they were still higher than before exercise (Tables 2.2 & 2.3).

2.3.1.2.4 Subjective Exercise Experience Scale. The univariate repeated measures ANOVA for positive well-being (WB) subscale of the SEES yielded a significant period main effect only ($F(2,244) = 26.2$, G-G $p < .001$). The t-tests showed that mean WB scores increased significantly in three exercise groups from pre- to five minutes post-exercise ($t(26) = -3.4$, $p < .002$, aerobic; $t(27) = -3.2$, $p < .003$, weight training; $t(20) = -8.2$, $p < .001$, tai-chi and yoga), except in the martial arts and music appreciation groups (Tables 2.2 & 2.3).

The repeated measures ANOVA for psychological distress (DISTRE) yielded a significant main effect for the period ($F(2,246) = 18.9$, G-G $p < .001$). T-tests showed that scores on the DISTRE subscale of the SEES were lower five minutes as well as 3 h after exercise in the aerobic ($t(26) = 3.4$, $p < .002$, and $t(26) = 3.2$, $p < .003$) and tai-chi and yoga ($t(20) = 4.8$, $p < .001$, and $t(20) = 3.6$, $p < .001$) groups (Tables 2.2 & 2.3). The changes were not significant, after using Bonferroni correction, in the other groups.

The ANOVA for fatigue (FATIG), on the SEES, yielded a group by period interaction only ($F(2,246) = 3.9$, G-G $p < .001$). Before exercise, there was a trend for higher FATIG scores in the tai-chi and yoga group, in contrast to martial arts (HSD = 1.12, $p < .06$) and to music appreciation (HSD = 1.22, $p < .06$) groups. Five minutes and 3 h after exercise, FATIG scores were lower in the tai-chi and yoga group than in the aerobic (HSD = 1.0, & 1.25, respectively, $p < .05$), and martial arts (HSD = 1.2, & 1.16, respectively, $p < .05$) groups. Scores on the FATIG subscale of the SEES decreased for the tai-chi and yoga group from pre-exercise (Tables 2.2 & 2.3) to five minutes post-exercise (t((20) = 4.9, $p < .001$) and remained lower at 3 h following exercise ($t(20) = 4.4$, $p < .001$). Changes in FATIG scores, reported by subjects in the other groups, were not significant.

2.3.1.3 Discussion

This field research has demonstrated that exercise-induced psychological feeling states vary across different forms of exercise. They could be assessed with EFI and SEES, two tools developed to gauge the affect in exercise settings. The specificity of these instruments is supported by the finding that no psychological changes were seen in the music appreciation group, even though research has shown that music has psychological benefits (Chang, Chen, & Huang, 2008).

While it may be surprising that the strongest positive change in feeling states was observed in the tai-chi and Hatha yoga group, several psychological benefits of these low physical exertion activities were known earlier (Benson, 1983; Berger & Owen, 1992; Berger & Owen, 1988; Blumenthal et al., 1989). In line with the current findings, a recent investigation showed that a 20-

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minute yoga session resulted in lower state anxiety in contrast to a comparable duration aerobic exercise (Gothe, Hillman, & McAuley, 2012). In the here-presented work, only the tai-chi and Hatha yoga group demonstrated positive changes in all the seven measures of the EFI and SEES. Moreover, the positive changes remained present even three hours following the activity in most of the measures. However, the aerobic group showed positive changes only on three of the seven measures (REV, WB, DISTRE) and three hours following exercise only the decrease in psychological distress was still lower than pre-exercise. Could these findings imply that the overall "positive" mental benefits of aerobic exercise may be inferior to that of tai-chi/yoga? If the answer is yes, the results of the presented study imply that psychological changes after exercise are not linked to the workload, because the group experiencing the most positive changes on the EFI and SEES also reported the least physical exertion on the RPES. Consequently, these findings appear to raise an important concern about the presumed dose-response relationship between physical exercise and its psychological benefits.

Participants in the anaerobic group showed positive changes on only two measures out of seven (REV, WB) after exercise. These changes did not persist 3-hours following exercise, but tranquillity was higher at this time. Finally, the martial arts group showed changes only on REV scores and only immediately after exercise. Martial artists report that their exercise regimen contributes to their well-being (Konzak & Boudreau, 1984; Konzak & Klavora, 1980) and evidence exists that martial artists, in general, have lower anxiety and depression levels than the general population (Konzak & Klavora, 1980; Layton, 1988). Why similar, positive, changes are not trapped by the EFI and SEES? Columbus and Rice (1991) pointed out that martial arts may not be approached with the same perspective as other forms of exercise, because they involve strong traditional and cultural values from the orient that may influence both the teaching and the practising of martial arts. In line with this explanation, it is possible that the EFI and the SEES are relatively insensitive to some *specific* feeling states induced by martial arts.

A few cautionary comments, regarding the interpretation of group differences observed in this study, should be emphasized. The first is that for some reason subjects in the most responsive low-physical-exertion exercise group, or the tai-chi/ yoga group, reported initially (pre-exercise) lower REV, TRQ, and higher EXH, and FATIG mostly in comparison to music appreciation group and in some instances in comparison to one or more exercise groups too. Having rated the scales on the lower end at the beginning, subjects in this group may have had a greater range in the flexibility of the ratings following exercise (a methodological concern known as floor and ceiling effects, generated by too low or too high initial scores). Motives for taking part in exercise, that regrettably were not scrutinized in the present study, may influence the data as well. For example, tai-chi and yoga practitioners may have some pre-conceived expectations about the immediate psychological benefits of their exercise that could be different from psychological values associated with other types of activity. Indeed, the expectation may be a critical determinant of the subjective feeling states (Szabo, 2013). For example, Szabo et al. (1993), have found that subjects reported higher vigour scores on the POMS before exercise than before watching a movie depicting geographical sceneries. Therefore, the role of pre-conceived values, associated with various forms of exercise, should be raised in future studies.

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2.3.1.4 Contribution to the advancement of knowledge

This cross-sectional field study has demonstrated that various forms of exercises trigger different psychological feeling states as reflected through indices of exercise-related states of affect. The study has revealed that the low physical exertion group comprised of yoga and tai chi practitioners ripped off the most psychological benefits after a single bout of exercise. Further, the positive changes in affect persisted even three hours later in this group in contrast to the other groups in which physical effort was greater. Therefore, it may be concluded that the psychological benefits of various forms of exercises differ and they are not a function of the exercise intensity. It is also a novel finding that the effects of some forms of exercise may last for at least three hours. The next emerging question was whether the positive effects experienced after a single exercise session could translate into an overall more positive appraisal of that day in the exerciser's life. In other words, does the psychological perception of the quality of an *exercise day* differ from that of a *non-exercise* day?

2.3.1.5 The take-home message of the study

Exercise-induced affect differs in *magnitude* and *duration* in various forms of exercise**.**

2.3.2 Are exercising days better than non-exercising days in runners?[3]

Consensus statements reached at the Office of Prevention of the United States National Institute of Mental Health have proposed that exercise is associated with the reduction of stress-emotions such as state anxiety (Morgan & Goldston, 1987). Three decades ago, Hughes (1984) already found more than 1100 research articles focusing on the psychological effects of exercise. Today, using these keywords, the Google Scholar yields over two million (!) articles that may be closely or distantly related to the concept (Figure 2.1). However, there are virtually no studies that posed the simple and basic question: Given that a number of stressful and pleasant events that may take place during an ordinary day, does the exercise experience make the average days different from one another? Simply stated, ignoring all mundane life-events, does a single bout of exercise result in measurable effects on psychological states?

In their early meta-analysis, Petruzello et al. (1991) concluded that aerobic exercise has anxiety lowering effects. These effects appeared to be similar to the effects of other anxiety reducing methods, such as relaxation, meditation, or episodes of quiet rest. However, two other meta-analytic reviews found only average (Kugler, Seelbach & Kruskemper, 1994) or minor effects (Schlicht, 1994) for the anxiety lowering ability of exercise, in general, regardless of its form. Further, contrary evidence also exists. For example, one review (Leith & Taylor, 1990) showed that 32% of the studies that examined the connection between exercise and anxiety yielded negative findings. In one of these studies, exercise was related to an increase, as opposed to the expected decrease, in anxiety (Cameron & Hudson, 1986). A recent meta analysis failed to

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[3] *Based on: **Szabo, A.,** Frenkl, R., Janek, Gy., Kálmán, L., & Lászay, D. (1998a). Runners anxiety and mood on running and non-running days: An in-situ daily monitoring study. Psychology, Health & Medicine, 3(2), 193-199.*

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provide support for the efficacy of aerobic exercise in reducing anxiety (Bartley, Hay, & Bloch, 2013). Finally, although the anxiety lowering capacity of acute exercise was reported in some past studies, it is not known whether self-perceived level of anxiety is lower on exercise- as opposed to no-exercise days in regular exercisers.

Figure 2.1. The results of a Google Scholar search involving the keywords "psychological effects of exercise". The search was performed on December 20, 2014, 9.30 am.

With regard to affect and mood, there are numerous inquiries that have revealed mood improvements either after a single bout of exercise or chronic exercise training (Leith & Taylor, 1990). But the main problem with these subjectively reported effects, as it may also apply to anxiety, is that they were disclosed through a limited number pre- to post-treatment assessments. Whether testing the acute (e.g., McGowan, Pierce, & Jordan, 1991) or the chronic effects of exercise (e.g., Frazier & Nagy, 1989) researchers relied more often on only two assessments. The problem with this type of methodology is that participants cannot be prevented from guessing the hypothesis and, therefore, they may convey their "anticipated" answers into the responses.

Another methodological problem with the mood and affect moderating effects of exercise is that they were measured with instruments that are non-specific to exercise, or tools measuring global or overall affect (Gauvin & Rejeski, 1993). Most of these tools comprised mainly negative mood states. For example, the Profile of Mood States inventory (Lorr, McNair, & Droppleman, 1971) has only one positive - vigour - subscale. However, Gauvin and Rejeski (1993) argue that exercise results in divers, distinct and *mostly positive* mood states. Four of these specific feeling states are: (1) revitalisation, (2) tranquillity, (3) exhaustion, and (4) positive engagement. These exercise-related states of affect may be gauged with the Exercise Induced Feeling Inventory (EFI - Gauvin & Rejeski, 1993) as also shown in the study presented in section 2.3.1.

Given that exercise is only one of the many possible daily activities, and that its acute psychological effects appears to be disputed in the literature, in this inquiry the research objective was to simply assess whether there are differences in exercise-related affect and anxiety between exercise (running) and non-exercise days, and if so, how significant these differences really are? In contrast to most previous studies (except Conboy,1994) in this inquiry the results were based on daily and in-situ (real life setting) measurements over a three-week period.

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2.3.2.1 Materials and methods

2.3.2.1.1 Participants. Participants for this study were recruited during an assembly of an amateur running club in the Budapest metropolitan area. As an incentive for their participation, runners were offered a chance to win a trip to an international running race (odds were about 1/13). The winners were selected by lot. Sixty-nine runners have volunteered for participation and 40 of them - 10 females and 30 males - completed the study. Unfortunately, 29 runners (more than a third of the total sample) did not complete the study, because they felt that the repeated (daily) completion of the questionnaires was cumbersome. All participants consented in writing to taking part in the three-week study. The characteristics of the final sample are presented in Table 2.4.

Table 2.4. Subjects' characteristics (means and standard deviations in parenthesis)

	Males	Females
Number of runners	30	10
Age (years)	40.5(11.4)	37(11.8)
Height (cm)	177(8.4)	167(4.3)*
Weight (kg)	75.7(10.4)	60.1(6.6)*
Running experience (months)	134(102)	60(37.5)*
Average weekly run (minutes)	172(122)	258(189)
Average running speed (km/h)	12.2(2.5)	9.4(1.8)*
Commitment to Running score**	47.3(5.5)	43.0(4.1)*

NOTE:* Statistically significant differences ($p < .05$) between the two genders (refer to Results section). ** The maximum score is 60. The norms reported for various runner-subgroups ranged between 47.7 and 48.2 (Carmack & Martens, 1979).

2.3.2.1.2 Instruments. At the beginning of the study, the Commitment to Running Scale (CRS - Carmack & Martens, 1979; Appendix C) was completed by all the runners. The 12-item CRS was used to assess the subjects' dedication to running. On a scale from 1 to 5, ranging from *strongly disagree* to *strongly agree*, the respondents were required to indicate the extent to which each statement applies to them. The internal consistency of the original CRS was reported to be high (Cronbach alpha = .93; Carmack & Martens, 1979).

During the course of the study, the runners completed two questionnaires every evening before their bedtime. One of them was the Spielberger State Anxiety Inventory (SSAI - Spielberger, Gorsuch, & Lushene, 1970; Appendix D). The internal consistency of the scale was reported to be relatively high (Cronbach alpha = .83 to .92; Spielberger et al., 1970). This questionnaire was designed to assess momentary states. Therefore, the instructions were changed from "how do you feel right now" to "how did you feel during the day". Participants also completed the Exercise Induced Feeling Inventory (EFI - Gauvin & Rejeski, 1993; Appendix A), which contains 12 states of affect that are thought to be specifically influenced by exercise behaviour (Gauvin & Rejeski, 1993). The original internal consistencies of the four subscales were reported to be good (i.e., Cronbach alpha ranging from .72 to .91). Similar to SSAI, the instructions for the ratings were changed from the "right now" form to the "during the day" form.

2.3.2.1.3 Procedure. In this study, an *in-situ* data collection method was used (Hormuth, 1986). The study lasted for 21 consecutive days. Runners were requested to complete the questionnaires every evening, before their bedtime, so that this task would be their last activity on each day. In contrast to the original instructions accompanying the scales that call for the subjective ratings of affect and anxiety in the very moment of completion, in this study subjects were requested to recall, to the best of their ability, how they felt during the awake period of the past 24 hours. It was conjectured that the scales' internal reliability could be affected by such a modification and the inclusion of retrospective assessment. Therefore, internal consistencies were calculated for each of the adopted scales and compared with the originally reported internal consistencies (see Results section). This control was necessary, because by averaging one's feeling states we were measuring mood (an aggregate feeling state of affect) rather than the quickly changing and emotion-sensitive affect.

Participants were instructed to report their running date, time and distance. Further, they were asked to identify any *major* life-stress, experienced during the data collection period, if they perceived that as having an impact on their mood and/or anxiety levels. These stressors did not include recurring minor hassles and challenges of the daily life. It was pre-conceived that these days (if any) would be eliminated from the final data-analysis, but none of the runners reported any major life-stress during the three weeks of the study. Two instructions provided to the subjects requested them to leave blank the questionnaire pages if they forgot to complete them on a pre-designated day and to refrain from browsing the previous (already filled) pages at times when they complete the questionnaires. At last, the runners were asked not to complete the scales when they were under the influence of any psychoactive agents, including medication and/or alcohol.

2.3.2.2 Results

First the internal consistencies of the questionnaires were calculated. The answers given by the participants on the first day of the experiment were adopted for this purpose. The Cronbach alpha levels were as follows: .94 for SSAI, .78 for the exhaustion sub-scale of the EFI, .89 for the tranquillity sub-scale of the EFI, .72 for the revitalisation sub-scale of the EFI, and .90 for the positive engagement of the EFI. These values were comparable or even higher than the values originally reported for the six scales (see Materials section).

Apart from height ($F(1,38) = 14.5$, $p < .001$) and weight ($F(1,38) = 19.5$, $p < .001$), gender related differences (Table 2.4) were observed in running history ($F(1,38) = 4.9$, $p < .03$), the reported running speed ($F(1,36) = 10.5$, $p < .003$), and commitment to running as determined with the CRS ($F(1,36) = 4.9$, $p < .03$). In all instances, males had higher values than females. Over the course of the study, subjects ran an average of 8 km (SD = 3.9) in 40.6 min (SD = 20.4) on running days. The latter outnumbered the non-running days (means = 11.9 (SD = 3.9) running days and 9.1 (SD = 3.8) non-running days) significantly ($F(1,38) = 5.18$, $p < .03$).

To establish whether mood and anxiety levels differed on running and non-running days and to account for gender related differences, gender (male, female) by period (running, non-

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running day) repeated measures analyses of variances (ANOVA) were performed for the studied variables. In cases when statistically significant differences were observed, the effect sizes (ES) were also calculated to attribute more meaning to the magnitude of the observed differences (Cohen, 1969). For the SSAI, the ANOVA only yielded a period main effect ($F(1,38) = 5.22$, $p < .03$; Table 2.5). As indicated in Table 2.5, the gender by period ANOVAs yielded a period main effect for all the sub-scales of the EFI ($F(1,38) = 4.34$, $p < .04$, for exhaustion; $F(1,38) = 5.56$, $p < .02$, for tranquillity, ($F(1,38) = 18.32$, $p < .001$, for revitalisation, and ($F(1,38) = 11.79$, $p < .001$) for positive engagement). Apart from the period main effects, two gender by period interactions were also disclosed. The first for exhaustion ($F(1,38) = 8.69$, $p < .005$) was related to a trend for greater feelings of exhaustion reported by women on non-running days (mean = 5.8, SD = 2.0) than on running days (mean = 4.9, SD = 1.4; $t(9) = 1.9$, $p < .09$) in contrast to men (means = 4.9 (SD = 1.4) and 5.1 (SD = 1.4; t=ns). Another trend of interaction for tranquillity was not significant ($F(1,38) = 3.89$, $p < .06$). The trend was related to greater tranquillity reported by men (mean = 9.0, SD = 2.1) than women (mean = 7.6, SD = 1.6) on the non-running days only ($t(20,2) = 2.16$, $p < .04$).

Table 2.5. Measures of anxiety and mood for running and non-running days. Means and standard deviations in parenthesis, and effect sizes (ES (d)) are shown in the last column.

Variable	Running Day	Non-Running Day	ES(d)[a]
Anxiety (SSAI)	35.7 (7.1)	37.2 (7.9)*	0.19
Exhaustion (EFI)	5.0 (1.4)	5.2 (1.6)*	0.07
Tranquillity (EFI)	9.0 (1.9)	8.7 (2.1)*	0.15
Revitalisation (EFI)	7.6 (1.8)	6.6 (1.6)*	0.56
Positive Engagement (EFI)	8.2 (2.2)	7.4 (2.1)*	0.36

NOTE: * All the six variables were significantly different ($p < .05$) between running and non-running days. [a]In line with Cohen's (1969) interpretation, an ES around 0.2 implies a small difference, an ES around 0.5 means moderate difference, and an ES around or over 0.8 reflects a large difference.

Because there were no reports on the relationships between state anxiety and the four subscales of the EFI (exercise-specific mood states), a series of Bonferroni corrected correlations were performed between the six variables studied. The correlations were carried out separately for

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running- and non-running days to reveal whether possible associations are related (or not) to running (Table 2.6).

Table 2.6. Bonferroni corrected correlations between the studied variables on running and separately on non-running days (Pearson's *r*; n = 40).

	SSAI[a]	*EFI Subscales*			
		EXH	TRQ	REV	POE
Running days					
SSAI	-	.45	-.86*	-.70*	-.67*
EXH	-	-	-.23	-.16	-.03
TRQ	-	-	-	.70*	.76*
REV	-	-	-	-	.84*
POE	-	-	-	-	-
Non-running days					
SSAI	-	.48*	-.87*	-.79*	-.71*
EXH	-	-	-.26	-.20	-.15
TRQ	-	-	-	.75*	.77*
REV	-	-	-	-	.87*
POE	-	-	-	-	-

[a]SSAI = State anxiety, EXH = exhaustion, TRQ = tranquillity, REV = revitalisation, POE = positive engagement. The last four are subscales of the EFI (Exercise induced feelings inventory). *Statistically significant correlation ($p < .05$).

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2.3.2.3 Discussion

Using aggregated data collected from real life settings, the results of this inquiry agree and expand previous findings. For example, in line with Conboy's (1994) report, on non-running days committed runners report more negative moods. In the present study exercise specific positive moods were lower, and negative moods as well as anxiety were higher on non-running days. However, when examining the effect sizes (refer to Table 2.5) the differences were small. With regard to state anxiety, the results agree with the meta-analytic conclusions of Kugler et al. (1994) and Schlicht (1994) who reported only mild to moderate effects of exercise on anxiety. A recent analysis of meta-analytical reviews revealed similar findings, but larger effects for the clinical population (Wegner et al., 2014). The current finding should not be surprising, because no control over life-events or over the delay (in time) from running to the completion of the questionnaires was (purposely) set in this study. Therefore, any effect, no matter how small it is, can be considered as having a significant theoretical implication. Such an explanation clearly implies that regardless of the time of running and the intervening life events, runners experience lesser anxiety and have better moods on running as opposed to non-running days.

However, two notes of caution should be addressed. First, it is conceivable that runners are better pre-disposed for running on the days when they are less anxious or when they are in a better mood. In this case, running would be a consequence and not an effect of the lower anxiety and better mood states. However, this explanation is in contrast to the "therapeutic" running concept proposed by Robbins and Joseph (1985), whereby running is often used as a coping mechanism with the hassles and challenges of the daily life. Still another note of caution relates to the fact that participants may have appraised running days as more satisfactory or self-fulfilling from a life quality perspective - that could have been augmented by their participation in the study - without actual differences in mood and/or anxiety. In this case, the observed differences were pseudo-differences that could be explained in terms of self-perception or evaluative-appraisal rather than actual mental or psychological benefits.

In this study, women reported greater exhaustion on their non-running days than males. There are two possible explanations for these findings. The first is that women schedule their running in light of other energy requiring commitments. Their work and chores around the house, especially in the current middle aged sample, may represent such commitments. When too much work is to be done, running is prevented while exhaustion may surface. (Many women today still work in double shifts at their workplace and at home.) Another explanation may be traced back to a study by Robbins and Joseph (1985). These authors observed that female runners reported more negative affect than males when they cannot run. It is possible that women rely more heavily on running as a form of coping mechanism with stress and/or anxiety than males. In light of this explanation greater psychophysiological exhaustion may be experienced when the adopted coping mechanism is not activated and stress or anxiety is present.

State anxiety was positively correlated with exhaustion and negatively related to revitalisation, tranquillity and positive engagement on both running and non-running days. The correlations suggest that there is a stable association between exercise specific mood and anxiety and this association appears to be independent from running. These findings may seem to reflect

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the common sense since anxiety and tranquillity are opposite psychological states, and therefore the negative relationship between the two should not be surprising.

In conclusion, the present *in-situ* study supports the external validity of numerous previous laboratory and field research and suggests that running influences the life-quality of the runners either at an actual or at an expected level. More precisely, considering all life events equal, there is a significant difference between the "average" running and non-running day of the committed runner in terms of mood and anxiety. It should be noted, however, that these results do not shed light on the mechanism by which the reported anxiety is lower and mood is more favourable on running versus non-running days. Both psychophysiological effects and placebo effects, related to beliefs associated with the beneficial effects of running, may be involved. Future research should study these mechanisms to yield a deeper understanding. Another aspect of the current results suggests that the acute or single bouts of running, as opposed to the accumulating long-term performance of the activity, may mediate the reported state anxiety and affect of the runners.

2.3.2.4 Replication of the study with competitive athletes

The above presented work was conducted with *amateur club runners.* They may be viewed as committed recreational athletes. The question whether competitive, or *elite*, athletes respond in the same way was also raised. This research question is theoretically justified. In fact, professional athletes may respond in the opposite direction, considering that regular athletic training is a sort of obligation for them. It is analogous to one's work that simply has to be done. Therefore, on non-training days (or on their rest days) the competitive athletes could exhibit more positive affect than on their training days. To test this hypothesis at an exploratory level, Dagrou and Szabo (1998), recruited elite short distance runners (sprinters) through poster-advertisements at the National Institute for Youth and Sport in Abidjan in Ivory Coast. All the athletes were volunteers, males, and members of the Ivory Coast Athletic Federation (mean age = 22. 2, SD = 3.8 years). They trained, over the 21 days of the study, more than every other day (mean of training days = 12.2, SD = 2.9 and non-training days = 8.8, SD = 2.9) for an average of 62 minutes of total physically *active* time. During the 21-days of the study, participants had to complete two questionnaires every evening. This task was apparently difficult for many athletes, since initially 35 volunteered for the study, but only 25 of them have completed the full period of three weeks. Data were obtained on a daily basis with two questionnaires. One of them was the Spielberger State Anxiety Inventory (SAI – Spielberger et al., 1970) and the other was the Exercise Induced Feelings Inventory (EFI - Gauvin & Rejeski, 1993). The completion of the questionnaire had to be done in the evening, just before bedtime, so that this task would be the athletes' last activity on each experimental day. Research participants were instructed to report all major life-event changes (stressors), including changes in family status, relationships, career, experienced during any one of the test days. It was pre-conceived that these days (if any) would have been eliminated from the final analysis, but none of the participants reported any major stress or life event change during the course of the study. Contrary to the exploratory hypothesis, the results were identical to those obtained with the amateur or recreational runners. The competitive runners showed lower anxiety and exhaustion while reporting higher tranquillity, positive engagement, and revitalization on training days as compared to their rest days. These findings are illustrated in Figures 2.2 and 2.3.

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Figure 2.2. Mean values of five psychological measures (state anxiety (SSAI), exhaustion (EXH), tranquility (TRQ), revitalization (REV) and positive engagement (POE)) obtained from 25 male short-distance runners (mean age = 22.2 years, SD = 3.8) on 12.2 (SD = 2.9) training days and on 8.8 (SD = 2.9) rest days. All the values obtained on training days were statistically significantly (p < .001) different from those obtained on the rest days.

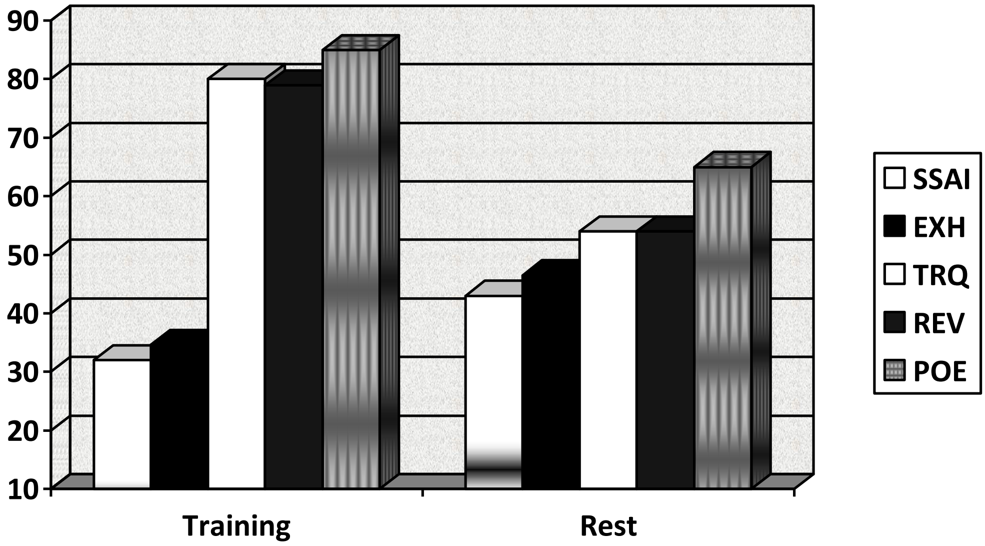
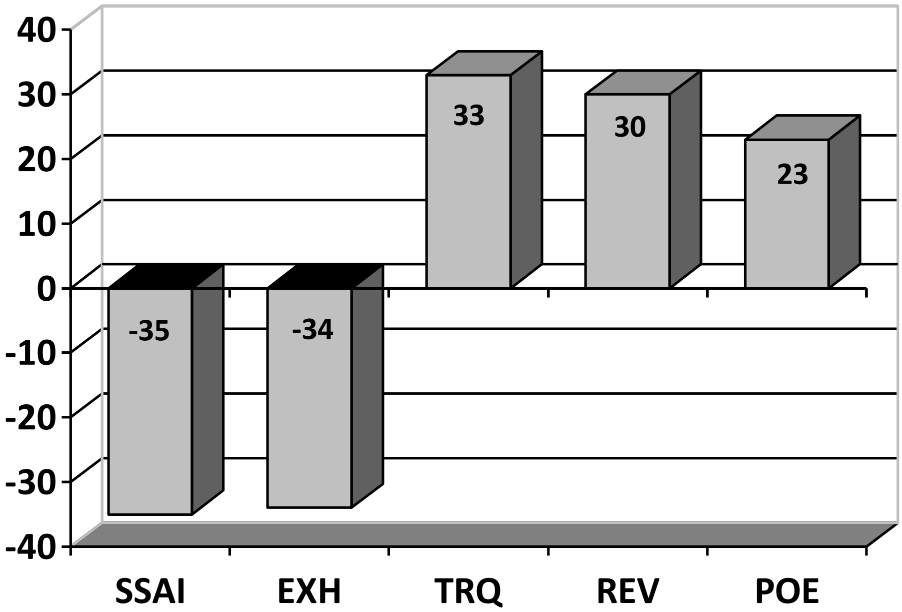


Figure 2.3. Percent (%) differences in five measures (state anxiety (SSAI), exhaustion (EXH), tranquility (TRQ), revitalization (REV) and positive engagement (POE)) between training and non-training days (line at 0) in 25 short-distance runners over a period of 21 days of assessment.



2.3.2.5 Contribution to the advancement of knowledge

The in-situ study conducted on amateur or recreational runners and replicated with elite athletes, has demonstrated that subjectively reported psychological states, as based on anxiety and mood, are more positive on exercise than on non-exercise (rest) days. Whether the actual mental states or simply their appraisal contributes to the documented differences is hard to untangle, because there is no control over the link between one's expectations and life events. The "feeling good" sensation after exercise may be carried over to retrospective analysis of the day and the life events may be judged in function of the feel good factor. If the latter case is the actual explanation for the observed positive effects, it may be stated that placebo-related expectations yield more favourable appraisals of the exercise days' psychological states. However, that is only a plausible speculation. This study showed small, but significant difference in anxiety and mood between exercising and non-exercising days over a three-week period in highly committed exercisers and elite athletes. The mechanism for the observed differences is only speculative at this time.

2.3.2.6 The take-home message of the study

In contrast to non-exercise days, exercise or training days days are perceived as more positive, in terms of retrospective *mood*- and *anxiety*-evaluation, by habitual runners and elite athletes.

2.3.3 Does exercise intensity matter?[4]

Knowing that many theoretical models accounting for the acute psychological benefits of exercise are linked to the dose or volume of exercise, a thought-provoking question is whether the effects of acute exercise are indeed dose-dependent, in which case exercising harder or longer could buffer more stress or yield more psychological benefits. Ekkekakis and Petruzzello (1999) recognized the important implication of this question in theory as well as in practice. However, their literature review based on over 200 research papers did not yield an unambiguous answer. Based on the study reported in section 2.3.1 showing that the light-effort exercises (tai chi and Hatha yoga) have produced the most psychological benefits, the hypothesis that exercise benefits are not dose-dependent should be considered empirically. Indeed, there is evidence in the relevant literature that passive interventions, used mainly as control treatments to exercise, trigger affective benefits that are comparable to exercise (Parente, 2000; Snowball & Szabo, 1999; Szabo, 2006; Szabo et al., 1998a; Wilson, Berger, & Bird, 1981). These empirical findings call for a second look at the hypothetical dose-response relationship between exercise and affect.

At the time of their review, Ekkekakis and Petruzzello (1999) could only locate 31 relevant research of which 26 inquiries examined the affective benefits of acute aerobic exercise at different workloads. A majority (56%) of these studies did not find a dose-response relationship. The few studies that have found different affective responses at different exercise workloads

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[4]*Based on:* ***Szabo, A****. (2003b). Acute psychological benefits of exercise performed at self-selected workloads: Implications for theory and practice. Journal of Sport Science and Medicine, 2, 77-87.*

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showed that differences existed on specific measures only, such as physical fatigue, exhaustion, or state anxiety. Moreover, the findings were often related to the fitness level of the participants.

Another key problem with the dose-response research methodology is that it lacks external validity. These interventions are distorted by the ignorance of the fact that in real life most people *self-select* both the duration and intensity of their workload. These are dynamic aspects of exercise behaviour that vary with personal or situational factors ranging anywhere from physical state to external factors such as the tempo of music accompanying the exercise (Bacon & Hookway, 2003). Accordingly, experimenter-selected exercise intensity, even if that is relative to the fitness level of the participant, may not correspond to the momentary preference of that person and for that reason could yield imprecise results. An even greater mistake is that the selection of the exercise intensity is often unjustified. Indeed, only two out of the 31 studies, examined by Ekkekakis and Petruzzello (1999), were theory-driven.

Since the states of affect cannot be independent of personal choices or preferences for exercise intensity, studies using a participant-selected exercise workload may offer a valuable contribution to the understanding of the exercise-affect relationship. In their analytical review, however, Ekkekakis and Petruzzello (1999) could only locate two published accounts about the affective benefits of self-selected exercise intensity. In the first study, Farrell et al. (1982) have indirectly studied affect in only six well-trained athletes who run on a treadmill for 30 minutes in three situations: at self-selected pace, at 60% VO_2 max and at 80% VO_2 max. Total mood disturbance (TMD) from the Profile of Mood States (POMS) inventory (Lorr et al., 1971) was the only measure of affect which were not significantly different after the three exercise conditions. In the second study, Zervas, Ekkekakis, Emmanuel, Psychoudaki, and Kakkos (1993) examined the mood states of female participants after 30 minutes of aerobics, performed at self-selected intensity and at 40%, 60% and 80% of their maximal heart rate (MHR). Vigour and exhilaration have increased after 60% and 80% MHR as well as after self-selected exercise intensity. However, the highest level of exercise-enjoyment was reported by those participants who self-selected their exercise workload. Later, Parfitt, Rose, and Markland (2000) compared the affective benefits of 20 minute treadmill running at 65% VO_2 max to that of preferred exercise intensity and, matching the of previous studies, they found no statistically significant differences.

Why is then the sport and exercise psychology literature virtually void of studies using participant-selected exercise intensity in examining the affective benefits of exercise when even the common sense begs for such protocols? The limited evidence, stemming from studies in which the self-selected exercise condition was not the primary focus of the inquiry, clearly shows that self-selected exercise workloads are at least as effective as pre-set and/or relative workloads in generating affective benefits. If this finding could be replicated, then a number, if not most, of the physiological models connecting exercise and affect, such as the endorphin hypothesis (Dunn & Dishman, 1991; Farrell, Gustafson, Morgan, & Pert, 1987), the amine hypothesis (Dunn & Dishman, 1991; Kety, 1966; Morgan & O'Connor, 1988), or the thermogenic hypothesis (Koltyn, 1997; Petruzzello et al., 1991), may be rather incomplete.

Therefore, I have conducted two exploratory studies as a first attempt to directly examine the affect-enhancing properties of self-selected exercise, of equal modality and duration, in a pilot field experiment and in a follow-up laboratory experiment. My research hypothesis was that a

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bout of exercise at a subject-preferred and controlled intensity (effort) will yield acute positive psychological changes that are independent of the exercise intensity.

2.3.3.1 The field experiment

2.3.3.1.1 Methods. Participants were 96 first year university students enrolled in Sport and Exercise Psychology lectures at the Nottingham Trent University. They were invited to participate in this research as part of a practical session. This method eliminated the problem of self-selection, but to adhere to ethical standards, students were asked not to take part in the study if they suspect that there may be any medical or health reason that could result in any negative consequences to them. They were also instructed not to give their names for the sake of maximal confidentiality, but they were requested to report their gender and age. Out of the 96 students 66 men and 27 women complied with the requirements of the study (mean age = 19.5 years SD = 2.0). Three students did not disclose their gender. Upon completion of the experiment, the research details were discussed collectively and several educational tasks, in relation to the study, were completed jointly in and out of the class.

2.3.3.1.2 Instruments. An abbreviated version (Grove & Prapavessis, 1992) of the Profile of Mood States (POMS - Appendix E) inventory was the main instrument used in these studies. This tool is claimed to be the most popular instrument in sport and exercise context (LeUnes & Burger, 2000), it is sensitive to affective changes induced by exercise performed for only 20 minutes (Berger & Motl, 2000), and it was reported that it possesses adequate psychometric properties for use in sport and exercise psychology research (Fleming, Bourgeois, LeUnes, & Meyers, 1992). This version of the POMS consists of a 40-item questionnaire containing 7 subscales of which 2 measure positive affect and 5 measure negative affect. The 40 items are rated on a 5-point Likert scale ranging from “not at all” to “extremely” to measure affective states like “Lively”, “Confused”, “Annoyed”, “Helpless”, “Vigorous” etc. In a past research the internal consistencies (Cronbach α) of the 7 subscales were found to be: fatigue = .90, anger = .90, vigor = .93, esteem = .70, tension = .87, confusion = .76 and depression = .93 (Wann, Inman, Ensor, Gates, & Caldwell, 1999).

2.3.3.1.3 Procedure. Participants reported for their Exercise Psychology practical session ready dressed for exercising. The testing phase of the practical session was held in a large sports hall. Before this session, students were trained in the palpation of the radial artery for estimating heart rate during exercise (Pronk, Pronk, & Sisco et al., 1995). After several refresher exercises of this method, all participants completed the POMS in the presence of two experimenters. Talking and other forms of interaction were prohibited during the course of the study. After the completion of the POMS, students were instructed to start running or jogging at *self-selected* pace. However, walking was not permitted, because that would introduce another exercise modality (different motor program in the brain) that could act as a confound. Fifteen minutes into their exercise, participants were requested to take their pulse for 10 seconds, as prescribed by Pronk et al. (1995). Given the pilot nature of the study, the absolute accuracy of heart rate was not a major issue. It was simply taken to estimate the workload at which students chose to run or jog and to establish the range of the approximate self-selected exercise intensities. Pronk et al. (1995) reported that palpation is an accurate method for gauging heart rate during exercise. However, some contrary

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reports exist in the literature (e.g., Bell & Bassey, 1996; Erdmann, Dolgener, & Hensley, 1998). The target duration of the exercise was set to 20 minutes. This period was based on the reviews of Ekkekakis and Petruzzello (1999) and Berger and Motl (2000) showing that this interval is usually sufficient for detecting exercise-induced changes in affect. After running, participants completed the POMS again.

2.3.3.1.4 Data reduction and results. The exercise workload at 15-minute period was calculated in terms of the percent (%) of the maximal heart rate reserve (MHRR) derived from the Karvonen formula (Karvonen, Kentala, & Mustala, 1957). Accordingly, heart rate reserve (HRR) = 220 – age – baseline heart rate (BHR), and then MHRR = (exercise heart rate – BHR) / HRR x 100. It should be noted that in this pilot field experiment a single heart rate assessment at 15-minutes into exercise only reflected a momentary workload, that should be considered a rough approximation.

The POMS scores before and after exercise were analysed with a multivariate repeated measures analysis of variance (MRM-ANOVA). This analysis yielded a statistically significant period (pre- to post-exercise) main effect, $F(7, 89) = 20.67$, $p = .001$. Follow up univariate analyses revealed that pre- to post-exercise changes were statistically significant for all seven dependent measures derived from the subscales of the POMS. These results are summarized in Table 2.7. A total mood disturbance (TMD) score was also calculated by subtracting the sum of the ratings on the two positive subscales of the POMS from the sum of the ratings on the five negative subscales (Grove & Prapavessis, 1992). Employing a pre- to post-exercise repeated measures ANOVA, it was found that TMD decreased substantially ($F(1, 95) = 28.22$, $p = .001$), but the standard deviation was high.

Table 2.7. Means and standard deviations (in brackets) and effect sizes (Cohen's *d*) for seven dependent measures and total mood disturbance (TMD) pre- and post-exercise performed at self-selected exercise intensity in the field experiment.

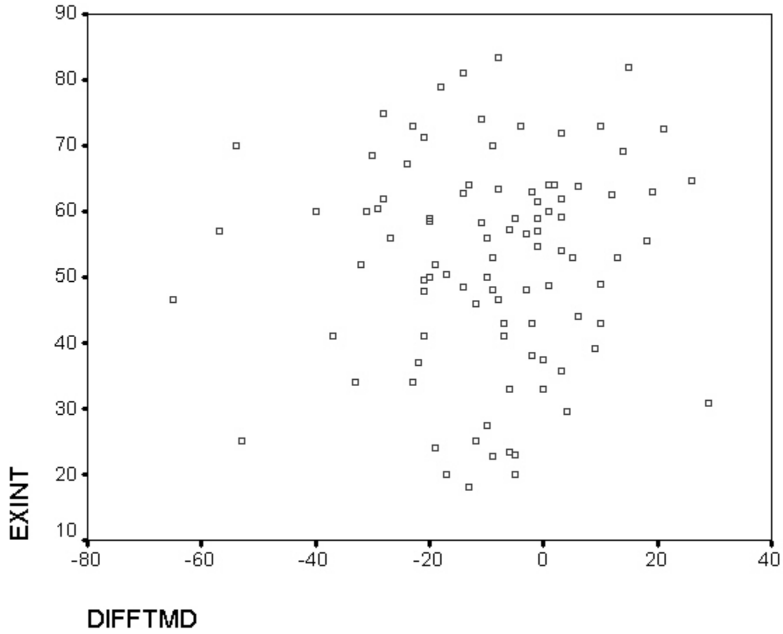
Dependent measure	Pre-Exercise	Post- Exercise	Effect size (*d*)	Significance*
Anger	8.62 (3.97)	7.08 (2.11)	.39	p = .001
Confusion	6.59 (2.62)	5.25 (2.06)	.51	p = .001
Depression	9.96 (4.38)	8.19 (2.20)	.40	p = .001
Fatigue	9.81 (4.31)	11.43 (4.97)	.38	p = .01
Self-esteem	20.30 (3.23)	21.82 (3.20)	.47	p = .001
Tension	10.86 (3.94)	8.18 (2.45)	.68	p = .001
Vigour	11.86 (3.34)	13.94 (4.05)	.62	p = .001
TMD	13.69 (18.91)	4.35 (13.03)	.49	p = .001

*NOTE: All changes from pre- to post-exercise were statistically significant.

The percent (%) of the MHRR at which the participants exercised at the 15th minute mark was calculated to be moderate (M = 52%, SD = 15.78). However, the range of individual exercise intensities, in terms of % MHRR, was high (65%) indicating that participants self-selected a wide range of exercise workloads. To examine whether the self-selected workloads had any relationship to the magnitude of changes in the measures of affect, difference scores were calculated for the latter by subtracting the pre- from the post-exercise scores. The correlations between workload and difference scores were not significant for any of the affective measures, including TMD (Figure 2.4).

2.3.3.1.5 Interpretation of the findings in the field experiment. The results of this pilot field experiment clearly showed that a 20-minute bout of acute aerobic exercise, performed at participants-selected exercise intensity, generates significant affective-benefits. The lack of correlation between the calculated workload at the 15th minute of exercise and the magnitude of changes in mood (difference scores) may suggest that exercise intensity does not mediate the affective benefits of exercise. However, the lack of correlation (Figure 2.4) provide only tentative findings. Yet, if they reflect the genuine case, then as proposed by Stoll (1997) some of the physiological theories, or models, accounting for the exercise-affect relationship may be invalid. It is possible that the 'classical' models including the endorphin, amine, and thermogenic hypothesis may better explain the chronic rather than acute affective benefits of exercise.

Figure 2.4. Scatter plot depicting the relationship between self-selected exercise intensity (EXINT), expressed as a percentage (%) of maximal heart rate reserve (%MHRR), and pre- to post-exercise difference or change scores of total mood disturbance (DIFFTMD), that is a global or rather composite score of affect, in the pilot field experiment.



It may be argued that the workload, expressed in terms of MHRR and calculated on the basis of a single palpated pulse 15 minutes into exercise, is an imprecise reflection of the exercise intensity. Indeed, error due to palpation may have occurred, but proper training in palpation, which was the case in this research, could yield an accurate pulse rate measure (Pronk et al., 1995). Still, it may be argued, that the momentary heart rate does not represent the overall or average workload in the exercise session. While this argument is also valid, a steady state is often reached early during exercise and, therefore, an average workload could be expected to be close to the calculated workload even on the basis of a momentary pulse rate. But such assumptions do not satisfy the required rigour in scientific research and hence they remain speculative, but noteworthy enough to call for further more systematic inquiry, that was attempted in the laboratory experiment presented in the next section.

Another noteworthy result emerging from the field experiment is that the participants have selected a wide range of exercise intensities. This finding may send a powerful message: Imposed exercise intensity is highly unlikely to match what a participant would (otherwise) select for her or his exercise workout. Therefore, an experimenter-imposed exercise intensity may be perceived as stressful, compliance-demanding, and/or annoying. The results in imposing-workload experiments may reflect improvements in affect that are not due to exercise itself, but rather to *being through with it* (it = an imposed chore). Similar findings were revealed in previous research in relation to state anxiety (Szabo et al., 1993a).

Consequently, given that the results of this pilot field-experiment raised some significant theoretical and practical questions, I have designed a laboratory experiment to explore whether such findings could also be obtained in a controlled environment.

2.3.3.2 The laboratory experiment

2.3.3.2.1 Methods. Due to the fact that I have obtained a young female research assistant, for ethical considerations only women participants were recruited through a campus-wide call for participation in the research at a large British university. Thirty-five students volunteered for the study and 32 (mean age = 20.3 years, SD = 2.4; height = 164.8 cm, SD = 5.4; weight = 64.3 kg, SD = 6.1) showed up for testing. All participants have read and signed an informed consent form. They were informed that the purpose of the study was to determine whether a relatively short exercise bout could influence their feeling states. More detailed explanations were provided only upon debriefing after participation.

2.3.3.2.2 Instruments. Mood measures were obtained with the same instrument as in the field experiment (POMS). A Powerjog treadmill (model GM200; manufactured by Sport Engineering Ltd.) was used for exercising (running). Heart rate was measured with a Polar heart rate monitor (Model S610) comprised of a receiver unit and a chest transmitter (Model T61; both manufactured by Polar Electro Oy). Heart rate records obtained every 5-seconds were downloaded to a computer via infrared link using the polar precision performance (SW3) software.

2.3.3.2.3 Procedure. Upon showing up for testing, the participant has received detailed explanation about the experimental protocol. Subsequently, she was fitted with the heart rate monitor following which she was invited to sit and relax until a stable reading of her heart rate was obtained (approximately 5-minutes). This heart rate was recorded as the 'baseline' heart rate and it was used for the calculation of maximal heart rate reserve. After the recording of a stable baseline heart rate, the participant was given the POMS for completion. Five minutes later she was invited to the treadmill. The controls of the treadmill, to which the participant had easy access during running, were explained and she was invited to set a pace at which she feels like exercising on that day (i.e., at the time of testing). She was told that both running and jogging is acceptable, but walking is not permitted because in the latter, she would use a different motor-nerve program

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and, hence, a different form of exercise. The participant then started to run or jog for 20 minutes. After the exercise, she was invited to rest quietly for 5-minutes and then she was given the POMS again for completion. At the very end of the session her questions (if any) were answered and then she was debriefed.

2.3.3.2.4 Data reduction and results. The exercise intensity for the 20-minute period was defined as the percent (%) of MHRR like in the pilot experiment. However, instead of a single heart rate measurement, it was based on the average of the 5-second by 5-second heart rate records throughout the 20-minute exercise period. Therefore, continuous heart rate monitoring in this laboratory experiment yielded an overall measure of workload, in terms of the calculated MHRR, for the 20-minute exercise session.

The POMS scores before and after exercise were analysed by using a multivariate repeated measures analysis of variance (MRM-ANOVA). This analysis yielded a statistically significant period main effect, $F(7, 25) = 5.98$, $p = .001$. The follow up univariate analyses revealed that the pre- to post-exercise changes were statistically significant in five out of the seven dependent measures. No significant pre- to post-exercise changes were seen in fatigue and vigour scores. Participants' TMD decreased significantly from pre- to post-exercise $F(1, 31) = 30.98$, $p = .001$, $d = .85$. These results are shown in Table 2.8 and Figure 2.5.

The average percent (%) of the MHRR at which the participants chose to exercise during the 20-minute treadmill running was calculated to be relatively high ($M = 71\%$, $SD = 13.00$). Similar to the field experiment, the range of individual exercise intensities, in terms of %MHRR, was wide (67%). Like in the field experiment, change scores, or pre- to post-exercise difference scores, were calculated for each dependent measure. Their relationship to exercise intensity, operationalized as the percent (%) of the MHRR, was examined through correlation analyses. The results, matching those obtained in the field experiment, were not significant neither for the POMS subscales or for TMD (Table 2.9).

Table 2.8. Means and standard deviations (in brackets) and effect sizes (Cohen's *d*) in seven dependent measures and TMD, pre- and post-exercise performed at self-selected exercise intensity in the laboratory experiment. (NS = statistically not significant; $p > .05$).

Measure	Pre-Exercise	Post- Exercise	Effect size (*d*)	Significance
Anger	7.78 (2.49)	6.47 (1.02)	.53	*p* = .001
Confusion	7.22 (2.41)	5.75 (1.14)	.61	*p* = .001
Depression	8.25 (1.83)	7.38 (1.04)	.48	*p* = .001
Fatigue	9.44 (3.25)	9.34 (3.82)	.03	NS
Self-esteem	17.38 (2.37)	18.75 (2.16)	.58	*p* = .01
Tension	9.91 (3.60)	7.03 (1.33)	.80	*p* = .001
Vigour	14.47 (4.47)	16.03 (4.96)	.35	NS
TMD	10.75(11.19)	1.19 (7.79)	.85	*p* = .001

Figure 2.5. Percent (%) changes in the Profile of Mood States (POMS) scores from pre- (line at 0) to post-exercise after 20-minutes of running - at a subject-selected workload - on a treadmill.

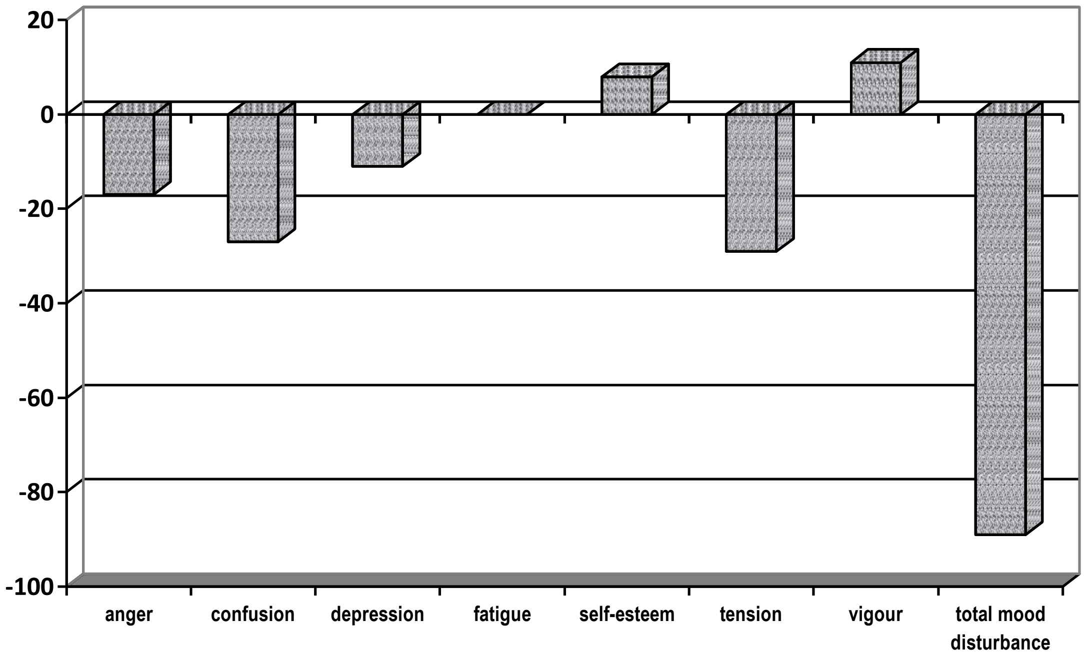

Table 2.9. Pearson correlation coefficients (r) obtained between self-selected exercise intensity, expressed as a percentage (%) of maximal heart rate reserve, and pre- to post-exercise change scores of eight measures of affect in two experiments (a pilot field experiment and a controlled laboratory experiment).

Dependent measure	A pilot field Experiment	Significance	Laboratory Experiment	Significance
Anger	r = .02	p = .87	r = .26	p = .15
Confusion	r = .16	p = .12	r = .32	p = .08
Depression	r = .02	p = .84	r = .15	p = .42
Fatigue	r = .13	p = .20	r = .29	p = .11
Esteem	r = .09	p = .39	r = .08	p = .68
Tension	r = -.10	p = .32	r = -.06	p = .73
Vigor	r = .10	p = .30	r = .06	p = .73
TMD	r = .06	p = .56	r = .19	p = .31

2.3.3.2.5 Interpretation of the findings from the laboratory experiment. The results of the laboratory experiment mirrored those obtained in the field experiment during the pilot work. Again, a 20-minute bout of running or jogging that was performed at the participants' preferred exercise intensity yielded significant positive changes in affect. In this lab experiment, however, the increase in vigour did not reach the accepted level of statistical significance, which could have been due to relatively high vigour scores reported before exercise. Indeed, examination of Tables 2.7 and 2.8 reveal that average vigour scores pre-exercise in the laboratory experiment were higher than those recorded post-exercise in the field experiment. A possible explanation for this finding is that in the laboratory experiment the participants were volunteers who may have looked forward to an exercise session where they had control over the workload, while in the field experiment the participants were required to take part in the study to fulfil an educational exercise. The latter may be associated with lesser initial enthusiasm and hence lower vigour. The same explanation may account for the finding that perceived fatigue has increased post-exercise in the field but not in the lab.

Another notable finding, matching the results of the pilot field experiment, was the lack of correlation between exercise intensity and change scores or difference scores in measures of affect (Table 2.9). In contrast to the field experiment, where the workload was based on a single pulse rate measurement, in the lab it was calculated from the continuous heart rate records, thus giving greater weight and precision of the results. The lack of correlation is noteworthy because it implies that the magnitude of affective-benefits is unrelated to exercise intensity. Therefore, physiological mechanisms, relying on exercise-dose or volume as a mediating factor in the affective beneficence of exercise, may not account for the findings in this study and possibly for the findings in several previous investigations of similar nature.

Another finding, again mirroring those obtained in the field work, was the wide range of exercise workloads selected by the participants. This finding justifies the rationale for using a self-selected workload protocol by showing that preferred workload varies to a large extent among research participants. Research prior to these studies has overlooked this fact, which may have affected sensitive affective measures and their results.

2.3.3.3 General discussion

Results based on two different research approaches show that a 20-minute bout of exercise performed at a participant-selected workload yields positive changes in affect. The effect sizes (Tables 2.7 and 2.8) obtained in these two experiments were comparable or higher than those previously reported in literature (Berger, Grove, Prapavessis, & Butki, 1997; Berger, Owen, Motl, & Parks, 1998). The findings agree with most findings emerging from acute exercise and affect research (Berger & Motl, 2000). Indeed, a meta-analytic review of 158 studies concluded that exercise increases positive mood (Reed & Ones, 2006). However, unlike the bulk of research performed in the past, the two studies reported here involved participant-selected exercise intensities. Matching the results of research using experimenter-set workloads, as well as that of those few inquiries that also used a self-selected exercise protocol (Farrell et al., 1982; Parfitt et al., 2000; Zervas et al., 1993), the current studies clearly show that exercise intensity *is not* instrumental in the acute affective beneficence of exercise.

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These findings are further amplified by the fact that no correlation was disclosed between the magnitude of change in affect and self-selected exercise intensity. Previous research did not examine this correlation. Berger and Motl (2000) thought that setting the exercise intensity for affective benefits is mainly guesswork that is based on exercise intensities from past research that led to positive changes in affect. These authors see moderate exercise to be the most beneficial. This contemplation could be justified by the fact that moderate intensity exercise is the least different from one's preferred or self-selected workload. Berger and Motl (2000) also posit that people's personal preference for exercise intensity may influence the exercise-effect relationship. On the basis of the current results, it is safe to suggest that a participant-set workload may be the most beneficial for immediate or acute psychological gains *after* exercise.

The wide range in the observed participant-selected exercise intensities in both studies reported here indicates that there is high variability in individuals' momentary preferences for exercise workload. This finding means that a single experimenter-set workload is in fact an imposed workload to many research participants. The affective benefits observed after an imposed-treatment reflect relief rather than gain emerging from such treatment. Self-selected exercise intensity, perhaps combined with self-set duration, could be the way forward in futures research to solve this dilemma. To date, however, no studies have directly examined the role of one's control in such research.

From a theoretical point of view the findings seem to support Stoll's (1997) contention that physical models may not properly account for positive changes in affect after exercise. Alfermann and Stoll (1996) observed that both physical exercise and relaxation interventions yielded identical affective benefits and, therefore, Stoll (1997) concluded that physical effort is not necessary for affective benefits to occur. His conclusion is backed up by several studies in the literature showing that physically effortless activities yield affective benefits similar to exercise (Berger & Owen, 1992; Parente, 2000; Snowball & Szabo, 1999; Szabo, 2006; Szabo, 2003a; Szabo et al., 1998b; Wilson et al., 1981). These findings and the current results show that physical effort, especially in a dose-response context, is not instrumental in the post-exercise affect. Consequently, a number of physiological models like the endorphin, thermogenic, or aminergic hypotheses may not account for the psychological benefits of exercise. Based on my findings, I agree with Stoll (1997) that the psychological models could yield the larger proportion of the explanation for these findings.

A further dilemma is that even the existing psychological theories may not fully account for the acute affective effects of exercise. For example, unless there is some ongoing stress the distraction hypothesis (Morgan, 1985) does not apply. A mastery or self-efficacy hypothesis (Paluska & Schwenk, 2000) may only apply if something has been accomplished through the activity. However, the positive changes in affect observed after passive activities (Parente, 2000; Snowball & Szabo, 1999; Szabo, 2003a; Szabo, 2006; Szabo et al., 1998b; Wilson et al., 1981) cannot be linked to achievement behaviours. Therefore, a mastery hypothesis may only be relevant in some achievement situations. Finally, an earlier social interaction model (Ransford, 1982) could not account for positive changes in the laboratory experiments where social interaction is absent.

A more likely explanation for the acute affective benefits of exercise (and some other passive treatments) may be linked to the mental interpretation of the activity that the participant is engaged in. In light of a 'cognitive appraisal hypothesis' (proposed in relation to stressful experiences by Lazarus in 1988), immediate beliefs and thoughts influence the view one takes on the situation or an activity. Consequently, any life-experience interpreted as pleasant is likely to trigger a positive affect (Sandlund & Norlander, 2000). Currently, this is the only common denominator between affective improvements after a bout of exercise and quiet rest (Koltyn & Schultes, 1997). Again, it is stressed that the cognitive appraisal hypothesis only accounts for the immediate pre- to post-treatment changes. It is uncontested that physiological models (La Forge, 1995) could be instrumental in the delayed affective benefits of exercise for which evidence has been produced in the literature (Cox, Thomas, & Davis, 2000; Raglin & Wilson, 1996). It is also agreed that exercise intensity-generated affect *during* exercise (Ekkekakis, Parfitt, & Petruzzello, 2011) may have an impact on the post exercise affect, but rigorous experimental data linking these feeling states in two different phases of exercise are lacking. More research is needed on post-exercise affect to disclose the duration of benefits of various forms of exercises in contrast to rival intervention while keeping in perspective the evidence-based controversy surrounding the current models. In such an effort, the rated perceived exertion (RPE) as a subjective index of the exercise intensity has to be assessed along the objective physiological indices, like the heart rate.

2.3.3.4 Contribution to the advancement of knowledge

The results of two experiments revealed that exercise intensity is unimportant in generating more positive affect, in contrast to pre-exercise measures, after a single 20-min bout of running. While only a few measures of affect were taken in this research, the findings call for the revisiting of the physiological models advanced in the explanation of acute affective benefits of exercise. It is more likely that affective changes triggered by exercise in the immediate post-exercise period are regulated by the subjective cognitive appraisal of the whole exercise session in which control over the exercise workload is instrumental. A wide range was found in the participant-selected exercise intensities, which demonstrates that experimenter-imposed exercise workloads, that often represent an arbitrary research decision, could have been erroneously employed in past research.

2.3.3.5 The take-home message of the study

A 20-min bout of running generates positive changes in momentary mood states or affect that are *independent of the exerted physical effort* or exercise intensity.

2.3.4 Do exercise characteristics influence feeling states after a bout of running?[5]

My work (section 2.3.1) and several other research shows that different forms of exercise yield psychological benefits: walking (Dasilva et al., 2011), cycling (Petruzzello, Snook, Gliottoni, & Motl, 2009), swimming (Valentine & Evans, 2001), yoga (Lavey et al., 2005), dance aerobics (Rokka, Mavridis, & Kouli, 2010), shadowboxing (Li & Yin, 2008), treadmill running (Hoffman & Hoffman, 2008), etc. Running is one of the most popular and least expensive leisure exercises because it can be performed almost anywhere and at any time. Further, as demonstrated

[5]*Based on:* ***Szabo, A.*** *& Ábrahám, J. (2013). The psychological benefits of recreational running: A field study. Psychology, Health & Medicine, 18(3), 251-261. doi: 10.1080/13548506.2012.701755*

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in the two experiments presented in the previous section, running can be performed at a participant-selected workload while one can still experience its psychological benefits. However, in-situ investigation of the psychological effects of planned or self-scheduled run in conjunction with exercise characteristics has not been performed to date, which leaves a question mark about the external validity of experimenter-planned studies. Further, it is possible that other exercise characteristics, apart from exercise intensity, may influence the psychological benefits of exercise.

Based on the two studies presented in the previous section, it can be assumed that the acute psychological benefits of running are dose-*independent* and runners running slower or faster and/or shorter or longer distances, as part of their usual running regimen, may report comparable improvements in affect. In the daily life, recreational runners usually self-select both the duration and the intensity of their running. These two characteristics of exercise could be influenced by various factors and, therefore, in-situ studies examining the psychological benefits of exercise have greater external validity than studies conducted in a controlled, but artificial, laboratory setting or experimenter-planned field studies in which both the duration and intensity of exercise are prescribed for the participants (Ekkekakis, 2009).

This in-situ study was designed to investigate the changes in affect in recreational runners following their planned bout of running, during which they had control over running pace and the duration of the run. Another purpose of the work was to explore the relationship between changes in exercise-induced affect (if any) and four exercise characteristics (duration of run, past running experience, average weekly running times and distances). Based on current information from the literature, it was hypothesized that regardless of the differences in running pace and duration, all runners – *in-situ* - would report improved affect after running. Further, it was posited that there would be little or no relationship between the changes in affect and the duration of the run.

2.3.4.1 Materials and methods

2.3.4.1.1 Participants. Participants for this study were recruited by using the method of systematic randomization. Accordingly, every third runner preparing to start her or his run on a specially designated 5-km long public running path was approached politely by the experimenter and asked to take part in the inquiry. Less than 10% of the approached runners have rejected the invitation to participate in the study. The conditions for participation were that the volunteering runners are at least 18 years old, consent in writing to their participation, run for at least 12 months prior to the current research, and have planned to complete the path at least once (run at least 5 km) on the day of the data collection. A total of 50 runners (37 males and 13 females), who met the above criteria were recruited in the study. Nine runners, that is less than 10% of the volunteers, were refused participation because they did not meet the selection criteria. Participants' mean age was 29.02 years (SD = 6.55), ranging from 19 to 45 years and mean running experience was 69.64 months (SD = 48.07), ranging from 12 to 240 months. The volunteers reported running an average of 33.80 km/week (SD = 11.19), ranging from 15 to 65 km, for an average duration of 171.30 min/week (SD = 49.57), ranging from 90 to 280 minutes.

2.3.4.1.2 Instruments. In conjunction with a demographic questionnaire assessing running habits, like time and distance of weekly runs and running experience, the Exercise-Induced Feeling Inventory (EFI, described in section 2.3.1- Gauvin & Rejeski, 1993; Appendix A) was

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employed because of its reliability as based on several works, proven specificity and sensibility, as well as quick and easy administration. Therefore, the EFI was used to gauge the changes in affect from pre- to post-run. To avoid working with zeros (0), in the current study a constant (+1) was added to the rating scale, making it range from 1 to 5.

2.3.4.1.3 Procedure. After consenting to participate, the eligible volunteers completed a demographic and the EFI questionnaires. This task lasted less than three minutes in all instances. Subsequently, the runner set her/his chronograph while the experimenter recorded the time on the file of the participant. The runner was instructed to run as she/he would do it normally, self-setting the pace of the run, and to stop where the experimenter stood, which corresponded to the start and finish line of the circular 5-km running path. Upon the completion of the run, the elapsed time was recorded again by the experimenter and cross-checked for accuracy by the time measured by the runner. The running times ranged from 23 to 74 min (mean = 39.26 min, SD = 11.88). Within five minutes after the run, the participant rated the EFI again, which marked the end of the testing. At that time, the runner was thanked for participation and in case she/he had any questions or queries they were answered by the experimenter. All test sessions took place during the day, primarily on the weekend, between 10.00h and 16.00h, in dry and sunny weather, with outside temperature ranging between -1^{o} and $+4^{o}$ C.

2.3.4.1.4 Data reduction and analysis. Raw data from the questionnaires were coded and manually entered into a data file. Next, a multivariate analysis of variance (MANOVA) was used to examine whether there were statistically significant differences in the exercise characteristics between men and women. The psychological effects of exercise, as measured with the EFI, were tested by using multivariate repeated measures analysis of variance (MRM-ANOVA). Finally, multivariate regression analyses were performed to investigate the relationship between exercise characteristics and changes in exercise-induced affect as a result of the running. All statistical calculations were performed with the Statistical Package for Social Sciences (SPSS) software, version 17.

2.3.4.2 Results

2.3.4.2.1 Gender differences in exercise characteristics. The 2 (gender) by 4 (time of the current run, running experience (months), weekly running distance (km), and weekly running time (min)) MANOVA yielded statistically no significant results (Wilks' Lambda = .917, $F(4,45) = 1.02$, $p = .41$). Therefore, in the subsequent analyses the four exercise characteristics were studied together for men and women.

2.3.4.2.2 Changes in affect from pre- to post-run. The two (gender) by two (pre- to post-run) by four (indices of affect; positive engagement, revitalization, tranquility, and exhaustion) repeated measures MANOVA yielded a statistically significant main effect for time (Wilks' Lambda = .234, $F(4,45) = 36.9$, $p < .001$), as well as a time by gender interaction (Wilks' Lambda = .705, $F(4,45) = 4.71$, $p = .003$). Therefore, the interaction was followed up first with the univariate tests (automatically calculated in the SPSS), which have revealed that the multivariate effect was due to a time by gender interaction only in exhaustion because women reported greater exhaustion before the run than men ($t(48) = 2.1$, $p = .04$). No statistically significant interaction effect has emerged for the other three measures of affect. Therefore, the multivariate main effects

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were also examined. They have revealed that pre- to post-changes in affect have occurred in all four dependent measures: revitalization ($F(1,48) = 145.93$, $p < .001$, effect size expressed as partial ETA^2 (η^2) = .75), positive engagement ($F(1,48) = 97.11$, $p < .001$, $\eta^2 = .67$), tranquillity ($F(1,48) = 85.02$, $p < .001$, $\eta^2 = .64$), and exhaustion ($F(1,48) = 32.25$, $p < .001$, $\eta^2 = .40$). Means and standard deviations of these results are presented in Table 2.10.

Table 2.10. Means and standard deviations (SD) in four measures of affect before and after running; The percent (%) changes were all statistically significant ($p < .001$).

Measure of Affect	Pre-Run	Post- Run	Change (%)
Revitalization	8,72 (2,33)	12,70 (1,58)	31%
Positive engagement	9,62 (2,47)	12,88 (1,59)	25%
Tranquillity	9,50 (2,03)	12,20 (1,55)	22%
Exhaustion	6,92 (2,55)	4,86 (1,63)	-30%

2.3.4.2.3 Connection between exercise characteristics and changes in affect. Since all the affect scores have changed statistically significantly from pre- to post-run, the difference (Δ) scores were calculated for the four psychological measures. The Δ scores formed the dependent measures of the multivariate regressions performed using four exercise characteristics (duration of the current run, time (minutes) and distance (km) of the weekly runs, and running experience (months) as the independent variables. The regression analyses yielded significant regression models for three out of four dependent measures, the sole exception being exhaustion. Current running time was the only predictor in the model to explain a statistically significant proportion of variance in changes in tranquillity (R^2=.14, $F(1,48) = 8.04$, $p < .007$, Table 2.11). The regression model including the duration of the current run and weekly running distance (dulling the effects) has accounted for a statistically significant proportion of the variance in the changes observed in positive engagement (R^2=.21, $F(2,47) = 6.36$, $p < .004$, see Table 2.11). Finally, running experience (dulling the effect) and the duration of the current run yielded a model that explained 30% of the variance in changes in revitalization. (R^2=.30, $F(2,47) = 10,17$, $p < .001$, refer to Table 2.11).

The findings from this in-situ field study are consistent with previous lab and field research showing that an acute bout of exercise has a positive impact on affect (Anderson & Brice, 2011; Berger & Motl, 2000; Biddle & Mutrie, 2001; Dasilva et al., 2011; Fontaine, 2000; Hoffman & Hoffman, 2008; O'Connor et al., 2000; Paluska & Schwenk, 2000; Raglin, 1990; Szabo, 2003a,b). Further, these results add to the mounting evidence that exercise intensity or the workload is not a factor in generating positive changes in affect after exercise (Alfermann & Stoll,1996; Ekkekakis, 2009; Minjung, Sungwoon, Jingu, Petruzzello, & Hatfield, 2010; Parfitt et al., 2000; Rokka et al., 2010; Szabo, 2003a). This finding may not be surprising knowing for a long time that physically effortless activities also trigger affective benefits similar to exercise (Alfermann & Stoll, 1996; Parente, 2000; Szabo, 2006; Szabo, 2003b). Therefore, the results support Stoll's (1997) view that

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physiological models are not enough to account for the repeatedly observed positive changes in affect after exercise.

Table 2.11. Summary results of the multivariate regression analyses of exercise-induced changes in tranquillity, positive engagement, and revitalization.

Dependent Measure	Components in Model	β (unstandardized coefficients)	Standard error (SE)	β (standardized coefficients)	t	p
Tranquillity	Duration of current run	0.06	.02	0.38	2.84	.007
Positive Engagement	Duration of current run	0.11	.03	0.58	3.50	.001
	Weekly running distance	-0.09	.03	-0.45	-2.72	.009
Revitalization	Running experience	-0.03	0.01	-0.54	-4.04	.001
	Duration of current run	0.09	0.03	0.47	3.48	.001

2.3.4.3 Discussion

The exploration of the relationship between changes in four psychological measures and running characteristics showed that the largest proportion of variance, accounting for changes in revitalization, was only 30% as predicted by running experience and duration of the current run. However, running experience was inversely present in the model, indicating that runners may become habituated to the invigorating effects of running and report lesser revitalization over time. Two exercise characteristics have predicted 21% of the variance in positive engagement: duration of the current run and weekly running distance. The latter was inversely contributing to the model, indicating that habitually longer running bouts may be associated with lesser positive affect. Finally, only 14% of the variance in changes in tranquillity was accounted by the duration of the current run, while exhaustion could not be connected to running characteristics at all.

An emerging question is then, what other factors account for more of the variance in the improved affect following running than the studied exercise characteristics? A recent experiment showing that habitual exercisers responded to acute running with positive changes in affect while no changes were seen in non-exercisers (Hoffman & Hoffman, 2008), could suggest that runners *expect* to experience positive changes after the exercise has been fulfilled. They may feel that they deserve - or should experience - those feelings after working out. Findings from a new study that manipulated subjects' expectation, concerning the psychological effects of exercise, supports this explanation (Helfer, Elhai, & Geers, 2014). This presumption may be even more applicable in-situ than in the laboratory work reported by the Hoffmans and Helfer et al., because in the former the exerciser plans her/his exercise whereas in the latter the exercise is planned for her or him.

Indeed, the acute affective benefits of exercise (and some other passive treatments) may be linked to the mental interpretation (Lazarus, 1988) of the activity that the person is engaged in. In light of this model, desire to engage in an activity should yield positive effects. Consequently, all life-experiences interpreted as pleasant are likely to trigger positive changes theoretically and experimentally (Sandlund & Norlander, 2000). Such an expectation-based effect is a form of self-fulfilled prophecy that matches the expectation model forwarded for the placebo effect (Stewart-Williams & Podd, 2004). This conjecture is strengthened by a recent study in which 10-min bout of jogging improved the mood of the participants and the results were augmented by the biased recall of pre-jogging mood (Anderson & Brice, 2011). Based on these findings, the authors of that work concluded that individuals' expectations regarding the psychological benefits of the exercise influence the results. Three years later the same conclusion was reached by Helfer et al. (2014).

2.3.4.4 Contribution to the advancement of knowledge

The findings from this in-situ research strenghten the current literature concerning the acute effects of exercise on affect. The results also expand the extant knowledge by showing that disregarding workload, distance and duration of running, the acute psychological benefits of exercise can be demonstrated, at least on the basis of four exercise-specific feeling sates mirroring one's affect. The results also demonstrate that the studied exercise components (in this case the characteristics of the running behaviour) may account little for the observed positive changes in affect emerging *after* a single bout of exercise. The current study, in conjunction with the studies presented in the earlier sections of this dissertation, suggest that the psychological benefits of exercise may be due, at least in part, to personal expectations and/or conditioning through pleasant past experiences, both of which are the founding blocks of the placebo response. Therefore, the current results, supported by additional research reports from the literature, lead to the generation of at least one important hypothesis: "*Running - and possibly other habitual leisure exercises - may act as a behavioral placebo in enhancing one's perceived psychological well-being*." Future investigations need to address this conjecture both theoretically and experimentally, and examine the role of the placebo mechanisms in the repeatedly demonstrated acute psychological benefits of exercise. In the interim, the current results should be interpreted as a robust signal for the lesser-than-presumed contribution of various exercise characteristics to the acute psychological benefits after of exercise, specifically running, in a naturalistic environment.

2.3.4.5 The take-home message of the study

An episode of running, *regardless of time, distance or intensity*, generates positive changes in affect almost independently of the exercise habits, suggesting the implication of the *placebo response* in the subjectively reported psychological benefits of exercise.

2.3.5 Evaluation of the research linking placebo responses and exercise?[6]

2.3.5.1 What factors point to the placebo effect in exercise behaviour?

Several theories, attempting to explain the mechanism by which a single bout of exercise triggers improvement in affect and lowers state anxiety, are based on volume or duration and intensity of exercise as key mediators of the psychological effect. Popular physiological theories - reviewed in some detail in section 2.1 of this dissertation - are the endorphin hypothesis (Dunn & Dishman, 1991; Hoffmann, 1997), the amine hypothesis (Dunn & Dishman, 1991; Morgan & O'Connor, 1988), and the thermogenic hypothesis (Koltyn, 1997; Petruzzello et al., 1991). However, there is growing research evidence that sheds doubt on physical explanations, because it is becoming clearer that exercise characteristics have a minimal role in mediating the subjectively reported mental benefits of exercise (e.g., Szabo et al., 2013a; section 2.3.4).

Earlier, Ekkekakis and Petruzzello (1999) have reviewed over 200 studies examining whether the intensity of exercise is instrumental in demonstrating psychological benefits after exercise. Their work showed that high intensity exercise has negative impact on affect, and when exercise intensity is kept at a constant intensity its duration does not matter in gaining mental benefits. Later, Szabo (2003b) and more recently others (Minjung et al., 2010; Rokka et al., 2010) have produced strong evidence showing that the intensity of exercise is unimportant in eliciting psychological benefits. In a relatively recent review, Ekkekakis (2009) examined over 100 reports and concluded that exercise performed at self-selected intensity may be the most appropriate from a health perspective. Therefore, in accord with earlier research (Berger & Owen, 1992; Szabo et al., 1998b), currently there is substantial evidence showing that several modes of exercise, performed at different level of workloads, could trigger positive psychological changes.

In considering the dose of the activity, which is the gist of the physiological models linking exercise to psychological benefits, apart from intensity the duration of exercise is also an important component. For psychological changes to occur, a 10-min brief exercise session appears to be sufficient (Anderson & Brice, 2011; Hansen, Stevens, & Coast, 2001; Sullivan, Covington, Scheman, 2010). Consequently, the results stemming from studies on exercise intensity and duration lend support to Stoll's (1997) suggestion that physiological models alone do not account for the positive psychological changes reported after exercise.

2.3.5.2 Placebo effect: An overlooked neuropsychological mechanism

In medicine and pharmacology the placebo-effects were often perceived as annoying to the treatment conditions. However, in the past decade, substantial support has emerged for the neural responses to expectancy and conditioning. These two mechanisms act as stimuli that may trigger strong brain activities (thought-induced responses), which are responsible for diverse behaviours (Petrovic, Kalso, Petersson, & Ingvar, 2002). Thus, placebos have neurobiological underpinnings and actual effects on the brain and body (for a review see: Price, Finniss, & Benedetti, 2008).

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[6] *Based on:* ***Szabo, A.*** *(2013). Acute psychological benefits of exercise: Reconsideration of the placebo effect. Journal of Mental Health, 22(5):449-55. doi: 10.3109/09638237.2012.734657*

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In case of low volumes of exercise, it is possible that psychological models could be the most appropriate in explaining the acute psychological benefits of exercise. However, currently there are few psychological models that could fully account for the phenomenon. The distraction hypothesis (Morgan, 1985) suggests that taking some time off from the daily routine may yield psychological benefits. For short duration exercises, the time-off or the distraction is too short to expect a notable effect. Further, research also shows that exercisers report experiencing affective benefits after a single bout of exercise while non-exercisers do not (Hoffman & Hoffman, 2008). Possibly, exercisers expect positive psychological changes as a result of past positive experiences, whereas non-exercisers do not. Therefore, expected or conditioned responses to exercise may be more plausible explanations for the psychological benefits than the distraction theory, since both groups have had an equal amount of time-off in the Hoffmans' study.

Stewart-Williams and Podd (2004) claim that expectancy is one of the routes of the placebo effect, the other being classical conditioning. According to these scholars, the placebo effect is a mindset based on classical conditioning and trusted information from social resources or the media. Both of the latter are components of exercise. The invigorating feeling after exercise and the abundant media information about the benefits of exercise could jointly shape the individuals' expectancy and mindset related to exercise. Indeed, a series of inquiries have shown that expectancy mediates the psychological effect of exercise. In a recent work, a 10-min bout of exercise has improved the mood of the participants and the observed effect was augmented by the biased recall of pre-exercise mood (Anderson & Brice, 2011). The report concluded that individuals' expectations regarding the acute psychological benefits of exercise are instrumental in maximizing the observed effects, thus linking the research outcome to the placebo effect. Earlier, Desharnais, Jobin, Cote, Levesque, & Godin (1993) have conducted an experimental study with 48 healthy adults enrolled in a 10-week exercise program. Half of the participants were told that the exercise program was designed to improve psychological well-being while the other half received no information pertaining to the mental benefits of exercise. Instead, they were informed about the physical benefits of the program. While both groups have improved in fitness, the former group also showed a significant increase in self-esteem. The authors have concluded that the placebo effect is a powerful psychological mechanism that underpins their findings. In spite of this awakening work, researchers have neglected the investigation of the role of the placebo effect in the psychological changes resulting from exercise for almost two decades.

The placebo effect is a mind-setting psychological mechanism that could result not only in psychological but also physiological health benefits. For example, in a study by Crum and Langer (2007) 84 female hotel room attendants were given a physical examination. Forty-four of them were told that their work yields sufficient physical exercise, in accord with the Surgeon General's recommendation, for an active lifestyle. The remaining 40 women did not receive such a feedback. While the daily routine of the women and the level of physical activity did not differ between the groups - and did not change over time -, four weeks later the informed group showed statistically significant decreases in weight, blood pressure, body fat, waist-to-hip ratio, and body mass index. Based on their results, the authors concluded that exercise affects health, either in part or in whole, via the placebo effect. However, Stanforth, Steinhardt, Mackert, Stanforth, and Gloria (2011) attempted to replicate these results with 53 university building service workers. Participants in the intervention group were told how their work qualifies as adequate exercise while the other group

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was taught about job safety. Several measures were taken 4 and 8 weeks after intervention. No differences were found between the groups in any of the outcome variables, with the exception of blood pressure that was lower in the intervention group. The researchers concluded that their study did not support the placebo effect. Notable is the fact that both of the above studies have only manipulated people's *expectation* rather than presenting an actual exercise intervention to the research participants. Doing something to achieve a positive and expected result is different from changing the view about an aspect of life and, therefore, expecting changes in several other areas as well. Consequently, there is no control for the actual change of view (and, hence, expectation) in studies that are not using an intervention or are not measuring an overt behaviour.

Building on Desharnais et al.'s study as well as on Crum's and Langer's work, Wullimann (2010) conducted a double-blind study with 64 healthy sedentary adults to test the role of the placebo effect in the benefits of physical activity. Participants were randomly assigned into positive- and negative- expectancy groups, as well as a no-information-bias control group. They were asked to complete a battery of psychological and physiological measures three times: 1) at the beginning of the study, 2) after tracking participants' activity using a pedometer for two days (at this time they were given the positive- (meeting the ACSM guidelines for active lifestyle), negative- (not meeting the ACSM guidelines), and unbiased information about their level of physical activity, depending on which group they were selected), and 3) one-week later to follow up the effects of the expectancy manipulation. The findings revealed that the positive expectancy group has reported increased levels of physical activity and psychological well-being. However, the subjective reports were incongruent with any of the psychological or physiological outcome measures. Wullimann concludes that expectancy manipulation could have an effect on perceived levels of activity and psychological benefits resulting from exercise. This work is important, because most published research is based on subjective reports reflecting the perceived psychological states of the participants, which – as demonstrated by Wullimann (2010) - also include expectancy effects. However, similarly to Crum and Langer (2007) and Stanforth et al. (2011), Wullimann only manipulated the expectancy associated with the *actual* level of physical activity, without introducing an exercise *intervention* program. Therefore, these studies should be cautiously compared to the research in which an exercise intervention has resulted in mental and physical benefits. When participants do something (i.e., invest special effort) in what they believe, the subjective perception of the expected effects may be different from situations where no action is taken apart from a change in the mindset. In the former situation, the work invested in achieving the desired result prompts individuals to expect the merited reward in exchange for their hard work, which a form of mental bargaining leading to expectation.

In a more recent inquiry, Helfer et al. (2014) have exposed 148 participants to an affective *expectation* manipulation and an *elaboration* manipulation. Subsequently, participants cycled for 10 minutes at low-intensity on a stationary bicycle in the laboratory. The participants were re-tested two weeks later again. The results indicated that participants in the affective expectation group showed more positive affect following exercise than participants in the no-expectation group. Further, the affective expectation group who also elaborated on their expectation, reported more positive post-exercise affect two weeks later than the no-elaboration group. The authors concluded that manipulation of the expectations about exercise increases the positive feelings, and further cognitive elaboration increases the duration of the effect. Since the exercise duration was

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short (10 min) and the workload was light in this study the observed between-group differences in the psychological benefits could be attributed to placebo- rather than physiological effects.

It may be assumed that in the everyday life, exercisers most often self-select both the duration and intensity of their activity. These two aspects of exercise could be influenced by a number of factors like feeling in shape, level of fitness, available time for exercise, social environment, equipment or facility at disposition, weather, or - if applicable - tempo of the music attended during exercise (Karageorghis, Jones, & Low, 2006). This self-selection represents a mental evaluation of the dose of exercise one needs at a given time. Therefore, scientists have to deal with a mental programme or a mindset that helps the exerciser to achieve the expected results from her/his exercise. The mindset changes in parallel with environmental changes, that could be both internal (somatic) and external (social/environmental). Those who exercise to "run away" from stress may need increasingly more exercise to cope with the problem and slowly may get on a self-destructive path known as exercise addiction (Szabo, 2010; Part III. of this dissertation).

Indeed, the acute affective benefits of exercise (and some other passive treatments) may be linked to the mental interpretation (Lazarus, 1988) of the activity that the participant is engaged in. In light of this thought, the engagement in a pleasant activity is expected to yield positive effects. Therefore, all the life-experiences that are perceived as pleasant, positive, or beneficial could (and perhaps should) trigger positive changes (Sandlund & Norlander, 2000). This expectation-based outcome is a form of self-fulfilling prophecy that matches the expectation model forwarded for the placebo effect (Stewart-Williams & Podd, 2004). Accordingly, some committed exercisers who pursue their rigorous exercise programs may also seek information about how to maximize the effect or benefits of their training. The gathered information shapes their thoughts about exercise and the exercise behaviour. This change in thought may eventually yield health and performance benefits that could be related to both, an altered training routine (action) and the placebo effect stemming from the thought-shaping information (expectancy).

2.3.5.3 Contribution to the advancement of knowledge

A synthesis of the research, concerned with the role of the placebo effect in exercise-induced feeling states, shows clearly that expectations related to exercise influence the emerging feelings, and the associated subjective reports, following a single bout of exercise. In line with the growing evidence showing that the acute psychological benefits of exercise cannot be explained by physiological mechanisms alone, the need to consider more closely the psychological models is justified. A plausible psychological explanation for the cognitive improvements that were noted even after very short duration (10 min) of light exercise, is the placebo effect. Nevertheless, physical and placebo effects may jointly contribute to the acute psychological benefits of exercise.

2.3.5.4 The take-home message of the review

Personal expectations associated with exercise influence the subjectively perceived psychological feelings after exercise and point to the implication of the placebo effect in the latter.

2.3.6 Do ultra-short and ultra-light exercises alter feelings of well-being?[7]

Relatively recent research evidence shows that positive psychological changes are reported even after a 10-minute brief exercise session (Anderson & Brice, 2011; Hansen et al., 2001; Helfer et al., 2014; Sullivan et al., 2010). Moreover, most of these studies have employed a relatively easy exercise workload. While it is now known that the intensity of exercise has little or no role in generating psychological benefits after exercise (Ekkekakis, 2009; Szabo, 2003a), the minimal duration of exercise, that is capable of producing subjectively perceived psychological benefits, is far from clear.

I have devised this inquiry to answer the research question whether an ultra-brief exercise session of only three-minutes would result in subjectively reported improvement in well-being. This question is important from a public health perspective as well, if one considers the health-risk factors associated with the increasing sedentary behaviour around the world. If three minutes of exercise, especially light or low-intensity exercise, makes a difference, many people would re-evaluate their attitude towards and opinion about physical exercise. The subjective feeling states or momentary well-being can be assessed through the "core affect" as based on Russell's (2003) work. Core affect is conceived as a basic process of conscious neurophysiological state accessible as a simple non-reflective feeling state such as feeling good or bad, feeling lethargic or energised (Russell, 2009). It is the manifestation of the *overall momentary well-being*. The theoretical foundation of the study stemmed from the orthogonal model of affect (Russell, 2009; Warr, 1990) with two main dimensions of pleasure and activation. It was proposed that - since orthostatic changes induce increased arousal (Szabo, 1993) - a very brief and light exercise session could result in improved core affect or overall feeling state, by affecting the activation dimension of the subjective affective state.

Based on recent evidence from the literature that both short duration and low intensity exercises trigger improved well-being, the research hypothesis was that undemanding exercises lasting only three minutes could yield subjective experiences of improved well-being.

2.3.6.1 Study I

2.3.6.1.1 Materials and method. The study was performed at a large urban university. One undergraduate class was randomly selected from among a number of potential classes having lectures on certain days of the week. The exercise-intervention was initially presented as a warm-up to the lectures to the attendees, and no cues for measuring feeling states were given to avoid possible biases in the responses. Upon completion of the study, the actual research question and the hypothesis were disclosed to the participants. Consent for participation was obtained in accord with local and international regulations concerning the ethical guidelines for conducting research with human participants (Harriss & Atkinson, 2011). Individuals who could not exercise for any reason, or did not wish to participate, were excused from the class for the duration of the testing. In this way the remaining - and, hence, consenting - participants were 24 men and 30 women (19.8

[7] *Based on: **Szabo, A.,** Gáspár, Z., & Ábrahám, J. (2013a). Acute effects of light exercise on subjectively experienced well-being: Benefits in only three minutes. Baltic Journal of Health and Physical Activity, 5(4), 261-266. doi: 10.2478/bjha-2013-0024*

yrs, SD=1.5 yrs). Study I was a "within-subjects" design, in which participants acted as their own controls.

Core affect - as the measure of subjectively experienced momentary feeling state - was the only variable of interest. This measure was determined by using a single-item Likert scale (Andrews &Withey, 1976). Participants had to indicate how they felt in that moment on a 10-point scale, ranging from *miserable* (1) to *excellent* (10). The scale was completed immediately before and after three-minutes of exercise. The test took place during the morning hours. The exercise intervention consisted of eight repetitions of the following set of exercises: extend the arms and reach for the ceiling, rotate the neck left and right, rotate the shoulders forward and backward, rotate the trunk left and right, stretch both hands sideways and rotate the arms forward and backward, move the head forward and backward, and shake the arms. The rhythm dictated by the experimenter (without reliance on music or a metronome) was synchronized with the time to ensure that the exercise routine is completed in three minutes.

2.3.6.1.2 Results and discussion. Data were analysed with time (pre-, post-exercise) by gender (men, women) repeated measures analysis of variance using the Greenhouse-Geisser correction method for the degrees of freedom. This test yielded a statistically significant main effect for time only ($F(1,52) = 26.5$, $p < .001$), due to increase in well-being (effect size (d) = .62) from pre- (mean = 6.66, SD = 1.21) to post-exercise (mean =7.44, SD = 1.51). No gender main effect or time by gender interaction was revealed. These results, yielding a moderate to large effect size, demonstrated that three minutes of light exercises trigger measurable improvement in self-perceived feeling states. A moderate to large effect size (Cohen, 1992) substantiates the meaningfulness of the results beyond mere statistical significance. In spite of the anticipated results, in light of extant scholastic evidence and theory, an issue of concern was that habituation or order effect in self-appraisal of feeling states may have contaminated the findings. Therefore, a second study was designed to employ the same experimental protocol as Study I, and to also include a non-exercising, sitting quietly (time-elapse) control-group.

2.3.6.2 Study II

2.3.6.2.1 Materials and method. To replicate Study I, two undergraduate classes were selected from among a number of larger classes, having early morning-lectures during the study-week. The method of participant selection and procedure was identical to that in Study I, with the exception that in a second group (n=48, 12 men, 36 women) a three-minute quiet sitting acted as the control for the exercise bout undertaken by the intervention group (n = 54, 18 men, 36 women). Participants' mean age was 20.3 years (SD = 1.3). In Study II we have used a repeated measures, mixed-model design.

Both groups were tested in the morning. The exercise group performed the same set of exercises, in the same sequence, as did the participants in Study I. The volunteers in the quiet-rest or time-elapse control group were requested to sit quietly and to do nothing for 3 min. After both sessions, the participants were informed about the details of the study.

2.3.6.2.2 Results and discussion. Data were analysed with time (pre-, post-three-minutes) by gender (men, women), by group (exercise, control) repeated measures analysis of variance with Greenhouse-Geisser correction method for the degrees of freedom. This test yielded only a

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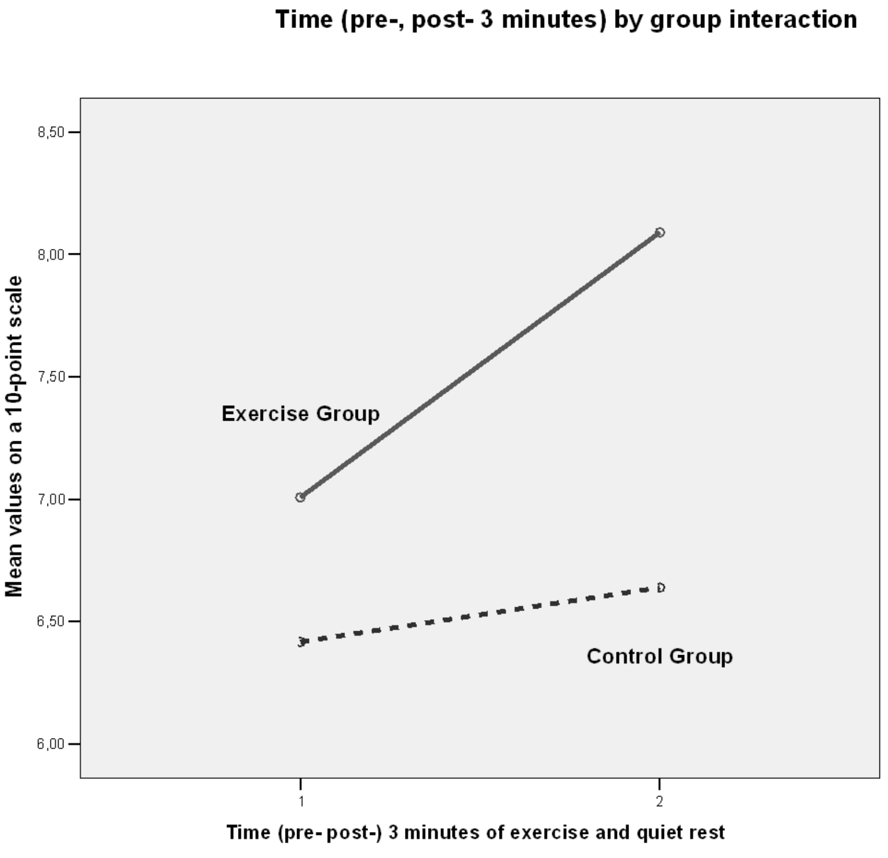
statistically significant group by time interaction (F(1,98) =15.73, $p < .001$) showing that while well-being has increased in the exercise group (t(53) = -8.72, $p < .001$, d =.75) it did not change statistically significantly in the control group (t(47) = -0.81, NS, - Refer to Figure 2.6). There were no initial differences between the groups (t(100) = 1.7, NS), but after the three minutes of exercise and quiet rest the groups' means differed statistically significantly (t(100) = 5.4, $p < .001$). These findings reveal that only three minutes of *light exercises* improve subjective experiences of well-being, or core affect, while such changes do not occur in the sitting quietly control condition.

Figure 2.6. Changes in the reported momentary feeling state of well-being (measured on a 10-point scale) from pre- to post-exercise and quiet rest in the experimental and the control groups in Study II. The continuous line represents the data obtained from the experimental group.



2.3.6.3 General discussion

The present findings, to the best of my knowledge, are the first to demonstrate that a set of undemanding exercises lasting for only three minutes trigger notable changes in subjective feeling states. Clearly, the three minutes of exercises used in the current work could be less than warming-up efforts before fitness or athletic workouts (McMillian, Moore, Hatler, & Taylor, 2006). These simple but robust findings have both theoretical and practical implications.

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Considering the very brief duration of exercise, only two mechanisms could account for the observed changes. The first is increased levels of arousal that could be generated even by short bouts of light exercise. Thayer (1989) showed that a short brisk walk, augmenting the level of arousal, yields positive changes in subjective feeling states. The current investigation employed a very brief and certainly light bout of exercise that, nevertheless, raises the level of arousal, since even simple changes in body position augments arousal (Szabo, 1993). Therefore, in spite of the fact that arousal was not measured in the current research, it is very likely that changes in arousal in the exercise group have led to improved feeling states.

The second plausible mechanism is based on expectation associated with exercise. The expectation may stem from conditioning (i.e., past positive experience), or simply information - based expectancy (i.e., exercise is good). Not long ago, it was shown (Hoffman & Hoffman, 2008) that exercisers report greater psychological benefits after exercise than non-exercisers. However, in the work reported by Hoffman and Hoffman (2008) both groups exercised at the same level and, therefore, must have experienced an augmented level of arousal. Consequently, these results show that changes in arousal *alone* may not fully explain the acute positive improvements in well-being following exercise.

From a practical/applied perspective, this study clearly substantiates the usefulness of planned or adapted interventions of ultra brief exercises at workplaces, schools, and also other environments for immediate improvements in subjective well-being. The effects of repeated short and light exercises during the day could be additive and yield more positive well-being.

2.3.6.4 Limitations and future directions

While the results obtained in Study I and then replicated in Study II show clearly that positive changes in core affect or momentary well-being occur only after three-minutes of light exercises, some issues may be raised and addressed right away. First, it may be argued that the findings cannot be generalized to the general population level because a stratified sample was used. However, if positive changes in this relatively young and healthy sample could be seen, improvements in other segments of the population may be even stronger. Indeed, future studies should look at the magnitude of changes after brief and light exercises in several age groups in healthy people and then do the same with the psychologically challenged population with a view to prevention or treatment of morbidity. Further, in this study core affect was the sole variable examined as a mirror of the subjective feeling state. Future studies should take a wider look at the effects of ultra short and ultra light exercises on various psychological measures. The current results may provide an incentive for undertaking further inquiries in this area with the aim of reducing sedentary behaviour and improving the overall quality of the day in the modern society.

2.3.6.5 Contribution to the advancement of knowledge

The studies reported in this section show clearly that an ultra-light exercise of ultra-short duration has a measurable effect on the perceived feeling state of well-being. Changes in arousal and expectations - regarding the benefits of exercise - may both contribute to improved feeling states after a very short exercise session. The type of exercise used in this study could be adopted

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in almost any public settings or environments in the daily life and could be performed even by those with restricted range of movement. Repeated performance of such exercises - during the day - may result in additive benefits in combating sedentary lifestyle (Garber et al., 2011).

2.3.6.6 The take-home message of the study

Subjective perception of well-being is improved after only three minutes of light exercises.

2.3.7. Summary of the acute psychological effects of exercise

Perhaps the most significant research contribution of my studies on the acute psychological effects of exercise is that exercise intensity - or the physical effort - is not a mediator or moderator of the positive feeling states repeatedly reported after a single bout of exercise. This finding has both theoretical and applied value. First, it discredits the presumed *dose-response* relationship and reshapes the thinking and, thus, the nature of psychological investigations of exercise behaviour. It has an important applied or practical value too, because it sends a clear message that one does not need to work hard to experience psychological gains from exercise. Indeed, even light and short exercise bouts have positive psychological effects (Szabo et al., 2013a). My future research effort will be geared towards the better understanding of the effects of mild exercise on psychological health to answer several questions emerging from my past work. One, is whether several short bouts of exercises during the day have a cumulative effect on the subjective feeling states. Another, is whether these effects are similar across different populations, including different age groups and those suffering of mild psychological disturbances, like borderline depression. Another major challenge is to separate the actual effect from expectancy or conditioning-based placebo effects. The role of subjective beliefs - before the exercise session - needs to be determined and the psychological changes observed after exercise examined in light of the personal expectations.

My next research has to rely on the experience sampling method (ESM: Csikszentmihalyi & Larson, 1987, 2014) to assess the cumulative effects of several short bouts of exercise during the day. *In-situ* studies relying on the retrospective self-analysis of the day (i.e., Dagrou & Szabo, 1998; Szabo et al., 1998a) assess mood instead of affect and may be distorted by the memory and the last life-event before the completion of the questionnaire(s). Probably the two methods yield answers to different questions. The ESM sheds light on the momentary feelings, whereas the recall method only provides an index of the appraisal of one's feelings about the overall day prior to the bedtime. A combination of the two methods, could yield even clearer picture about the cumulative effects of several short bouts of exercises throughout the day of the physically active individual.

In summary, my research results on the acute psychological effects of exercise support the extant reports in the literature, claiming that a bout of exercise generates subjectively experienced positive psychological states. My research also expands the extant literature, by showing: 1) that the effort invested in exercise, or exercise intensity, does not affect the psychological benefits, 2) exercise characteristics, like duration, experience, and weekly amount of exercise, share a little of the variance with the psychological changes reported after exercise, and 3) an ultra-short and ultra-light exercise session could induce an increased feeling of well-being in healthy young people.

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2.4 Psychological Effects of Regular Exercise and Training

2.4.1 Benefits of chronic exercise on psychological indices and personality

Involvement in long term or regular exercise has numerous positive effects on physical health and also benefits one's psychological well-being. Exercise training reduces depression in several populations (Carney et al., 1987; Ensari, Motl, & Pilutti, 2014; Ho et al., 2014; Ströhle, 2009; Tu et al., 2014). A relatively recent literature review by Gogulla, Lemke and Hauer (2012) concluded that the bulk of research claims that physical exercise results in a significant reduction of depression and also lowers the fear of falling in healthy older individuals. However, the evidence was not convincing in older people who had some form of cognitive impairment. The reviewed studies suggested that high-intensity aerobic-forms of exercise or anaerobic workouts appeared to be the most effective in reducing depression, while tai-chi and multimodal training were more effective in reducing the fear of falling. Further, long-term or regular exercisers exhibit greater extroversion than their non-exercising counterparts (De Moor, Beem, Stubbe, Boomsma, & De Geus, 2006; Szabo, 1992) and people who exercise regularly exhibit lower neuroticism than those who do not exercise (De Moor et al., 2006; Szabo, 1992). A recent study showed that physical exercise training helps in reducing symptoms of worry among generalized anxiety disordered patients (Herring, Puetz, O'Connor, & Dishmann, 2012). In contrast to a waiting list control group, the symptoms of worry have decreased after six weeks of bi-weekly interventions in the women participants, in both aerobic exercise and resistance training exercise groups. Consequently, it appears that both aerobic (endurance) and anaerobic (strength) exercises have beneficial long-term effects from a mental health perspective.

In an earlier review by Herring, Connor, and Dishman (2010) it was concluded that in contrast to no treatment conditions, exercise training has reduced anxiety symptoms. The authors noted that exercise interventions that lasted not longer than 12 weeks, used exercise sessions lasting at least 30 minutes, and measured the anxiety over a longer period than the week preceding the end of the intervention, resulted in the largest improvements in anxiety. Milani and Lavie (2009) have shown that apart from the anxiety mediating effects of habitual exercise, regular physical activity is beneficial in the management of stress related illnesses as well. The authors found that psychosocial stress is an independent risk factor for mortality in patients with coronary artery disease, and regular exercise training could effectively reduce its prevalence. The authors claim that exercise training reduced mortality in patients with coronary artery disease in their study, and that the observed effect may be mediated, at least in part, by the positive effects of exercise on psychosocial stress. However, these effects may be indirectly affected by exercise-induced changes in some aspects of personality. A recent review concluded that regular exercise fosters changes in one's personality (Allen & Laborde, 2014). The claim is supported by at least one longitudinal study (Boyce, Wood, & Powdthavee, 2013). Earlier, the link between regular exercise and personality was mainly studied through cross-sectional work, due to the difficulty in devising and completing longitudinal or intervention studies.

While personality was considered to be stable (Brunner, 1969), there is also evidence, from longitudinal investigations, that personality traits may change with various life events (Boyce et

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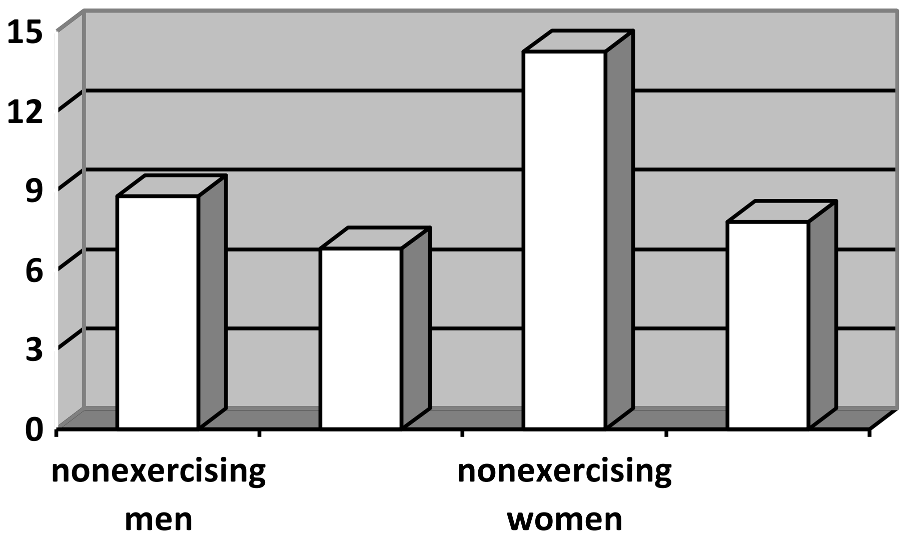
al., 2013). Further, evidence also exists for habitual participation in exercise affecting personality (Chodzko-Zajko & Ismail, 1984; El-Naggar, 1986; Ismail & Young, 1977; Jasnoski & Holmes, 1981; Jasnoski, Holmes, Solomon, & Aguiar, 1981). This evidence, however, may be equivocal (Leith & Taylor, 1990). Among the reasons for the emergence of ambiguous results is the short duration of the exercise programs, which are *very unlikely* to be sufficient to induce changes in personality. Although presumed to be more productive (Ismail & Young, 1977), controlled long-term exercise programs are hard to be carried out due to the conceivably high cost, and subject drop-out rate that could be as high as 40% (Nascimento, Pudwell, Surita, Adamo, & Smith, 2014). Therefore, cross-sectional work may prove to be the most feasible and most practical.

More than 20 years ago, I have examined personality characteristics in relation to long-term (at least two years) exercise participation. In that work (Szabo, 1992), I tested 21 students (12 women and 9 men) who were involved in high-intensity exercise training, at least three times per week, for at least one hour each time, and for at least two consecutive years prior to the study. I also tested another 14 participants (8 women and 6 men), who reported no regular exercise. Using the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1963), I have found that chronically exercising women show greater emotional stability than their non-exercising peers (Figure 2.7). The findings agree with the results reported later by others (Brunes, Augestad, & Gudmundsdottir, 2013; Wilson & Dishman, 2015). I also found that exercising men and women were more extroverted than the non-exercisers. Earlier findings have revealed that committed exercise participation was linked to higher extraversion in men (Brunner, 1969; Howard, Cunningham & Rechnitzer, 1987). It is possible that physical and mental gains from exercise are perceived as repeated or additive feelings of success in habitual exercisers, which appears to be connected to one's level of extraversion (Le, Donnellan, & Conger, 2014). A reverse explanation, favouring the personality-exercise direction, was also submitted recently (Wilson & Dishman, 2015).

Figure 2.7. High neuroticism scores manifested by non-exercising women (Szabo, 1992).



2.4.2 Intervention study on the effects of training on behavioural anxiety[8]

It is a popular belief that exercise reduces anxiety (e.g., Abele & Brehm, 1993; Flory & Holmes, 1991; Morgan, 1985). This popular belief is backed-up by scientific evidence as well (see review articles by Conn, 2010; Kerr & Vlaswinkel, 1990; Kugler et al., 1994; Landers & Petruzzello, 1994; McDonald & Hodgdon, 1991; Petruzzello et al., 1991; Schlicht, 1994). On the other hand, the role of exercise in the psychophysiological response to mental stress is more tentative than its role in the management of anxiety. Some reviews reveal a positive link between exercise and stress-response (Claytor, 1991; Crews & Landers, 1987; Forcier et al., 2006; Takenaka, 1992), while others claim that the two bear little or no association to one another (Jackson & Dishman, 2006; Peronnet & Szabo, 1993; Sloan et al., 2011; Sothmann, Hart, & Horn, 1991; van Doornen, de Geus, & Orlebeke, 1988).

2.4.2.1 Physical activity and anxiety; theoretical link, evidence, and limitations

The mechanism by which physical activity can modify anxiety is still unclear. However, several possible models have been proposed. The *thermogenic* model states that increased body temperature lowers muscle tension (de Vries, 1968) that also lower perceived anxiety (Raglin & Morgan, 1985). The *visceral-afferent feedback* model suggests that the working muscle sends afferent impulses to collateral neurons in the brainstem that elicit an increased stimulation of the ascending reticular activation system (Iwamoto & Kaufman, 1987). At some threshold, inhibitory mechanisms will try to overcome excitation so that the somatic afferent stimulation of the cortex is reduced (Bonvallet & Bloch, 1961). The *distraction hypothesis* (Bahrke & Morgan, 1978) states that a switch in the thought process (focus on exercise) is like a "time-out" from preoccupation with anxious thoughts. The *cognitive-psychological* model (Long, 1993) suggests that on the long-term exercise induces changes in self-concept and self-efficacy, which in turn influence how people judge the severity of a situation. As such, the impact of anxiety-provoking events may be lowered. The *somatic-feedback* model (van Zijderveld, van Doornen, & Orlebeke, 1992) states that adaptation to autonomic arousal, that may result from exercise, lowers the perception of somatic symptoms accompanying anxiety, resulting in fewer complaints by people who exercise. Finally, the *endorphin hypothesis* (Morgan, 1985) suggests that exercise promotes the release of β-endorphins while triggering pleasant feelings of euphoria that counteract anxiety. These models, combined or separately, provide a foundation for the link between physical activity and anxiety.

In a meta-analysis, Petruzzello et al. (1991) concluded that only aerobic exercise has anxiety lowering effects. Further, the anxiolytic effects of aerobic exercise are comparable to the effects of other anxiety-reducing methods, such as relaxation, meditation, or episodes of quiet rest. Three other meta-analyses (Conn, 2010; Kugler et al., 1994; Schlicht, 1994) did not reinforce the superiority of aerobic exercise in decreasing anxiety. These studies found an average (Kugler, et al., 1994) or a minor effect (Schlicht, 1994) for the anxiolytic effects of exercise.

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[8] *Based on: Calvo, M. G., **Szabo, A**., & Capafons, J. (1996). Anxiety and heart rate under psychological stress: The effects of exercise-training. Anxiety, Stress, and Coping, 9, 321-337. doi: 10.1080/10615809608249409*

Although meta-analytic studies provide tentative evidence for exercise's anxiety-lowering capacity (Conn, 2010), contrary findings also exist. For example, one review (Leith & Taylor, 1990) showed that 32% of the studies that examined the connection between exercise and anxiety yielded negative findings. In one of these studies, exercise was related to an increase in anxiety (Cameron & Hudson, 1986). The limitation of the anxiety-mediating effects of exercise to aerobic exercise was challenged in past research. For example, in three inquiries (Berger & Owen, 1987; Martinsen, Hoffart, & Solberg, 1989; McPherson et al. 1967) no differences were found between the anxiolytic capacities of aerobic and non-aerobic forms of exercise. Further, Altchiler and Motta (1994) revealed that the acute anxiolytic capacity of aerobic exercise was superior to non-aerobic exercise, but after eight weeks of training both forms of exercise resulted in lower state anxiety. In line with Conn (2010), the superiority of aerobic exercise in reducing anxiety is not factual at this time and, therefore, the effect of other forms of exercise merits further attention.

On major conceptual and methodologica1 concern, emerging from the studies examined in meta-analyses, is that most inquires examined general and *self-reported* anxiety. Most of them have used the Spielberger State and/or Trait Anxiety Inventory (STAI; Spielberger et al., 1970), or the tension-anxiety subscale of the Profile of Mood States inventory (POMS; Lorr & McNair, 1984). Interestingly, however, none of the studies reviewed by Conn (2010) or Petruzzello et al. (1991) examined *overt* behavioural anxiety. Further, the relationship between cognitive and somatic anxiety was almost totally ignored. Schwartz, Davidson, and Goleman (1978) proposed that exercise may mainly decrease somatic anxiety while other anxiety-reducing interventions (i.e., meditation) may primarily decrease cognitive anxiety. These authors found that, in contrast to meditation, exercise training resulted in lower somatic and higher cognitive anxiety. This concept merits attention, because when anxiety is treated as a general variable the opposing effects of cognitive and somatic anxiety may cancel out each other. Altogether, while meta-analytic evidence for the anxiolytic properties of exercise exists, conflicting reports regarding the type of exercise, the numerous negative findings, and the lack of distinction between the various forms of anxiety, call for significantly more work in this area.

2.4.2.2 Exercise training and reactivity to stress

The surmise that exercise may benefit heart rate response to mental stress was originally based on a *nonspecific* model (Holmes & Roth, 1985). This model suggests that exercise results in a lower basal heart rate and lower absolute heart rate response to a constant exercise-workload. If the autonomic processes are similar in exercise and mental stress, the adaptation to exercise would be also transferred to mental stress situations and result in lower responses to the latter (Brooke & Long, 1987; Claytor, Cox, Howley, Lawler, & Lawler, 1988; Holmes & Roth, 1985; Kubitz & Landers, 1993). However, some reviews present critical evidence that the autonomic response-mechanisms to physical exercise and mental stress are different (Peronnet & Szabo, 1993; van Doornen et al., 1988). Therefore, the nonspecific model may not be totally applicable. Szabo, Brown, Gauvin, and Seraganian (1993b) proposed a modified theory of the nonspecific model. We acknowledged that different mechanisms may be activated by different stressors (i.e., exercise versus mental stress), but we proposed that the homeostatic mechanism, that returns heart rate to

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resting level, may be nonspecific. Therefore, the beneficial effects of exercise (manifested through a more adaptable heart) may emerge during *recovery* from stress.

Heart rate response to mental stress was examined in cross-sectional- and also longitudinal research. Cross-sectional research compared the heart rate responses to stress in high-fit (mostly aerobically-fit) and low-fit subjects. Except for one work (Holmes & Roth, 1985), most studies failed to reveal differences in heart rate responses, during laboratory stress, between high- and low-fit subjects (e.g., Hollander & Seraganian, 1984; Szabo et al., 1993; Szabo et al., 1994). However, following stress-exposure, heart rate returned faster to the baseline in high-fit, than in low-fit people (Hollander & Seraganian, 1984; Jamieson, Flood, & LaVoie, 1994; Keller & Seraganian, 1984; Szabo et al., 1994).

Longitudinal studies, examined the heart rate responses to mental stress after an exercise training program, yielded mixed results. In some research, aerobic training was associated with lower heart rate responses during stress (Blumenthal et al., 1990; Holmes & Roth, 1988; Stein & Boutcher, 1992). One study (Sinyor, Golden, Steinert, & Seraganian, 1986) only found faster heart rate recovery after stress in the trained subjects. Finally, a number of studies found that exercise-training did not influence heart rate response to psychological stress (de Geus, van Doornen, & Orlebeke, 1993; de Geus, van Doornen, de Visser, & Orlebeke, 1990; Seraganian, Roskies, Hanley, Oseasohn, & Collu, 1987; Sinyor, Peronnet, Brisson, & Seraganian, 1988). Based on the incongruity among longitudinal investigations, it is evident that the association between exercise training and heart rate response to mental stress is inconclusive.

2.4.2.3 The presented study

The aim of the here presented intervention study was to examine the impact of a 12-week exercise training program on emotional reactivity under stressful conditions (evaluative stress), as reflected in: 1) self-reported cognitive and somatic anxiety, 2) overt/objective behavioural anxiety, and 3) heart rate response. In contrast to other research, that used aerobic and/or anaerobic training, in this study, we employed an exercise-program that was aimed to the improvement of the global physical fitness including strength, flexibility, and endurance (American College of Sports Medicine, 1991). Unlike in other studies performed in this area, in this work the general notion of anxiety was replaced by the concepts of cognitive and somatic anxiety. Further, in this study the impact of exercise-training on overt behavioural anxiety was also determined. Finally, heart rate response to psychological stress was gauged for two reasons: 1) to ensure that the adopted stressors were challenging to subjects, and 2) to study whether the heart rate response is affected by the adopted form of exercise training. We tested three hypotheses in this investigation: 1) exercise-training is related to lower somatic, but not cognitive anxiety, 2) exercise-training is associated with lower behavioural anxiety in a stressful situation, and 3) heart rate is recovering faster in exercise-trained subjects than the control group.

2.4.2.4 Materials and method

2.4.2.4.1 Participants. The sample consisted of 89 healthy men and women volunteers. The participants' characteristics are presented in Table 2.12. All volunteers were undergraduates

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recruited from among students registered in a two-semester psychology course at a large urban university. Participants were randomised into an experimental (training) and a control (waiting list, no training) group. Fourteen subjects who did not accept to the outcome of the random selection were not included in the study (eight from the experimental and six from the control condition). Participants were tested for exercise history, aerobic fitness level, performance on a physical capacity and skill test, and for a battery of psychological measures (see section *2.4.2.4.3*) to determine whether the subjects in the two groups were comparable at the beginning of the study. Subjects in the experimental group were informed that they will train for 12 weeks. Control subjects were informed that they will be given the same tests as the experimental subjects and that they could participate in training sessions after the experimental group had completed the 12-week programme (waiting list control group). At times when participants in the exercise group trained, subjects in the control group attended seminars on practical issues in psychological research.

2.4.2.4.2 The training programme. The exercise group participated in a one-hour training sessions, three times every week, for 12 weeks in a row. The 12-week program consisted of six consecutive stages, representing six increasing levels of difficulty. Progressive increase of absolute exercise intensity was necessary to maintain a constant level of relative exercise intensity (i.e., to control for adaptation to exercise). The training program was run by a qualified instructor from the university's sports centre. Each training session in all the six stages included strength, flexibility, and endurance exercises in an evenly balanced ratio. Further, each session consisted of a warm-up, a workout, and a cool-down period. The three parts of each session contained about 60 exercises. The warm-up exercises were performed at about 60% of the subjects' maximal heart rate reserve for about 10-15 min and included arm-rotation, walk-jog, trunk-rotation, stretching and other similar exercises. The workout, or the main exercise, was performed at about 75% of the subjects' maximal heart rate reserve for about 35-40 min (depending on the respective exercise stage) and involved exercises like running, climbing and descending stairs, sit-ups, push-ups, stretching, balance and reflex exercises, and the like. The cool-down exercises were performed for about 10 min at about 60% of the maximal heart rate reserve and contained various stretching and relaxation exercises. A minimum of 80% attendance was required for consideration in the study.

2.4.2.4.3 Materials. At the beginning of the study, all subjects were given a series of tests, relevant to emotional reactivity to stress, that included: a) trait anxiety, gauged with the Trait Scale of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970; Appendix F); b) depression, measured with the Beck Depression Inventory (BDI; Beck, 1967; Appendix G); c) satisfaction with life, assessed with the Satisfaction With Life Scale (SWL; Diener, Emmons, Larsen, & Griffin, 1985; Appendix H); and d) general health, gauged with the General Health Questionnaire (GHQ; Goldberg, 1978; Appendix I). In addition, subjects were asked about the amount of weekly exercise that they had performed during the past year. Physical capacity of both control and experimental subjects was assessed before and after the training program to determine the exercise-induced changes. The assessment was carried out in two phases. First, a standard physical capacity and skill test (Blazquez, 1990) was given to all subjects. This test consisted of nine specific measurements: a) best time in 60-meter sprint-running, b) maximal reach-back flexibility test, c) jump-forward test (farthest-distance measured), d) maximal number of sit-ups within 60 s test, e) throwing of a 3 kg (female) or 5 kg (males) ball test (farthest-distance measured), f) dynamic equilibrium test (walking on a 4.5 cm wide gym bar), g) corporal ability test (obstacle-

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running in a field), h) corporal ability with a moving object test (running in a zigzag while kicking a ball), and i) distance running test (1200 m for females and 1600 m for males). Second, subjects' VO_2 max was determined by using the standard Bruce Protocol (Bruce, 1972; DeBusk, 1990). A Quinton 65 treadmill and a Fukuda Cardimax 66 electrocardiograph were used for this purpose.

The stressors were comprised of three tasks, used to create an evaluative stress situation, presented to the subjects. The first, a 5 minute mental arithmetic task, consisted of checking sums in the numeric factor of the Primary Mental Abilities test (PMA; Thurstone & Thurstone, 1979). The number of correct responses was recorded. The second task, a fine motor performance test, the Steadiness test, required that subjects hold a metal-tipped stylus in an apparatus with nine progressively smaller holes (Model 32011, developed by Lafayette Instruments) without touching the sides. Subjects' arm and hand were suspended in the air (i.e., not leaned on the table or the body). An electric impulse counter (Model 58022) recorded the errors (number of times the stylus touches the sides). There was one 20-s practice trial for the larger hole, and a 20-s trial for each of the eight remaining holes, each followed by a 10-s rest interval between trials. The third task, a 5 minute speech, was required from each participant on different topics about popular issues (e.g., “The drugs: Use, dangers, business”). The topics were the same for the experimental and the control group, and the duration of the speech was measured. This stressor was intended to create a strong evaluative stress situation (Sarason & Sarason, 1990) by overtly videotaping the subjects' performance (Otto, 1990) and deliberately giving them ego-threatening instructions (Calvo, Ramos, & Estevez, 1992). Videotaping started before the instructions to observe subjects' behaviour in the anticipatory phase, that also included a 5-minute interval of the preparation of speech. The ego-threatening instructions were given in writing to the subjects and indicated that the purpose of the experiment was to gauge intellectual capacity, psychomotor skill, and linguistic ability along with subjects' heart rate response to measure their resistance to stress. In addition, subjects were told that their individual results on the tasks will be evaluated and compared to those of other students. They were also instructed to perform at their best. Thus, subjects were led to anticipate the evaluation of their competence in a presumably important personal endeavour.

Anxiety measures included self-reported cognitive and somatic anxiety that was gauged with the Cognitive-Somatic Anxiety Questionnaire (CSAQ; Calvo, Alamo, & Ramos, 1990). The CSAQ is a 20-item scale containing ten statements aimed to gauging the cognitive anxiety (e.g., “I am worried about my performance”) and ten statements intended to gouging the somatic anxiety (e.g., “My hands feel moist”). The statements were rated on a five-point scale ranging from not at all (1) to very much (5). Behavioural and verbal anxiety were evaluated according to the method described by Lamb (1978) and Waxer (1977) (see also Bernstein, Borkovec, & Coles, 1986). There were 12 components of the behavioural anxiety measure: lick or bite lips, swallow, clear throat, sigh, grimaces or facial tics, gratuitous torso movements (trunk contortions), bite nails, touch hair, touch face, grab or touch objects, touch the clothes or the body, gratuitous head movements. There were four indices of verbal anxiety: speech blocks, “ah...” sounds during speech, pet words, and avoidance comments. All the indices were determined from the videotaped records by two independent raters who observed the frequency of their occurrence in twenty 15-s (5 minute) intervals. The verbal indices were not assessed in the anticipation phase, because the subjects were silent. The judges were blind to the experimental condition, purpose and hypothesis. The inter-rater reliability was 0.98, that is very high.

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Heart rate was monitored with a photoelectric finger pulse transducer (Biociber, Model CI450) attached to the distal phalanx of the middle finger on the subjects' non-dominant hand, connected to a Letica polygraph (Module LE 135, "cardioback biofeedback", Scientific Instruments). The data were relayed on-line from the polygraph to an ALR-486 computer, in which the signals were digitised, and pulse rate data were averaged on the seconds-basis for subsequent analysis. Recording took place in a temperature and humidity controlled laboratory, which was shielded from noise and dimly illuminated. The subjects were seated in a comfortable armchair. Heart rate was continuously recorded during a pre-baseline adaptation phase (until heart rate became stable; 8 min average), a baseline phase (3 min 30 s), an anticipation phase (6 min), a task phase (16 min), and a recovery phase (5 min). The heart rates were averaged for each phase.

2.4.2.4.4 Procedure. At the beginning of the study, following randomisation into two groups, subjects completed the series of preliminary self-report measures. In the following days, the physical capacity and skill test was performed at the University's Sports Centre, and $V0_2$ max (aerobic capacity) was measured in the Department of Cardiology at the Candelaria Hospital (Tenerife) where subjects' aptness for taking part in an exercise program was also ascertained. Then the 12-week experimental period began, during which subjects trained or attended seminars (controls). Training sessions were given on Mondays, Wednesdays, and Fridays, from 12.00 to 1:00 p.m. for half the subjects, and from 6.00 to 7.00 p.m. for the other half. The laboratory sessions under evaluative stress were carried out for each subject during the first week following the last (12th) week of the training-program. This test session was given only once to each subject to avoid habituation effects (Szabo & Gauvin, 1992) that decrease the impact of stressors. During the same week, $V0_2$ max and motor skill capacities were reassessed.

The laboratory session; sequence of measures: First, after the general instructions to the subjects (about the safety of the procedure, the convenience of staying quiet and relaxed), and the attachment of the electrodes, the physiological stabilisation period began. Next, baseline heart rate was taken. Subsequently, the anticipation phase of evaluative stress started with the placement of the video camera in front of the subjects, the delivery of the ego-threat instructions, and the preparation of the speech. After this stage, subjects were asked to perform the three tasks in the same order: mental arithmetic, steadiness test, and speech. There was a rest-interval of 2-min between the tasks. Subsequently, in the recovery phase, the video camera was removed, subjects were told that there will be no more tasks, and asked to relax. Finally, subjects were requested to fill in the CSAQ, in order to measure the cognitive and somatic anxiety that they were feeling during the task phase.

2.4.2.5 Results

2.4.2.5.1 Preliminary demographic and self-report measures. Possible differences between the groups, at the beginning of the study, were examined with group by gender ANOVA of the dependent variables. There were no significant differences in subjects' a) age, height, and weight (Table 2.12), b) exercise history (Table 2.12), c) performance of physical capacity and skill test (Table 2.13), d) aerobic fitness level (Table 2.12), and e) the psychological measures (trait anxiety, depression, satisfaction with life, and reports of health status; see Table 2.12).

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Table 2.12. Subject characteristics (means, and standard deviations in parenthesis) at the beginning of the study for the control group and the exercise training group.

	Control Group		Exercise Group	
	Males	Females	Males	Females
n	14	31	17	27
Age (years)	21.8 (3.1)	20.9 (2.1)	21.1 (2.7)	21.3 (2.6)
Height (cm)	174 (8.0)	164 (5.6)	175 (7.5)	163 (4.7)
Weight (kg)	74.0(12.1)	59.9 (9.0)	75.6 (9.6)	58.7 (6.4)
$V0_2$ max*	51 (6.7)	46 (3.1)	52 (3.1)	47 (4.3)
Exercise history	1.2 (1.3)	1.0(1.4)	1.3 (1.5)	1.1 (1.2)
Trait anxiety**	39.1 (9.2)	44.3 (10.4)	36.9 (5.5)	47.8 (12.1)
Depression***	7.1 (5.8)	8.5 (7.7)	5.4 (3.4)	7.5 (6.9)
Satisfaction****	27.8 (4.9)	28.5 (7.6)	30.4 (5.1)	7.6 (9.7)
General health*****	76.1 (11.7)	71.1 (16.3)	81.1 (1 1.0)	74.8 (19.5)

NOTE: *Estimated $V0_2$ max = ($ml*kg^{-1}*min^{-1}$); **Trait Anxiety -STAI- Spilberger's State-Trait Anxiety Inventory; ***Depression = BDI - Beck Depression Inventory; ****Satisfaction = SWL - Satisfaction With Life scale; *****General Health = GHQ ~ General Health Questionnaire; cm = centimetres; kg = kilograms; ml = millilitres.

2.4.2.5.2 Changes in physical capacity and aerobic fitness. A group by gender by time (pre- and post-training) by skill test (1-9) MANOVA on the performance in the nine physical capacity and skills tests yielded significant main effects for gender ($F(1,82) = 190.79$, $p < 0.001$) and interactions of group by time, ($F(1,82) = 5.81$, $p < 0.025$) and group by time by skill, ($F(8,656) = 18.20$, $p < 0.0001$). As there was no interaction between gender and group, gender was removed for subsequent two-way ANOVAs on each skill separately. As shown in Table 2.14, there were significant group by time interactions on each skill performance score: Though of different magnitude, in all cases there was an improvement from pre- to post-training for the training group, relative to the control group. A group by gender by time (pre- to post-training) ANOVA on the estimated VO_2 scores revealed main effects for group ($F(1,74) = 13.73$, $p < 0.001$), gender, ($F(1,74) = 32.20$, $p < 0.001$), and time, ($F(1,74) = 27.85$, $p < 0.001$), and also a group by time interaction ($F(1,741) = 9.69$, $p < 0.01$): From pre- to post-training, there was an increase in aerobic fitness level of the training group relative to the control group (refer to Table 2.13).

Table 2.13. Motor skills capacity and aerobic fitness (VO_2) mean scores before (Pre-) and after (Post-) training, for the control group and the exercise training group, and F values as well as probability levels for the group by time (Pre- versus Post-) interaction.

Type of test	Control Group		Exercise Group		
	Pre-	*Post-*	*Pre-*	*Post-*	F^a/p
60 m sprint (s)	10.93	10.85	10.75	10.15	4.94*
jump-forward (cm)	161	156	161	179	5.83**
reach-back (cm)	23.8	23.2	25.2	27.6	16.85***
sit-ups 160 (s)	29.6	31.0	30.9	37.5	19.32***
ball-throwing (cm)	426	429	435	462	4.24*
dynamic equilibrium					
(metres in one min)	14.7	13.3	16.3	24.1	108.05***
obstacle running (s)	24.0	23.8	26.1	19.0	23.67***
zig-zag running (s)	13.8	14.8	13.3	12.7	16.76***
distance run (s)					
1200 (females)	488	497	493	448	16.59***
1600 (males)	498	500	528	43 I	23.45***
$V0_2$ max	47.1	49.0	48.9	53.5	9.68***

NOTE: [a]df(l,87); all cases there were significant differences from pre- to post-values within the exercise group, and between the exercise and the control group in the post-values; *p < 0.05; **p < 0.025; ***p < 0.01; s = seconds; cm = centimetres; min = minutes.

2.4.2.5.3 Reactivity to evaluative stress. Self-reported anxiety. A group by gender ANOVA was performed on cognitive anxiety and somatic anxiety separately. Regarding cognitive anxiety, main effects of group ($F(1,90) = 5.00$, $p < 0.05$) and gender ($F(1,90) = 5.30$, $p < 0.025$) emerged. The subjects in the control group and females reported greater cognitive anxiety than exercise trained subjects and males, respectively (Table 2.14). Concerning somatic anxiety, there was only a main effect for group ($F(1,90) = 6.38$, $p < 0.025$) with control subjects showing greater somatic anxiety than their experimental counterparts (see Table 2.14).

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Table 2.14. Self-reported cognitive and somatic anxiety mean scores (standard deviations in parenthesis) under evaluative stress, as a function of group and gender.

	Control Group		Exercise Group	
Type of Anxiety	Males	Females	Males	Females
Cognitive	8.5 (2.6)	10.4 (4.9)	6.6 (2.9)	8.5 (3.6)
Somatic	11.1 (4.3)	12.6 (7.6)	7.5 (3.2)	10.1 (4.0)

2.4.2.5.4 Behavioural anxiety. A group by gender by anxiety index (1 - 12) MANOVA was performed on the behavioural anxiety scores in the anticipation phase and in the delivery (speech) phase. With regard to the anticipation phase, the MANOVA yielded main effects for group, ($F(1,87) = 5.44$, $p < 0.03$), anxiety index ($F(11,957) = 101.69$, $p < 0.0001$), and a group by anxiety index interaction ($F(11,957) = 1.86$, $p < 0.05$). In order to examine the interaction, two-way (group by gender) ANOVAs were carried out on each anxiety index separately (Table 2.15). These analyses revealed significant differences between the experimental and the control group in the anticipation phase, specifically in two indices: gratuitous movements of the trunk ($F(1,87) = 4.06$, $p < 0.05$) and of the head ($F(1,87) = 9.27$, $p < 0.01$). No between-group differences were found in the speech delivery phase in none of the measures.

Table 2.15. Behavioural anxiety mean scores (number of 15s periods) during the anticipation of evaluative stress, as a function of group and gender (standard deviations in parenthesis).

Behavioural Anxiety Indices	Control Group	Exercise Group
Clears throat	0.68 (0.95)	0.45 (0.90)
Trunk contortions	1.08 (1.21)	0.66 (0.94)*
Bites nails	1.18 (1.88)	0.66 (1.27)
Touches hair	1.54 (1.90)	1.21 (1.40)
Swallows	1.47 (1.61)	1.44 (2.30)
Grabs/touches objects	1.96 (1.64)	1.76 (2.15)
Sighs	2.10 (1.75)	1.64 (1.8 1)
Licks/bites lips	2.26 (2.79)	1.98 (2.73)
Touches clothes	2.23 (1.91)	2.42 (3.21)
Touches face	5.13 (3.73)	4.49 (3.73)
Grimaces /facial tics	5.55 (2.12)	4.98 (4.66)
Head movements	10.95 (4.65)	8.47 (3.33)**

NOTE: *p < 0.05; **p < 0.01 (significant differences between groups in univariate ANOVAs). The total number of 15-s periods = 20.

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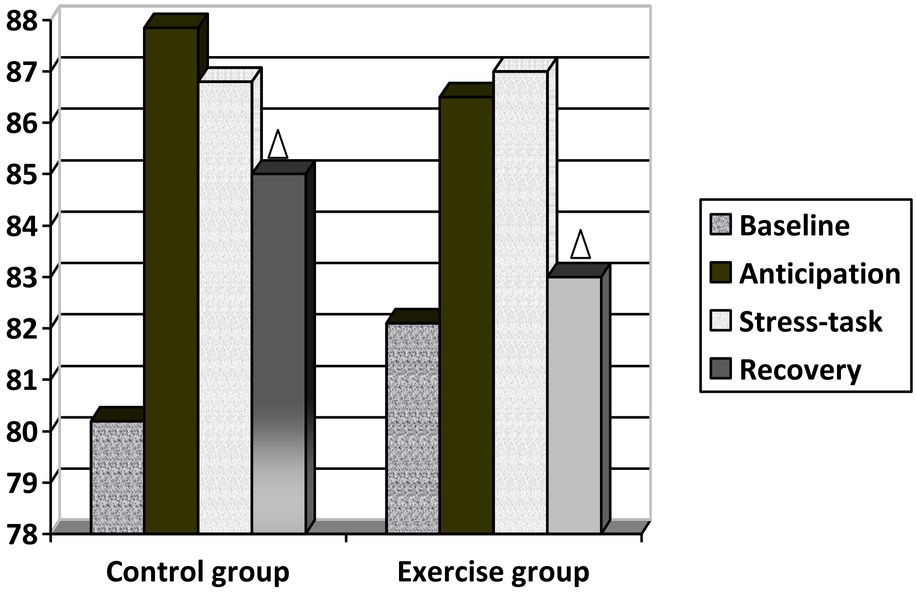
2.4.2.5.5 Heart rate responses to stressors. The group by gender by phase (baseline, anticipation, task, recovery) ANOVA for heart rate yielded a main effect of phase, ($F(3,255) = 17.49$, $p < 0.001$) and a group by phase interaction, ($F(3,255) = 2.68$, $p < 0.05$). Tukey's HSD tests revealed that the heart rate responses of the two groups were significantly different in the recovery phase only (Figure 2.8). In addition, heart rate was greater in the anticipation and in the task phases than during baseline for both groups. Heart rate remained elevated above the baseline in the control group, but there were no statistical differences between baseline and recovery phase in the exercise training group (Figure 2.8).

Figure 2.8. Mean heart rate values (beats per minute) in the baseline, anticipation, stress-task, and recovery phases of the control group and the exercise-training group. The two groups differed statistically significantly ($p < .05$) after the stress-experience, *in the recovery phase* (Δ) only.



2.4.2.6 Interpretation of the findings

Summarizing the most important results of this experiment, exercise training was effective in improving physical capacity and skills, and aerobic fitness of the experimental subjects. Most importantly, and according to the specific aims of this study, exercise was effective in reducing reactivity to psychological stress, in terms of a) self-reported cognitive and somatic anxiety, b) behavioural anxiety during the anticipation of the stressor, and c) the speed of heart rate recovery after stress. This experiment provides support for the beneficial role of regular exercise training in mediating anxiety. It also expands on previous research in three ways. First, it demonstrates that aerobic exercise may not be necessary to influence anxiety, but that a global-fitness oriented mixed-activity exercise can also elicit the desired effects. Second, it suggests that exercise may affect specific forms of subjectively reported anxiety, namely cognitive and somatic anxiety, in stressful situations. Third, it strengthens the relationship between exercise and anxiety by

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revealing that overt, as opposed to subjective, behavioural anxiety is also influenced by exercise-training. The study also lends support to our previous findings, and our model (Szabo, et al., 1993b), that training is associated with a faster heart rate recovery from stress.

2.4.2.6.1 Forms of exercise-training. Although Petruzzello et al. (1991) concluded, in their meta-analysis, that only aerobic exercise is associated with reduction of anxiety, a mere 8.9% of the studies reviewed by these authors have used other or non-aerobic forms of exercise. This figure reflects a strong bias toward the adoption of aerobic exercise. This bias is due to a number of reasons including easy access to participants (i.e., runners may be found everywhere), convenience in explaining connections simply on physiological grounds, and great facility in measuring aerobic exercise-induced training effects by simply gauging the changes in subjects' $V0_2$ max. The belief that aerobic fitness is a necessary factor in mediating anxiety has been challenged with contrary evidence (Altchiler & Motta, 1994; Martinsen et al., 1989; McPherson et al., 1967). Further, none of the studies that compared aerobic and other forms of exercise could divulge the superiority of aerobic training in anxiety management (Altchiler & Motta, 1994; Berger & Owen, 1987; Martinsen et al., 1989; McPherson et al., 1967). Finally, a new review of the anxiolytic properties of exercise concluded that resistance exercise training also alleviates anxiety (Asmundson et al., 2013). Therefore, our findings presented in this research may not be surprising even if they challenge earlier meta-analytic conclusions.

The results of the presented study are important from health and/or "total physical fitness" perspective. The latter has three main components: a) strength, b) flexibility, and c) endurance (American College of Sports Medicine, 1991, 2013). The use of exercise programs that develop all these three components are clearly more beneficial for the general health than the exercises that strengthen only one of them. (Fitness training may be more enjoyable, for some individuals, than aerobic activities due to the high variety of movements involved in it.) In the present study the exercising group improved on all components, including $V0_2$ max. Based on these grounds, the adoption of global fitness-oriented exercise programs may be useful in future research.

2.4.2.6.2 Cognitive and somatic anxiety. In this study, we demonstrated that subjects who exercise-trained reported less cognitive and somatic anxiety, during an anxiety-provoking stress situation, than control subjects following the exercise-training. In this study a pre- to post-training design was not employed to avoid "habituation" effects that are common in these types of studies (Szabo & Gauvin, 1992). Indeed, the findings of an inquiry that examined cognitive and somatic anxiety in relation to exercise (Jambor, Rudisill, Weekes, & Michaud, 1994) may be ascribed, at least in part, to habituation. Jambor et al. (1994) have found that cognitive and somatic anxiety was lower after an eight-week experimental period in both exercising and control subjects. However, in contrast to the here presented study, the anxiety measures were not taken under stressful conditions and, therefore, the decrease in both groups may be related to the fact that at the beginning of the study subjects were more anxious, because of the unknown protocol than at the end of the study. Pre-treatment anxiety is often greater than post-treatment (e.g., Szabo et al., 1993a) in designs involving repeated measurements. Therefore, testing for anxiety levels at post-treatment and under stressful conditions may be more appropriate.

Except for the present study and the two studies by Jambor et al. (1994) and Schwartz et al. (1978), past research examined the anxiolytic properties of exercise by gauging general anxiety. This pattern was criticized by Schwartz et al. (1978) decades ago, who proposed that two

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components, cognitive and somatic, of anxiety should be examined apart. Schwartz et al. (1978) showed that exercise-training was associated with lower somatic anxiety while meditation was related to lower cognitive anxiety. In contrast to the hypothesis, based on Schwartz et al. (1978) findings, in the present inquiry exercising subjects also reported lower cognitive anxiety than controls. One explanation for this finding is that physiological mechanisms do not act alone in the mediation of anxiety. Rather, exercise induced changes in psychological processes (Long, 1993) may also have an impact. For example, changes in self-perceptions (Long, 1993) may shape the way people appraise a stressful situation, which in turn may influence the reported cognitive anxiety. This hypothetical chain reaction, at a psychological level, needs to be addressed directly in future studies to better understand the association between exercise and cognitive anxiety.

2.4.2.6.3 Behavioural anxiety. In contrast to other research that examined subjective and general states of anxiety in relation to exercise, the presented study reveals that overtly observable behavioural anxiety is also lower in subjects who underwent training than in controls under an anxiety provoking situation. Unfortunately, because of a lack of existing research, these findings cannot be discussed in relation to previous studies. They do, however, significantly strengthen the relationship between exercise and anxiety. A possible explanation may be that exercise improves neuromuscular control which is reflected in the capacity to relax or keep still during anticipation of stress. As seen in the present study, trained subjects showed lower behavioural anxiety during the stress-anticipation phase, but not during the coping with stress phase (i.e., while performing the cognitive, motor, and linguistic tasks). In this performance phase, the presumed advantage in motor control is lost. This may be due to the fact that all the coping resources, including the neuromuscular ones, are used in performance, according to the processing efficiency theory of anxiety (Eysenck & Calvo, 1992). Thus, when coping with evaluative stress, the general activation of the physical resources is an adaptive behavioural mechanism, with a general purpose, which overrides a more specific adaptive mechanism such as neuromuscular control. In order to improve neuromuscular control when performing tasks under evaluative stress, specific exercises and/or task-specific practice sessions may be required.

Nevertheless, the facts that, a) in the anticipation phase behavioural anxiety was lower for the training group than the control group, whereas there were no significant differences in heart rate responses, and b) in the task phase, the training group showed less self-reported anxiety than the control group, whereas there were no differences in behavioural or verbal anxiety, reveals an asynchrony among the three response systems (self-report, behavioural, and physiological). This problem has been often encountered, and represents one of the key issues in the assessment and conceptualisation of anxiety (e.g., Bernstein et al., 1986; Fahrenberg, 1992). Therefore, the assessment of anxiety through behavioural and physiological indices, in addition to self-reports, may be necessary in studies exploring the relationship between physical exercise and anxiety.

2.4.2.6.4 Heart rate response to stress. In the present study, the heart rates of the exercising subjects were lower in the recovery phase from stress than the heart rates of the control subjects. These findings agree with previous cross-sectional research that found faster heart rate recovery in the exercise-trained as compared to the untrained subjects (Hollander & Seraganian, 1984; Jamieson et al., 1994; Keller & Seraganian, 1984; Szabo et al., 1994). The present findings also agree with one longitudinal study (Sinyor et al., 1986) in which exercise-trained subjects demonstrated faster heart rate recovery from stress than controls. The results also support our notion (Szabo et al., 1993b), that fitness related differences in heart rate responses are most evident during the recovery from stress. It is important to highlight that the exercise program employed in the present study was not purely aerobic in nature, in contrast to previous research. However, there was an increase in subjects' VO_2 max which has revealed an improvement in cardiovascular efficacy. These results indicate that a global fitness-oriented training program has comparable effects of purely aerobic exercise, with regard to anxiety and heart rate response to psychological challenge. With a total-fitness program, we gained the same results as reported by others with aerobic training program.

2.4.2.7 Contribution to the advancement of knowledge

In this study, we demonstrated that a 12-week total fitness intervention training program, was efficient in increasing fitness, in terms of aerobic capacity and physical capacity and skills. The short-duration multi-exercise intervention, consisting of at least 80% of 36 one-hour training sessions, was sufficient in favourably modifying cognitive, somatic and behavioural anxiety to a set of psychosocial stressors presented in the laboratory. Because laboratory stressors may be perceived as artificial, the effects that we have observed here may be more pronounced under real life stress situations (Chida & Steptoe, 2010). Supporting other studies in the literature, the presented work also demonstrated that a 12-week exercise training program was enough to yield differences in heart rate recovery from laboratory stress. Our research also lends support to our previous presumption (Szabo et al., 1993b) that exercise-training is more beneficial in the after-stress period, because during different forms of stress, different psychophysiological mechanisms may be involved in contrast to a more homogeneous parasympathetic mechanism trying to restore the homeostasis (i.e., return the heart rate to baseline).

2.4.2.8 The take-home message of the study

Training reduces cognitive, somatic, and behavioural anxiety and yields faster heart rate recovery from stress; therefore, exercise has a stress-buffering role that is both physical and psychological.

2.4.3 Summary of the chronic psychological effects of exercise

Chronic or long term effects of physical exercise and training are hard to study. It requires sophisticated exercise facilities and test/laboratory settings in addition to participants who adhere to a training programme that lasts for at least 12 weeks. The nearly 3-month period is essential to disclose even minimal changes. Long ago, Petruzzello et al. (1991) have pointed out that the most reliable anxiolytic effects of exercise training have emerged in intervention programmes lasting 16 weeks, which were statistically significantly different than training programmes lasting only nine weeks or less. However, even 12 weeks of participation could represent major lifestyle changes, commitment, and demanding life-schedule rearrangement for people not previously involved in exercise, which can result in a significant dropout rate. Studies that offer a monetary incentive for participation (i.e., Craft, 2005) may be biased in two ways. First, the participation motive can influence the outcome measures directly or indirectly. Second, paid participants may behave in a

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certain way to "please" the experimenters. However, volunteers too may have different moral and ethical values, or attitudes, as well as personality predispositions (Martin & Marcuse, 1958) that are different from non-volunteers (e.g., those individuals who would not engage in a physical activity programme). The former may have an affinity for or positive expectations related to exercise while the latter may not be attracted at all to a physically effortful activity requiring additional experimental compliances. This is not a new argument, because long ago Rosen (1951) has shown that there are differences between volunteers and non-volunteers in psychological research, the former exhibiting more favourable and positive characteristics. Therefore, a study that also involves substantial physical effort, in addition to psychological measurements, may segregate even further the participants from non-participants.

Nevertheless, longitudinal or intervention studies, reveal that positive changes take place in response to exercise training. These changes appear to be the most reliable in the context of anxiety (Calvo, Szabo, & Capafons, 1996; Herring et al., 2010, 2012) and depression measures Ensari et al., 2014; Ho et al., 2014; Kerling et al., 2015; Ströhle, 2009; Tu et al., 2014). One major challenge for the involved scholastic community is to determine how long the effects of exercise training persist after the intervention, or upon the termination of the exercise programme.

Differences in reactivity to mental between aerobically fit and less fit subjects was shown in one work (Holmes & Roth, 1985), while most others could not reveal differences (Hollander & Seraganian, 1984; Szabo et al., 1993b; Szabo et al., 1994). However, several studies have revealed that following a laboratory stress-exposure, heart rate returns faster to baseline in the high-fit, than in the low-fit research participants (Hollander & Seraganian, 1984; Jamieson et al., 1994; Keller & Seraganian, 1984; Szabo et al., 1994). Longitudinal studies using an exercise intervention, showed that regular training could be linked to lower heart rate responses to stress (Blumenthal et al., 1990; Holmes & Roth, 1988; Stein & Boutcher, 1992) or to faster recovery from stress (Calvo et al., 1996; Klaperski, von Dawans, Heinrichs, & Fuchs, 2014; Sinyor, et al., 1986). A number of earlier inquiries failed to reveal an effect of training on the acute laboratory stress-response (de Geus et al, 1990, 1993; Seraganian et al., 1987; Sinyor et al., 1988).

Given that most of the cross-sectional work and two of the controlled longitudinal and experimental investigations (Calvo et al., 1996; Klaperski et al, 2014) showed a faster autonomic recovery from stress after exercise training, it appears that our earlier argument (Szabo et al., 1993b) holds true. Indeed, we argued that a more efficient cardiovascular system - resulting from regular exercise training - will exert its effects on the stress-response via a faster recovery to pre-stress baseline, thus showing a more efficient resolution of the challenging situation. The heart rate is a crude but sensitive index of the sympathetic activity. Heart rate may increase in response to stress, anxiety, as well as joy. The sympathetic mechanism triggering the response, as argued by Péronnet and Szabo (1993), is different for the different forms of stress, but once the stimuli that caused a sympathetic response is removed, the parasympathetic mechanism may act to re-establish the equilibrium. Therefore, the faster recovery from stress is a manifestation of the more efficient cardiovascular system resulting from exercise training. Overall, the chronic effects of exercise training appear to be less pronounced than the immediate, acute effects of exercise.

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Part II.

The Dim Side: Psychological Effects of Exercise Deprivation

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3.0 Psychology of Exercise Deprivation

From Part I of this dissertation it should be clear that exercise has numerous psychological benefits. The topic has received substantial attention in the literature for at least two main reasons. The first is that modernization and technological development that took place in the past century resulted in an increasingly sedentary contemporary lifestyle that represents a major risk for human health (Owen, Salmon, Koohsari, Turrell, & Giles-Corti, 2014). The second reason is that exercise and regular physical activity is regarded as a personally and socially "correct" form of behaviour associated with social status and image as well as with mass media attention (Wakefield, Loken, & Hornik, 2010). Indeed, chronic exercise, or regular physical activity, has many physiological benefits that are also accompanied by psychological gains (O'Donovan et al., 2010). However, the immediate or instantaneous psychological benefits are linked to acute, or single bouts, of exercise. These benefits last for about 180 minutes after exercise as based on our current knowledge (Szabo, 2006; Wichers et al., 2012). Exercise, like most human behaviour, is motivated by some factors that could be related to health, social issues, mastery, etc. (Ábrahám, Velenczei, & Szabo, 2012; Trembath, Szabo, & Baxter, 2002). A sort of reward, or benefit is the *reinforcer* that motivates people to repeat the activity and to keep up with exercising. The reinforcement could be positive or negative (Freimuth, Moniz, & Kim, 2011; Szabo, 2010). Negative reinforcement is not punishment, rather, like positive reinforcement, increases the likelihood of a behaviour to reoccur (Michael, 1975). Both forms of reinforcements comprising the reinforcer (behaviour) and the reward (outcome) act as motivational incentives for exercise behaviour. The difference between the two is the form of the reward. In positive reinforcement the reward comes in a form of certain *gain*, like fitness, good mood, social benefits, feeling good., etc. In negative reinforcement the reward is the *avoidance* of something negative or undesirable like becoming fat, feeling lethargic, having high blood pressure or high blood glucose level, and the like. Regardless of the outcome (or reward), if the latter is a strong incentive for the individual, the motivation of the person can be expected to be high. If the motivated behaviour, exercise in this case, is prevented for some reason, like other urgent life-obligation, injury, prevented access to exercise facilities, etc., the person will be disappointed, because the relied-on reward is missed. This void causes *negative psychological feelings.* Of course, that would be the case with almost any planned and rewarding habitual or routine activities. In Part II of this dissertation, I will discuss research and theory concerning the psychological aspects of exercise deprivation. Feelings associated with exercise *deprivation* are also known as *withdrawal* symptoms and, therefore, the terms are used alternately.

3.1 Exercise Deprivation Surveys: First Attempts of Data Collection Using the Internet

3.1.1 An Internet-based cross-sectional research on exercise deprivation[9]

Nearly 20 years ago, I have recognized that the Internet may soon become a fertile ground for survey and cross-sectional data collection. Some theoretical publications have appeared in this

[9] *Based on: **Szabo, A.,** Frenkl, R., & Caputo, A. (1996). Deprivation feelings, anxiety, and commitment to various forms of physical activity: A cross-sectional study on the Internet. Psychologia, 39, 223-230.*

context, but the scholastic data-collection did not start yet (Lesgold, 1991; Szabo & Frenkl, 1996). The here presented inquiry was a pioneering attempt to collect scholastic data from the Internet for answering a research question. Readers of five Internet-based activity newsgroups were contacted on their web-forum to participate in the study. The newsgroups were on: aerobic exercise, weight training, cross-training, fencing, and bowling. Respondents were mainly from the United States, Canada, and the United Kingdom, given the initially limited access to the Internet in the world.

It was documented that the interruption of habitual physical activity, for some involuntary reasons, results in negative affect (Chan & Grossman, 1988; Gauvin & Szabo, 1992; Wingate, 1993). This feeling state is referred to as *deprivation sensation* (Robbins & Joseph, 1985). With a few exceptions, like karate practitioners (Wingate, 1993) fitness conditioners (Anshel, 1991), mixed exercisers (Gauvin & Szabo, 1992) and swimmers (Crossman, Jamieson, & Henderson, 1987), most studies examined deprivation sensations in only in runners (Szabo, 1995). Therefore, to determine whether deprivation sensations occur and/or are of comparable intensities in different forms of activity a multimodal-activity comparison is essential.

In examining the issue of deprivation from physical activity, it is important to understand whether the "physical" aspect of the activity or the general performance (associated with some-sort of self-gratification, social-interaction or other forms of reward) is the main contributing factor to the reporting of the intensity of deprivation feelings (Szabo, 1995). Placebo effects, through conditioned behaviour, could also lead to a feeling of void or deprivation (Szabo, 2013), For example, runners report deprivation sensations for the times when they cannot run, but what about the adherers of *physically* less demanding sport like bowling? Would these people also experience negative affect at times when they cannot go bowling for an upcoming reason?

Deprivation sensations may be stronger in people who are highly committed to their form of activity. Chapman and De Castro (1990) reported a positive correlation between the intensity of the deprivation sensations and the level of commitment in male runners. Contrary evidence to this finding also exists (Conboy, 1994). Apart from runners, there are no reports about this relationship with other forms of exercise. This lack of data calls for scholastic scrutiny. While many studies looked to people's reasons for taking part in a physical activity regimen for descriptive purposes, the extent to which they may be related to deprivation sensations at times of forced inactivity was neglected. Limited information stems from a study with runners (Robbins & Joseph, 1985), in which subjects who ran for health reason (therapeutic runners as labelled by the authors) reported greater deprivation sensations, for periods when they were unable to run, than runners who ran for other (i.e., mastery) reason(s). Robbins and Joseph (1985) introduced the notions of *therapeutic* running and *mastery* running to describe two main incentives behind one's personal goals in running. The former is linked to health-related reasons, while the latter includes other reasons, such as a challenge or self-fulfilment. It is unknown whether health, as a reason for involvement in physical activity (other than running), is related to the intensity or severity of deprivation sensations. Therefore, this plausible association, stemming from inquiries with runners, calls for further investigation involving other exercisers.

Apart from the levels of commitment and reasons for involvement in exercise, anxiety was also reported to increase during times of forced inactivity like injury (Leddy, Lambert, & Ogles, 1994) or experimentally required abstinence from running (Tooman, Harris, & Mutrie, 1985). Therefore, people with high trait-anxiety may be more vulnerable to exercise deprivation. The association between trait-anxiety and the reporting of deprivation sensations, however, was not examined in the literature. The impact of exercise deprivation is hard, if not impossible, to study experimentally (Baekeland, 1970; Szabo, 1995, 1998). People who are committed to their activity do not wish to stop their activity for the sake of participating in research. Further, there was a lack of acceptable control of the level of activity of the subjects in all experimental designs (Szabo, 1995). Nowadays that is changing with the wide range of sophisticated, and sometimes relatively accessible, availability of new monitoring instruments (Westerterp, 2014). However, nearly 20 years ago surveys were the easiest means for gathering data on exercise deprivation.

In the reported study, the retrospectively reported deprivation sensations were measured to determine whether they differ, in terms of intensity, in five different forms of physical activity (aerobic exercise, weight-training, cross-training, fencing, and bowling). Another question looked at the relationship between commitment to physical activity, trait-anxiety and the subjectively reported intensity of deprivation sensations. Finally, it was of interest to examine whether there are differences in the level of commitment to exercise and intensity of the reported deprivation sensations between people who exercise for health reason and those who are physically active for other reasons? To clarify these issues the readership of activity-specific discussion groups on the Usenet (newsgroup) was called for participation. These individuals also involve themselves in other than the physical aspects of their activity (as indicated by their adherence to the Usenet) and, therefore, it was presumed that they are highly committed to their activity (Joseph & Robbins, 1981). These Internet-based Usenet groups were formed to discuss training methods, health issues, and sport-specific topics in English.

Computer assisted data collection was started by government offices in the United States and Europe in the 1970s-1980s (Thornberry, Rowe, & Bigger, 1991). This new method, due to its efficiency with regard to cost, speed, and access, was spreading quickly. In the Netherlands, for example, there were over 3000 applications in one month in 1990 (Saris, 1991). The consistently increasing access to public access computer networks has started the data collection on these media (Gonzales, 1990). Two decades ago, it was already predicted that network technology for multiperson research will emerge at a rapid rate when computer network media will be common (Lesgold, 1991). At the time of the here reported study, however, there were still no published reports of similar research in the field of Psychology. At the time of this study, Szabo and Frenkl (1996) have formulated a set of guidelines for Internet research by following the directions of the American Psychological Association (APA) for traditional research. While keeping in perspective the guidelines and limitations of this novel method of data-gathering, in this inquiry, we have attempted to conduct one of the earliest and, therefore, pioneering study on the Internet.

3.1.1.1 Materials and method

3.1.1.1.1 Participants. One hundred and thirty (130) readers of five discussion groups (Usenet / newsgroups) on the Internet took part in the inquiry. The groups were selected to represent five forms of physical activity: 1) aerobic exercise, that included various exclusively aerobic activities like running, jogging, swimming, aerobic dance, brisk walking, and the like, 2) weight-training (almost exclusively anaerobic exercises), 3) cross-training (a mixture of both aerobic-anaerobic activities embracing the regular performance of four or more different activities), 4) fencing, and 5) bowling (minimal physical exertion or control group). The criteria for participation demanded that respondents be aged at least 18 years or over, practice their activity at least two times per week, and understand English fluently. Interested respondents were clearly informed that the completion and returning of the questionnaires implies that they consent to participate in the study. The respondents' characteristics are illustrated in Table 3.1.

3.1.1.1.2 Instruments. Three questionnaires were used. Trait anxiety was measured with the Spielberger Trait Anxiety Inventory (STAI – Spielberger et al., 1970; Appendix F). This inventory consists of 13 negative and 7 positive items. The scale's internal consistency (as determined a posteriori in this reported study) was excellent (Cronbach alpha (α) =.86) in comparison to the originally reported scale (α =.83). Deprivations sensations were assessed with the nine-item Deprivation Sensation Scale (DSS) developed by Robbins and Joseph (1985). The scale contains items describing negative affect, like restlessness, guilt, or irritability (at times when one cannot exercise for an upcoming reason), that should be rated on a seven-point rating scale ranging from *never* to *often*. In this study the internal consistency of the DSS was very good (α =.81; Appendix J). The internal consistency of the original scale was not reported. Last, commitment to subjects' adopted activity was measured with the Commitment to Physical Activity questionnaire (CPA - Corbin, Nielsen, Borsdorf, & Laurie, 1987; Gauvin & Szabo, 1992) that was modified from the Commitment to Running Scale (Carmack & Martens, 1979; Appendix C) by simply replacing the word "running" with "physical activity". The scale contains six directly rated items, such as "I am looking forward to (my) physical activity" and six inversely rated items, such as "I do not enjoy (my) physical activity". All items are rated on a five-point rating scale, ranging from one (strongly disagree) to five (strongly agree). In this study, the internal consistency of the 12-item CPA scale was lower, but good in comparison to the original scale (α =.78 versus .88).

3.1.1.1.3 Procedure. A three-part message was posted on five physical activity-groups or forums on the Internet. These were: *misc.fitness.aerobic*, *misc.fitness.weights*, *rec.sport.triathlon*, *rec.sport.fencing*, *alt.sport.bowling*. In the first part of the call, the aim of study and the criteria for participation were described. The second part asked for subjects' characteristics (Table 3.1) and the reason for which they have started and (now) maintain their chosen activity. The third part contained the questionnaires. The study was posted once every week for 12 consecutive weeks. While repeated posting was necessary to access new readers, the 12-week limited duration was *pre-established* to minimize annoyance to habitual readers and to readers who have already responded to the call. All replies were received via electronic mail that guaranteed confidentiality.

3.1.1.2 Results

Univariate analyses of variances (ANOVA) revealed group differences in age ($F(4,125) = 3.1$, $p < .02$), weekly frequency ($F(4,123) = 16.4$, $p < .001$) and duration of activity ($F(4,121) = 19.8$, $p < .001$), as well as in the intensity of the self-reported deprivation-feelings ($F(4,125) = 11.1$, $p < .001$). A posteriori tests (Tukey's HSDs) revealed that fencers were younger than subjects in the aerobic exercise group ($p < .01$; for the means, please refer to Table 3.1). With regard to the weekly frequency of the chosen activity, bowlers participated in less weekly sessions than subjects in the other groups, except the fencers ($p < .01$). Cross-trainers also worked-out more

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Table 3.1. Trait anxiety, deprivation-feelings and commitment to exercise in five physical activities. Subjects' characteristics (means and standard deviations (SD) in parenthesis) - AE = aerobic exercise, WT = weight-training, CT = cross-training, FE = fencing, BW = bowling. The values in the table are rounded.

Measure			Groups		
	AE	WT	CT	FE	BW
Total of cases (n)	30	24	21	30	25
Age (years)	35(10)	29(7)	33(9)	28(8)#	31(6)
Activity history (months)	95(85)	91(83)	146(88)	93(70)	135(91)
Weekly frequency	5(1)	4(1)	5(1)	4(1)	3(1)*
Duration (min)	70(39)	71(26)	81(25)	119(44)	152(55)
Trait anxiety (out of 80 max)	36(7)	33(7)	33(8)	37(9)	38(9)
Deprivation sensations (out of 63 max)	34(11)	30(8)	29(9)	31(9)	19(7)**
Commitment (out of 60 max)	49(8)	51(4)	50(5)	50(6)	52(4)

NOTE: # Significantly younger than respondents in the AE group; *Bowlers practiced less per week than subjects in the other groups;**Significantly different from the other groups.

frequently than fencers and weight-trainers ($p < .01$), but did not differ from aerobic exercisers. The latter exercised more often that fencers ($p < .01$). With regard to the duration of the activity, bowlers spent more time with their activity than all other groups ($p < .001$) including fencers $p < .03$). Fencers also spent more time with their activity than the subjects in the other groups, except bowlers ($p < .01$). Finally, bowlers reported less intense deprivation sensations, for the times when they cannot bowl for an involuntary reason, than respondents from the other four groups ($p < .001$; refer to Table 3.1).

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The reasons given by the subjects for starting and maintaining their activity were classified into two categories: health and other reason. As noted earlier, this classification was based on the therapeutic and mastery exercise concepts of Robbins and Joseph (1985). The testing of why respondents started their activity, by employing univariate analyses of variances, revealed significant effects for trait-anxiety ($F(1,124) = 5.5$, $p < .02$) and deprivation sensations ($F(1,126) = 7.3$, $p < .008$). Accordingly, respondents who became active for health reason (n = 58) reported less trait-anxiety (mean = 33.9, SD = 6.8) than respondents who started their activity for another (than health) reason (n = 70, mean = 37.2, SD = 8.8). The former also reported stronger deprivation sensations (mean = 31.3, SD = 10.4) than the latter (mean = 26.5, SD = 9.6). Subjects who maintained their preferred activity for health reasons (n = 47) also reported lesser trait-anxiety (mean = 33.2, SD = 7.0) and lesser commitment to their activity (mean = 48.8, SD = 6.3) than respondents who continued to be active for other reasons than health (n = 81, mean = 37.2, SD = 8.4, $F(1,124) = 7.1$, $p < .009$, for trait-anxiety and mean = 51.3, SD = 5.0, $F(1,126) = 6.3$, $p < .01$, for commitment to physical activity). There was an only marginally significant difference in the reported deprivation sensations between the two groups ($F(1,126) = 3.4$, $p < .07$). Accordingly, respondents who were physically active for health reasons tended to report more intense feelings of deprivation (mean=30.9, SD=11.2), for the times when they could not be active for an involuntary reason, than subjects who were active for other than health reasons (mean = 27.7, SD = 9.5).

Bonferroni corrected correlations only yielded a significant positive relationship between the weekly frequency of the activity and deprivation sensations ($r = .29$, $p < .01$). However, the coefficient of determination was low ($r^2 = 0.084$, or 8.4%.). Nevertheless, due to this correlation, the analyses on deprivation sensations were also examined with the analyses of covariance, using weekly frequency as the covariate. The latter was not significant and none of the results changed.

3.1.1.3 Discussion

Retrospectively reported deprivation sensations, for the times when one cannot fulfil the need of a chosen activity, appear to be "non-specific" when there is a significant "physical" component to the activity. Bowlers, who were as highly committed to bowling as subjects in the other groups, reported lesser deprivation feelings than the others. In terms of physical effort, bowling is physically less demanding than the other four activities scrutinized in this inquiry. Therefore, it is likely that the degree of the "physical" component in a given activity, that may be associated with health benefits, influences the perception and/or description of affective states at the times when activity is hindered by some reason.

This finding strongly suggests that a "physical" facet of an exercise behaviour may be a key contributor to the feelings associated with the inability of fulfilling that routine behaviour. Again, it should be emphasized that bowlers were strongly committed to their activity, thus the level of commitment could not play a role in the disclosure of these findings. While a significant positive correlation was found between the weekly frequency of the performance of habitual activity and the intensity of deprivation sensations, the former could not be attributed to the differences seen between the bowlers and the other groups, since the analysis of covariance, using weekly frequency as covariate, also yielded the same results as the univariate analysis of variance.

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These results cannot be discussed in relation to other studies, because no comparable research was performed until now.

Subjects who started their activity for health reasons reported more severe deprivation sensations that those who became active for other than health reasons. Further, albeit marginally significant, respondents who continued their usual activity for health reasons also tended to report more powerful deprivation sensations than those who remained active for other reasons. These findings agree with previous results obtained by Robbins and Joseph (1985) with runners. One possible explanation for these findings is that people who rely on their activity, as a method of mastery of their health, lose their principal coping resource (exercise) at times of coerced inactivity and, therefore, perceive deprivations sensations as more intense than others (Robbins & Joseph, 1985).

The only significant finding in relation to trait-anxiety was that respondents who both started and maintained their activity for health reasons reported lower trait-anxiety than those who became active and continued to be active for other reasons. Regrettably, the literature does not supply an explanation for this finding. It is only possible to speculate that people who are active for health reasons attribute a strong "coping" significance of their activity. In other words, they strongly believe that their activity improves, maintains, or positively influence all aspects of their health and lifestyle and they convey these convictions in their responses.

People who continued their activities for health reasons also reported lesser commitment to their activity than respondents who were active for other reasons. This finding is in contrast, at least in part, with a previous study in which a link was disclosed between the reasons of the maintenance of running for psychological health and the degree of commitment to running in a positive direction (Carmack & Martens, 1979). It should be noted that the comparison between the here reported study and that of Carmack and Martens (1979) may not be appropriate, because in the latter study health reasons were divided into physical and psychological health and the subjects were only runners. A plausible explanation for the current finding is that people who are active for health reasons, mostly wish to fulfil a sort of self-obligation, like taking a pill, and derive lesser pleasures that bound them otherwise to the activity. On the other hand, people who are physically active for other than health reasons (which may include: challenge, socialization, fun, or some form of mastery) gain some sort of subjective pleasure that binds them strongly to the activity. For example, people who exercise for health reasons may be motivated by negative reinforcement (i.e., to avoid illness) while people who exercise for other reasons may be motivated by positive reinforcement (i.e., deriving pleasure and self-recognition) in the maintenance of the adopted activity. This issue is important and, therefore, deserves systematic attention.

Overall, the results of this earlier study demonstrate that: 1) deprivation feelings are related to the physical aspect of habitual activities; 2) the reasons for starting and/or maintaining a preferred activity (when grouped under two categories of health and other reasons) influence the perceived deprivation sensations at times of coerced inactivity, trait-anxiety, and commitment to the adopted activity; 3) the frequency of performance of the adopted activity is directly related to the reporting of the intensity of deprivation sensations at times when one cannot be active for an involuntary reason; and 4) the gathering of cross-sectional data on the Internet appears to be both feasible and reliable. The latter point is substantiated by the finding that the internal consistencies

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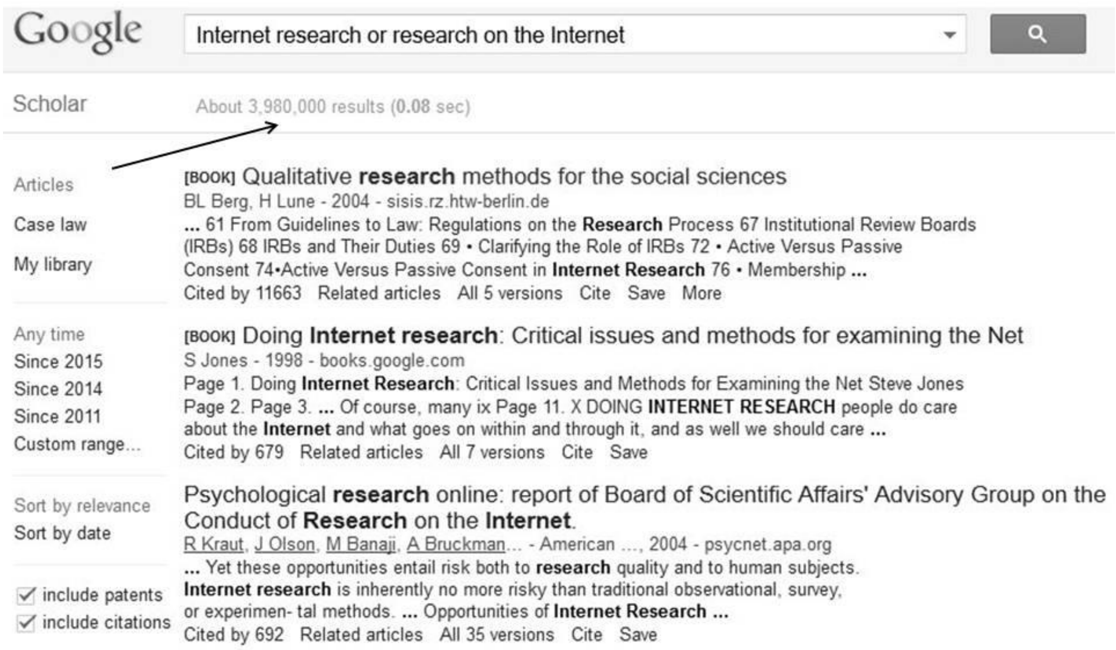
(see Materials section) of the three questionnaires used on the Internet were very good in this sample and comparable to the values furnished by the developers.

Due of the novelty of this form of data-acquisition method, a few cautionary statements should be emphasized. Public access to the Internet at the time was common and increased almost exponentially, but only in some technologically advanced sociological areas. Even in those areas, at the time, the access was limited to the advantaged individuals. Therefore, research findings gathered via this method could have been be restricted to upper social class people from some developed nations. Indeed, in this study more than 90% of the subjects were from North America. These factors are important if the class and cultural issues could bias the results. Except for trait-anxiety (which may not be a problem with a > 90% North American sample) the studied variables were not reported to be affected by cultural or social factors. Nevertheless, it is advised that the reader keeps in sight these limitations and interprets the current results accordingly. It should be appreciated that Internet research at the time of this study was in its infancy and much had to be learned before matching the conventional research strategies. However, this learning process called for more exploratory work of this kind. To the best of my knowledge this was the first data-collection attempt on the Internet to also address the reliability of psychometric tools in the virtual space. It was among the first (if not the first ever) study in Psychology and surely the first study in the field of Sport Science that has moved a research question-addressing scientific inquiry to the Internet platform. Today the words "Internet research" or "research on the Internet" appear nearly 4 million times in a Google Scholar search (Figure 3.1)

Figure 3.1. The results of a Google Scholar search involving the keywords "Internet research" or "research on the Internet". The search was performed on January 01, 2015, 10.48 am.



3.1.1.4 Contribution to the advancement of knowledge

The here reported work has at least two noteworthy contributions to the advancement of the scholastic knowledge. The first is that is shows that psychological feelings of deprivation - as based on retrospective subjective reports - do not differ among various types of physical activities in the highly committed exercisers, but it is lower in a lesser physical effort-involving leisure activity, like bowling. Simultaneously, the study shows that people who exercise for some health-related reasons report stronger feelings of deprivation at times when the physical activity cannot be performed for any reasons, in contrast to the individuals who exercise for other than health reasons. The second major contribution of this research is that it was perhaps among the very first attempts to conduct a study on the Internet and gather valuable scholastic results that were published in a peer reviewed publication. While research attempts on the Internet were documented earlier (e.g., Hewson, Laurent, & Vogel, 1996), the results of those works were only published in conference proceedings, to the very best of my knowledge. Finally, - based on an extensive literature search - this study appears to be the first to show that the internal reliability of psychological questionnaires completed on the Internet may be as good as those obtained via the traditional research methodology.

3.1.1.5 The take-home message of the study

Feelings of deprivation from exercise occur over a range of different physical activities and health reasons for exercising are associated with stronger feelings of deprivation. The Internet appears to be a reliable medium for survey research with humans.

3.1.2 Psychological aspects of running: Another Internet-based survey research[10]

Although decades ago Sachs (1981) differentiated between commitment and addiction to running, succeeding research implying an identical meaning to these two different concepts has still emerged (e.g., Rudy & Estok, 1989; Thornton & Scott, 1995). The confound was a result of a shortage of studies examining commitment and addiction to running on theoretical and conceptual grounds. While parallel terms to running-addiction, including obligatory running (Blumenthal, O'Toole, & Chang, 1984; Yates, Leehey, & Shisslak, 1983) and/or dependence (Lyons & Cromey, 1989: Pierce, 1994), were used to denote addiction, commitment is a different concept (Conboy, 1994; Sachs, 1981; Sachs & Pargman, 1984; Summers & Hinton, 1986).

3.1.2.1 Commitment to running

Commitment to running is a measure or index of how dedicated and devoted a person is to running behaviour. It is a measure of probability that could predict the maintenance of running

[10] *Based on:* ***Szabo, A.,*** *Frenkl, R., & Caputo, A. (1997). Relationships between addiction to running, commitment to running and deprivation from running: A study on the Internet. European Yearbook of Sport Psychology, 1, 130-147. ISBN 3-88345-740-X*

behaviour in lack of impeding events, such as injuries or other hindering commitments. In terms of the motivational theories, it reflects the *intensity of effort* (Brehm & Self, 1989) with which a human activity is pursued. For the committed runner, satisfaction, enjoyment and achievement derived from running are incentives that motivate the continuity of the behaviour (Chapman & De Castro, 1990). Sachs (1981) regarded commitment to running as a result of intellectual analysis of the rewards, including social relationships, health benefits, status, prestige, or monetary advantages, gained from the sport. Committed runners, in Sachs's (1981) view: 1) run for extrinsic rewards, 2) view running as an important, but not a salient part of their lives, and 3) do not suffer of severe withdrawal symptoms at times when they cannot run (Summers & Hinton, 1986). Commitment was often seen as "positive addiction" (Glasser, 1976; Morgan, 1979) to imply the same meaning (Carmack & Martens, 1979; Pierce, 1994). However, this definition disagrees with the behavioural conceptualization of *addiction* (e.g., Rozin & Stoess, 1993) that is akin to compulsive behaviour. Addiction cannot be correctly labelled as "positive".

3.1.2.2 Obligatory running

Obligatory runners (Sachs, 1981; Summers & Hinton, 1986) are individuals who feel "obliged" to run. For them, running is more than a pleasurable hobby or even goal-oriented task, it is a chore. Obligatory exercise has three dimensions: 1) dose or volume of exercise, 2) negative psychological feelings (e.g., when missing an exercise session), and 3) heightened preoccupation with exercise (Ackard, Brehm, & Steffen, 2002). However, as it will be discussed in Part III of this dissertation there are several other aspects of obligatory exercise, including some common symptoms. The terms obligatory exercise, exercise addiction, and exercise dependence are the most popular connotations of the behaviour and the terms are used interchangeably. In contrast to the committed runners, obligatory runners: 1) are more likely to run for intrinsic rewards, 2) view running as the chief part of their lives, and 3) experience strong deprivation-sensations when they are unable to run (Sachs, 1981; Summers & Hinton, 1986). Motivation for running is another distinguishing feature between commitment and addiction to running. Obligatory runners may be motivated by negative (i.e., to avoid withdrawal symptoms) and/or positive reinforcements (i.e., runners' high; - Pierce, 1994; Szabo, 1995). However, negative reinforcement, or avoidance, is rarely a motivating factor for the committed exerciser (Szabo, 1995).

Thus addiction to running can be distinguished from commitment. The former is often termed as *negative addiction* to denote destructive effects (e.g., Morgan, 1979) and to imply that a transition from commitment, which is erroneously viewed as a previous phase (Sachs, 1981), to addiction has taken place. At that point the behaviour starts to control the person. De Coverley Veale (1987) sets a few criteria for exercise addiction in general: 1) stereotypic exercise pattern, 2) increased priority over other life-activities, 3) increased exercise-tolerance, 4) severe withdrawal symptoms during periods of exercise interruption, 5) intentional avoidance of withdrawal symptoms, 6) awareness of the compulsion to exercise, 7) relapse after abstinence, 8) weight-loss for the sake of performance, 9) continuation of exercise despite of an injury, and 10) conflicts in human relations due to the excessive exercise (De Coverley Veale, 1987). Therefore, obligatory running, or exercise addiction, was (and still is) often viewed as a treatment-requiring condition (Blumenthal, Rose, & Chang, 1985; Sachs, 1981; Weinstein & Weinstein, 2014).

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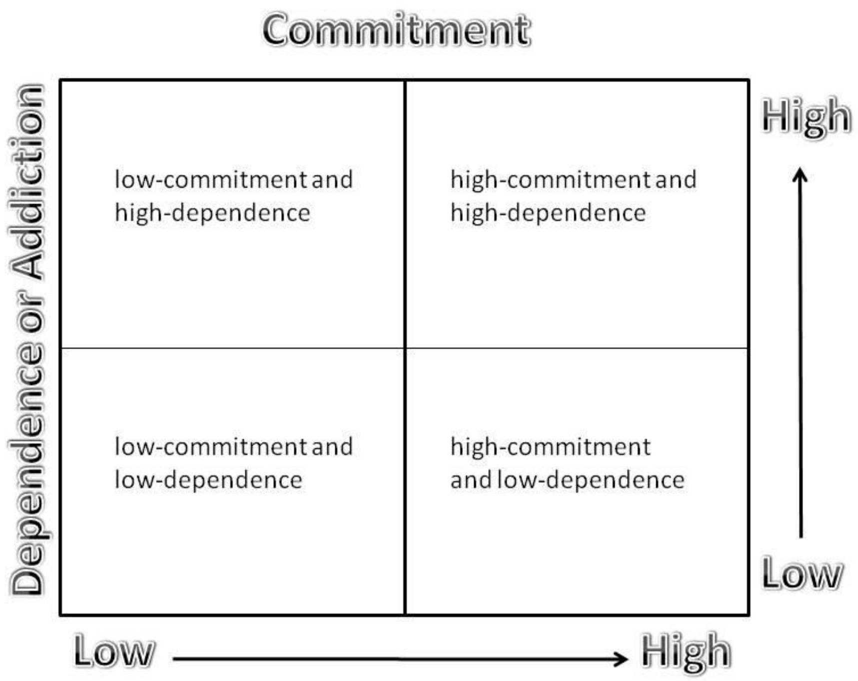
3.1.2.3 The relationship between committed and obligatory running

Addiction to running can only take place if the runner is highly committed. However, this type of commitment is rather an obsession and/or compulsion (Wyatt, 1997). The association between commitment to exercise and obsessive-compulsive personality was found in males only (Davis, Brewer, & Ratusny, 1993). Sachs (1981) warned that not all committed runners become addicted and regular, or even daily, running may not be linked to addiction. Sachs and Pargman (1984) proposed a two-factor model to describe the relationship between addiction, or obligatory running, and commitment to running. The former has a psychobiological base while the latter has a cognitive-rational base for running. The two can be placed in four quadrants with the following components: 1) low-commitment and low-dependence, 2) high-commitment and low-dependence, 3) high-commitment and high-dependence, and 4) high-dependence and low-commitment (see Figure 3.2). In this model commitment and addiction to running are viewed as separate but closely interrelated concepts.

Figure 3.2. A model explaining the relationship between commitment to running and addiction to running. The former, on the horizontal axis, is cognitive-rational in nature, while the latter, on the vertical axis, is psychobiological in characteristic. The figure is drawn upon (but it is not adapted from) the work of Sachs and Pargman (1984).



A decade later, Conboy (1994) tested the model and concluded that in spite of the hypothesis, highly-committed and highly-dependent runners were the least prone to withdrawal symptoms or deprivation-feelings. In contrast, runners who showed high-dependence and low-commitment were the most withdrawal prone. However, there is a major problem with this study;

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The author adopted an instrument aimed to the assessment of the commitment to running (i.e., the Commitment to Running Scale (CRS); Carmack & Martens, 1979; Appendix C) to measure obligatory running. Thus, obligatory running was not gauged in this study.

Other studies project equivocal findings. Thaxton (1982) reported that commitment to running was not related to perceived addiction scores. In contrast to this report, Summers, Machin, and Sargent (1983) found that runners who perceived themselves as addicted to running also showed a greater commitment to running. In line with this finding, Chapman and De Castro (1990) have revealed a positive correlation between committed and obligatory running. However, the latter correlation was based on a fairly small sample size (n = 47) and the scale for gauging addiction was developed and evaluated with the same sample. Consequently, while a theoretical separation between committed and obligatory running exists (e.g., Chapman & De Castro, 1990; Sachs, 1981) the actual relationship between the two needs further clarification.

3.1.2.4 Deprivation from running

Involuntary interruption of running, or exercise in general, affects the well-being of the habitual exerciser (Szabo, 1995). In fact, people retrospectively describe a number of negative symptoms when they cannot run or exercise. The most commonly reported reactions to exercise deprivation include: 1) guilt (Acevedo, Dzewaltowski, Gill & Noble, 1992; Blumenthal et al., 1984; Carmack & Martens, 1979; Harris, 1981a,b; Robbins & Joseph, 1985; Summers, Sargent, Levey, & Murray, 1982), 2) irritability (Blumenthal et al., 1984; Carmack & Martens, 1979; Robbins & Joseph, 1985; Sachs & Pargman, 1979, Summers et al., 1982), 3) restlessness (Robbins & Joseph, 1985; Sachs & Pargman, 1979), 4) tension (Blumenthal et al., 1984; Harris, 1981b), 5) lack of energy (Carmack & Martens, 1979; Harris 1981a,b; Summers et al., 1982), 6) stress or anxiety (Acevedo et al., 1992; Robbins & Joseph, 1985; Sachs & Pargman, 1979), 7) fatness (Acevedo et al., 1992; Harris 1981b), and 8) fatigue (Robbins & Joseph, 1985). Increased number of physical symptoms were also reported (Gauvin & Szabo, 1992; Morris, Steinberg, Sykes, & Salmon, 1990).

Deprivation sensations may be experienced by both committed and obligatory runners at different levels. The former group may experience less profound feelings of deprivation than the latter. Experimental research that intends to study the effects of running deprivation will most likely be based on results obtained from the *committed* runners, because obligatory runners are not keen to participate (and will not!) in this type of scholastic research (e.g., Baekeland, 1970; Szabo, 1995). That would interfere with their highest life-priority. Therefore, obligatory runners cannot be recruited for interventional research, but they may be studied via alternative methods.

3.1.2.5 Reason for running and the link to committed and obligatory running

While a few studies have assessed the reasons behind running for descriptive purposes, the extent to which they may be related to addiction and/or commitment to running was neglected. Only Carmack and Martens (1979) reported a weak link between commitment to running and psychological health as a reason given for the maintenance of running. However, the reason for starting running was not related to the level of commitment in that study. Given, that the reason for exercise may be linked to the severity or intensity of the retrospectively reported withdrawal symptoms (Szabo, Frenkl, & Caputo, 1996), which in turn may be related to exercise dependence, or obligatory exercise, a link between exercise motives, commitment, and dependence may exist. The shortage of work in this area calls for further examination of the link between commitment to running, obligatory running, and personal reasons for running.

3.1.2.6 The aims of the here presented study

This inquiry had four goals. The first goal was to examine further the relationship between commitment and addiction to running. It was hypothesized that the two concepts are independent. In line with this hypothesis, Sachs's and Pargman's (1984) model (Figure 3.2) was also tested. The second aim of the study was to examine the intensity of the reported deprivation sensations in relation to committed and obligatory running. It was presumed that the psychological feelings of deprivation are more closely related to obligatory- than committed-running. The third scope of the inquiry was to determine whether running for health reasons could be related to commitment and/or addiction. No specific hypothesis was formulated in this regard, because of the exploratory nature of this question. The fourth scope of this investigation was to study further the possibility of gathering questionnaire-data by using the Internet as the medium of research (Szabo et al, 1996). For this particular inquiry, the respondents were recruited from a specific runners' forum on the Internet. The topics discussed, at that time, on this forum were hardly of interest to anyone but runners. Based on Joseph's and Robbins's (1981), view, it was presumed that the readers of this group may represent a highly committed runner population, labelled by these authors as Type I and Type II runners, who also involve themselves in other than the physical aspects of running.

3.1.2.7 Materials and method

3.1.2.7.1 Participants. Subjects were English speaking volunteers who completed a series of questionnaires posted on the "*rec.running*" discussion group/forum on the Internet. The criteria for participation required that they be aged 18 years or over and run at least three times a week for at least 30 minutes each time. Prospective participants were informed about the purpose of the study, assured that their responses will be treated with confidentiality, and requested to reply via e-mail or regular mail. They were also clearly advised that by completing the questionnaires they give their consent to taking part in the study. As an incentive for participation, the subjects were told that the results will be posted (fulfilled) on their discussion group. Seventy-five respondents were males and 25 were females. Seventy-five respondents were from the United States, 12 from Canada, and 13 from other geographical locations, including Australia, Germany, and Sweden. Sixty-four respondents gave health as a reason for starting-up running while 34 gave another reason. Forty-seven participants maintained running at the time of the study for health reasons and 52 for other reasons such as the breaking of personal records, enjoyment, and fun. Further subject characteristics are presented in Table 3.2.

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Table 3.2. Subjects' characteristics (n =100).

Participant characteristic	Mean (SD)
Age (years)	34.87 (8.76)
Weight (kg)	69.41 (12.36)
Height (cm)	174.05 (9.85)
Running experience (months)	110.91 (88.28)
Weekly running-distance (km)	51.59 (20.56)
Weekly running-frequency	4.92 (1.29)
Weekly running-duration (hours)	4.62 (1.67)
Number of planned-runs missed in the past six months	8.73 (7.36)
Commitment to running *	51.1 (5.55)
Deprivation sensations when unable to run *	18.67 (4.94)
Obligatory running score *	47.5 (6.09)

* NOTE: These scores were obtained with the instruments described in the "Materials" section.

3.1.2.7.2 The Internet. At the time of the study only one research was published using data collection on the Internet in this area of psychological research (Szabo et al., 1996). Albeit computer use (and therefore access to Internet) started to increase, it was premature to conclude that people with access to the Internet are representative of the general population. While the case with runners may not be critical, because social class and economical status was not related to any aspect of running, it is cautious to keep in perspective that the findings from this study may be limited to a white collar, middle or upper class western runners. Except for one participant, whose education level could not be determined, all respondents reported occupations that required at least a college degree. Since at that time no other sources existed, but our own guidelines for Internet research was the only published reference material (Szabo & Frenkl, 1996), we have exerted maximum care to ensure that this form of data collection will not be in discord with the Principle 9 (points a to j) of the American Psychological Association's (APA) guidelines for research with human subjects (American Psychological Association, 1992). Finally, it should be emphasized that while this method of data collection was novel in the area of Psychology and Exercise Sciences, and possibly in other areas as well, computer networks were already used in non-scholastic as well as some research-data acquisition (Saris, 1991).

3.1.2.7.3 Instruments. Three questionnaires were used in this study. The Commitment to Running Scale (CRS - Carmack & Martens, 1979; Appendix C) was used to measure the level of commitment to running of the participants. The internal consistency of the scale was reported to be high (Cronbach α = .93; Carmack & Martens, 1979). Another instrument used in this inquiry was the Obligatory Exercise Questionnaire (OEQ - Thompson, 1990) that was used to measure exercise dependence. In this study the scale was modified, in consultation with its developer, into

Obligatory Running Questionnaire (ORQ; Appendix K) by simply replacing the "exercise" word with the "running" word. Previous investigations have shown that the swapping of these terms does not affect the reliability of the CRS (Corbin et al., 1987; Gauvin & Szabo, 1992). The ORQ contains 20 statements that respondents have to rate on a 4-point frequency scale, ranging from *never* to *always*, and includes statements like "When I don't run I feel guilty", or "I have had daydreams about running". The internal consistency of the scale was high (Cronbach α = .96; Pasman & Thompson, 1988). This scale was preferred over possible alternative choices, because it had a higher internal consistency and it was validated with a larger sample than the other viable tools (Hauck & Blumenthal, 1992).

To examine the deprivation-sensations in the current sample, in accord with those reported in previous work (section 3.1.2.4 above) and with most of the items on the running-deprivation scale of Robbins and Joseph (1985), subjects completed a 4-point rating scale (Appendix K), ranging from 1-*not at all* to 4-*very much so*. The sum of the ratings of eight items (tense, restless, guilty, stressed, irritated, fat, lacking energy, and fatigued) was adopted as the measure of the intensity of running deprivation sensations for the times when one cannot run for involuntary reasons. The dummy items, vigorous and energetic, were also embedded in the list. Post-facto, the internal reliability of the scale was relatively high (Cronbach α = .75) in this study.

3.1.2.7.4 Procedure. The study was posted on the Internet. The message consisted of four parts. In the first part information and general instructions were given to the potential subjects. In the second part, the respondents were asked to provide demographic information, including name, gender, age, height, weight, and country of residence (the disclosure of the occupation was optional). In the third part, questions about running habits, including the running experience, the weekly running frequency, distance and duration, and reason for starting-up and maintaining running, were posed. The fourth part of the message contained the questionnaires and a thanking note acknowledging the subjects' participation.

All the responses arrived in the form of electronic messages (e-mails). The e-mail files were coded for each subject, downloaded in ASCII format on a floppy disk at the local terminal (Appendix M), and the raised questions/concerns of the subject (if any) were answered at once via a reply e-mail. The responses of two individuals were disqualified, because they failed to provide the required demographic information, including their names, gender, age, and running habits and, therefore, it was uncertain whether they met the criteria for participation in the study (i.e., 18 years or over, and run at least 3 times/week for at least 30 minutes each time).

While the topics of discussion on this group on the Internet are hardly of interest to anyone but runners, a reliability check of the answers was deemed appropriate, considering the novel form of data collection. This verification was done by comparing the answers on directly and reversely rated items. For example, commitment to running is assessed through six directly rated and six reversely rated items. If a contradiction is detected between some items that call for oppositional responses, such as "I dread the thought of running" and "Running is pleasant", the responses of that subject were regarded as suspect. The Obligatory Running Questionnaire contains two reversely rated items, while two contradictory items (i.e., vigorous and energetic, to contrast fatigued and lacking energy) were embedded into the eight-adjective deprivation scale for reliability assurance. After meticulous examination of the answers, none of the responses were suspected of deception. All the reliability checks were performed by an independent reader.

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The reason for starting-up and maintaining running were assessed in with open-ended questions. The responses were grouped into two categories, health and other reason(s), similar to the "therapeutic" and "mastery" running classification of Robbins and Joseph (1985). Although the literature suggests three general categories, including physical health, psychological health, and goal-orientation (Carmack & Martens, 1979; Harris, 1981a,b; Summers et al., 1983; Summers et al., 1982), in this study no distinction between psychological and physical health was intended. The main analysis focused on the relationship between the "general" health reasons and commitment to running, obligatory running, and deprivation from running. Therefore, adopting the 'therapeutic running' notion (Robbins & Joseph, 1985) was deemed as the most appropriate.

3.1.2.8 Results

Gender differences in commitment to running, exercise dependence, and in the reported intensity of feelings of deprivation were statistically tested by using a multivariate analysis of variance (MANOVA). This test was significant (Wilks' Lambda = 0.898, $F(3,93) = 3.52$, $p < .02$) and, therefore, it was followed-up with univariate ANOVAs. These tests yielded a significant effect only for the deprivation sensations ($F(1,98) = 10.2$, $p < .002$), showing that women reported more intense feelings (mean = 21.3, SD = 4.4) than men (mean = 17.8, SD = 4.8) for the periods when they were unable to run.

The testing of the commitment to, dependence-on, and deprivation-from running, in connection with the reason for starting-up (R1) and continuing (R2) running, was tested with a factorial MANOVA, in which R1 and R2 were the categorical measures each having two levels (1=health, 2=other reason) and total scores of commitment, obligatory running and deprivation feelings were the multivariate dependent measures. The MANOVA resulted in a statistically significant multivariate main effect for R2 (Wilks' Lambda =.918, $F(3,91) = 2.70$, $p < .05$) and a significant interaction between R1 and R2 (Wilks' Lambda =.821, $F(3,91) = 6.59$, $p < .001$). Univariate follow-up tests have revealed that subjects who maintained running for a health reason reported deprivation-feelings of greater intensity (mean = 19.68, SD = 4.5) than those who continued running for non-health reasons (mean = 17.98, SD = 5.12; $F(1,93) = 8.2$, $p < .005$). The analysis of the interaction yielded significant effects for commitment ($F(1,93) = 9.13$, $p < .003$) and for deprivation sensations ($F(1,93) = 8.73$, $p < .004$). However, Tukey's HSD tests revealed significant effects only for deprivation. Accordingly, subjects who started running for another reason than health, but maintained their running for health reasons reported more intense feelings of deprivation (mean = 23.23, SD = 3.5) when they cannot run, than subjects who started and maintained running for health reasons (mean = 18.32, SD = 4.1, $p < .009$), than subjects who started running for health reasons but continued running for another reason (mean= 18.41, SD = 5.5, $p < .01$), and than subjects who both started and continued running for non-health reasons (mean= 17.38, SD = 4.7, $p < .003$).

To test the two-factor model (Figure 3.2), describing the relationship between addiction and commitment to running (Sachs and Pargman, 1984), two preliminary data manipulations were performed. In the first, a median-split was done for both commitment to running and obligatory running scores to transform them into categorical variables. Second, to test whether the transformation resulted in comparable cell-frequencies a chi-square analysis was performed on the four quadrants (Table 3.3). The chi-square test was not significant. Thus the sample sizes in the four quadrants were not significantly different from one another. After these tests, the main test was done by using a two (low-, high-commitment) by two (low-, high-obligatory score) ANOVA on deprivation feelings. This analysis yielded a significant main effect for obligatory running scores ($F(1,77) = 14.4$, $p < .001$), but no interaction.

Table 3.3. Intensity of deprivation sensations at times when running is not possible for involuntary reasons (out of a maximum score of 24) in context of high-, low-commitment and high-, low-dependence.

	Low commitment	High commitment
High dependence	n = 18 Mean = 20.7 (SD=4.5)	n = 23 Mean = 20.7 (SD=5.1)
Low dependence	n = 22 Mean = 16.8 (SD=4.6)	n =18 Mean = 17.7 (SD=3.9)

NOTE: Statistically significant difference emerged for high- and low-dependence scores (rows, $p < .001$) that was independent of the commitment to running scores.

A series of correlations were performed between running habits, commitment to running, obligatory running, and feelings of deprivation. These analyses revealed a positive association between obligatory running scores and: 1) deprivation sensations when one cannot run, 2) the frequency of running, 3) the running-distance, and 4) the duration of running. Obligatory running was inversely related to the runners' age. A positive correlation between age and running experience was also revealed. Components of running habits, including frequency, distance, and duration of running were strongly and positively correlated with one another. Commitment to running was not correlated with obligatory running scores or with any other variables (Table 3.4).

Table 3.4. Correlations (Pearson r) between various variables (see note).

	Age	Exp	Freq	Time	Dist	Miss	Comt	Oblig	Depr
Age	-	.45**	-.17	-.17	-.18	-.15	.01	-.34*	-.07
Exp		-	.08	-.10	-.08	-.16	-.04	-.09	.03
Freq			-	.53**	.61**	-.02	.18	.45**	.08
Time				-	.86**	-.12	.27	.46**	.16
Dist					-	-.06	.19	.45**	.05
Miss						-	-.16	.04	.03
Comt							-	.18	.18
Oblig								-	.46**

NOTE: Age = years; Exp = running experience in months, Freq = weekly running frequency; Time = duration of the run; Dist = distance of the run; Miss = number of missed runs in the past five or six months; Comt = commitment to running; Oblig = dependence on running; Depr = deprivation sensations when unable to run.
* $p < .05$, ** $p < .001$, ($n = 100$).

3.1.2.9 Discussion

The present study reveals a number of findings, of which the most important may be the dissociation between commitment to running and obligatory running. While Sachs (1981) and Sachs and Pargman (1984) differentiated between commitment to running and obligatory running, these authors thought that a relationship may exist between the two. This association was tested in the current Internet-based inquiry, but the results were negative. The lack of support for the relationship between committed and obligatory running is twofold. First, no correlation was found between the two concepts. Second, when the respondents were grouped into the four quadrants (refer to Table 3.3) as proposed by Sachs and Pargman (1984), no interaction between committed and obligatory running was disclosed during the examination of the subjectively reported deprivation sensations. Regardless of the level of commitment, runners scoring above the median on the ORQ also reported more profound deprivation-feelings for the periods when they cannot run (refer to Table 3.3). Based on these results, it is concluded that commitment to running and obligatory running *are independent* concepts.

The results of this Internet-based study agreed with Thaxton's (1982) findings whereby perceived addiction to running was not related to the participants' level of commitment to running. Further, Kirkby and Adams (1996) found that addiction or dependence scores were only weakly related - accounting for less than 11% of the variance - to exercise commitment scores. However, at least two contrary reports also exist. Chapman and De Castro (1990) found a link between the addiction- and commitment scores in men, but not in women runners. The two variables were also related in a sample of marathon runners (Summers et al., 1983). The comparison of the present study to the inquiry by Chapman and De Castro (1990) is difficult for a number of reasons. First, the dependence on running was measured with different tools in the two inquiries. Second, in the present study the sample size was twice as large, the respondents ran more frequently and for longer intervals, and they also reported greater commitment to running scores than subjects in the study by Chapman and De Castro (1990). These substantial differences in sample characteristics may account, at least in part, for the observed differences. With respect to the results of Summers et al. (1983), again a different sample (marathon runners) was examined, that could contribute to the contradictory findings in the two studies.

In the present study subjects may have failed in the Type I and Type II categories of runners (Joseph & Robbins, 1981). These runners also involve themselves in other than the physical aspects of running. This involvement was reflected by their affiliation to the newsgroup on the Internet. The strong alliance with running was also reflected by their high scores of commitment to running, which exceeded the norms provided by Carmack and Martens (1979). Consequently, it is possible that the findings of Chapman and De Castro (1990) could not be replicated here, because all the respondents failed in the narrow upper-end of the commitment spectrum. This line of thought was supported by the a posteriori finding that participants with commitment to running score below the median had a mean commitment score higher (46.7) than the mean (45.8) reported by Chapman and De Castro (1990). The differences in the levels of commitment to running may also explain the disagreement of the here reported work with that of Summers et al. (1983) as well as the agreement with the study by Thaxton (1982). In the latter

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study and in the present inquiry the levels of running-commitment displayed by the subjects were higher than in the investigations by Chapman and De Castro (1990) and Summers et al. (1983). Therefore, the conclusions of the here reported work may be limited to highly committed runners. In spite of this limitation, the findings clearly illustrate that strong commitment to running cannot be related to obligatory running, or dependence/addiction on running.

The volume of running, as based on reports of frequency, distance, and duration was positively correlated with obligatory running scores. This finding is in agreement with the results of previous inquiries (Chapman & De Castro, 1990; Thornton & Scott, 1995), as well as with the predictions of Morgan (1979). A dose-dependent relationship is conceivable in all forms of addictive behaviors (Morgan, 1979; Rozin & Stoess, 1993). Therefore, these findings are self-explanatory. Interestingly, obligatory running scores were not related to the running experience (years and/or months of running) of the subjects. This finding agreed with one inquiry (Thornton & Scott, 1995), but it was in disagreement with another (Summers et al., 1983). While it may be anticipated that running experience plays a role in the addiction process (Hailey & Bailey, 1982), such a contemplation is based on the assumption that addiction to running is the non-avoidable consequence of the cumulative running experiences. The contradictory finding in this study, and in the study by Thornton and Scott (1995), suggests that the process of addiction may onset at different stages in one's running career. This deduction implies that some igniting-causes may trigger dependence, which is more plausible than the conceptualisation of running addiction as an inevitable process. These aspects of addiction will be addressed in Part III of this dissertation.

The results in the here reported study showed that chronological age is correlated with running experience. Furthermore, a previously unreported negative correlation emerged between age and obligatory running scores. In light of these findings, it may be speculated that younger runners are more prone to addiction than their older counterparts. The more systematic follow-up of this relationship merits scholastic attention.

In the present study female runners reported more intense deprivation sensations for the times when they cannot run for an involuntary reason. This finding agrees with antecedent reports (Harris 1981a; Robbins & Joseph, 1985; Summers et al., 1983). The higher deprivation sensations in female runners were not associated with greater dependence scores. On one hand, this finding was in agreement with the report of Chapman and De Castro (1990) in which no relationship was found between running- dependence and deprivation sensations in female runners. On the other hand, it was in contrast with the results of Summers et al. (1983) who found that both self-reported addiction scores and withdrawal symptoms were greater in women than in men. The interpretation of this controversy is difficult, but it may be related to the point that self-reports of addiction are subjectively appraised on the basis of the severity of withdrawal symptoms or the feelings of deprivation at times when one cannot run. This judgement will surely result in an association between the two variables. Withdrawal or deprivation sensations, however, are not the only determinants of addiction to running. Therefore, when questionnaires are used the theoretical connotation of addiction may differ from subjective perceptions reflected in self-reports.

The reason for running (or exercise in general) may be a key factor in both obligatory and committed running. However, little attention was devoted to this issue in the extant literature. In accord with a previous report (Robbins & Joseph, 1985), in the here presented work respondents who maintained their running for health reasons also reported greater deprivation sensations, for the periods when they were unable to run, in contrast to subjects who continued running for other reason(s). Robbins and Joseph (1985) suggested that "therapeutic" runners, or runners who run for health-motives, lose their mastery over the health aspects that they control with running. In other words, when she/he cannot run the person loses her or his main coping resources that she/he has developed to fight stress or to deal with other health predicaments. This explanation is in full agreement with Thornton and Scott (1995), who suggested that individuals who start-up running for health reasons are at risk of developing an obsessive pattern of running, especially if they also experience significant life-stress. This explanation is also supported by the results of the previously reported Internet-based study (Szabo et al, 1996) with different exercisers (section 3.1.1.) showing that those who exercise for health reason experience greater withdrawal symptoms at times when they cannot fulfil their planned exercise.

The importance of health as a reason for running also emerged during the examination of the reasons for starting and continuing running. Respondents who started running for another reason than health, but maintained running for a health reason, reported greater deprivation feelings than all other subjects. These finding agree with at least two research reports (Szabo et al., 1996; Thornton & Scott, 1995). A change in the motivation for running during the running career may result in a shift from enjoyment or challenge to a reliance on running that manifests itself in the form of intense subjective feelings of deprivation. These feelings may be more powerful than in cases when reliance was consistently there (i.e., when running was both started and maintained for health reasons). However, this explanation is subject to research scrutiny and the psychological mechanism underlying the shifts in personal motives for running need to be determined.

3.1.2.10 Contribution to the advancement of knowledge

The here reported Internet-based work revealed that high levels of commitment to running are independent of obligatory running or addiction/dependence on running. The study confirmed that the level of commitment to running is not related to the characteristics of the activity, including: 1) deprivation sensations (or withdrawal symptoms) when one cannot run, 2) the frequency of running, 3) the distance of running, and 4) the duration of running. This study also strengthened previous reports from the literature that individuals who exercise, or run, for health reasons, as well as women in general, tend to report more intense feelings of deprivation for the times when they are prevented from fulfilling their planned exercise session. Finally, this work added support to a previous study carried out on the Internet by the same authors (Szabo et al. 1996), that the world wide web (www) is a promising medium for research and data collection in the fields of psychology and exercise sciences.

3.1.2.11 The take-home message of the study

Level of commitment to running is independent of exercise characteristics and obligatory running. Feelings of exercise deprivation are stronger in people who run for health reasons and in women.

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3.1.3 Further investigation of exercise deprivation; replication of Internet studies[11]

The halt or interruption of regular physical activity, for an involuntary reason, results in negative mood states (Aidman & Woollard, 2003; Antunes, Terrão, & de Mello, 2011; Berlin, Kop, & Deuster, 2006; Chan & Grossman, 1988; Fogaa Leite et al., 2014; Gauvin & Szabo, 1992; Szabo, 1995; Szabo et al., 1996; Szabo, Frenkl, & Caputo, 1997; Wingate, 1993). These states are known as *deprivation sensations* (Robbins & Joseph, 1985) or *withdrawal-like symptoms* (Aidman & Woollard, 2003), or plainly *withdrawal symptoms* (Pierce, 1994). With a few exceptions, like martial arts practitioners (Szabo & Parkin, 2001; Wingate, 1993) fitness exercisers (Anshel, 1991), mixed exercisers (Gauvin & Szabo, 1992; Szabo & Gauvin, 1992; Szabo et al., 1996) and swimmers (Crossman et al., 1987), most studies examined the deprivation sensations in runners. Apart from the Internet-based study performed by Szabo et al. (1996), at the time of this work there was virtually no information about the psychological feelings resulting from exercise deprivation in different forms of physical activities. Szabo et al.'s work suggested that responses to exercise layoff in various forms of physical activity may cause similar symptoms.

Szabo et al. (1996) in an Internet-based inquiry, based on responses from 130 physically active people, have shown that psychological feelings associated with exercise deprivation do not differ among various types of physical activities. The participants in that study were highly committed individuals. Szabo et al. (1996) studied people from exercise-specific newsgroups involving, aerobic exercise, weight training, cross training, fencing, and bowling. The latter was a sort of comparison group to the others because of low physical exertion involved in the activity. It turned out that these individuals responded differently in terms of deprivation-feelings reported for the times when their activity cannot be performed for a reason (refer to section 3.1.1.). Given that Szabo et al.'s work was a primer in Internet research, the reliability of the results needed urgent verification. Therefore, using a similar, or almost identical, protocol to Szabo et al., in this inquiry I tried to replicate our previous work by studying a larger overall sample size, from other sports than those scrutinized by earlier (Szabo et al., 1996), and by using a more vigorous cultural and artistic type of exercise instead of bowling, specifically dance.

The aims of the hereunder presented investigation were to answer the following research questions, earlier posed and answered by my research team: 1) Do the retrospectively reported deprivation sensations differ, in terms of intensity (magnitude), in five forms of physical activity (fitness training, swimming, martial arts, triathlon, and dance)?, 2) Are commitment to physical activity scores and trait anxiety scores related to the intensity of the retrospectively reported exercise deprivation symptoms?, 3) Is there a difference in the level of commitment to exercise and the intensity of the reported deprivation sensations between people who exercise for health reason and those who are physically active for some other reasons?, 4) Does the method of data-gathering (i.e., Internet research) affect the internal reliability of the instruments used in the study?, and 5) Can the findings of Szabo et al. (1996) be replicated with other exercisers?

[11]*Based on: **Szabo, A.** (1997). Cross sectional research on the Internet; Trait anxiety, deprivation feelings, and commitment in five modes of physical activity; instituting sport-science research on a public-across computer network (InternetTM). Journal of Physical Education and Sport Sciences, 10(1), 14-22. ISSN 2319-9946*

3.1.3.1 Materials and method

3.1.3.1.1 Participants. Two hundred and twenty-eight readers from five exercise-specific forums (newsgroup) on the Internet took part in the study. The groups were selected to represent five forms of physical activity: 1) fitness training, or conditioning, that included various aerobic exercises, callisthenics, and weight-training, 2) swimming, 3) martial-arts, that consisted of karate, judo, aikido and the like, 4) triathlon, which includes swimming, cycling, and running, and 5) dance, including folk, rock, ballet and ballroom. The criteria for participation demanded that respondents be aged 18 years or over, practice their activity at least three times a week, and understand English fluently. Prospective subjects were advised that the return of the completed questionnaires implies that they consent to participate in the study. More of their characteristics are presented in Table 3.5.

3.1.3.1.2 Instruments. Three questionnaires were used in the data collection. Trait anxiety was measured with the Spielberger Trait Anxiety Inventory (STAI – Spielberger et al., 1970; Appendix F). The scale's internal consistency was immediately determined upon the completion of the data collection and was found to be very good (i.e., Cronbach α =.86), identical to the value reported by Szabo et al. (1996) and higher than the value reported for the original scale (.83). Deprivations sensations were assessed with the 9-item Deprivation Sensation Scale (DSS; Appendix J) developed by Robbins and Joseph (1985). In this study the internal consistency of the DSS was good (Cronbach α =.74), but slightly lower than the value reported by Szabo et al, which was .81. No data exists for the internal reliability of the original scale presented by Robbins and Joseph. Finally, commitment to subjects' adopted activity was gauged with the Commitment to Physical Activity questionnaire (CPA – Corbin et al., 1987; Gauvin & Szabo, 1992) modified from the Commitment to Running scale (CRS - Carmack & Martens, 1979; Appendix C). The internal consistency of the 12-item CPA scale was also found to be in the good to very good range in the current inquiry (Cronbach α =.81), slightly higher than the value reported by Szabo et al. (.78), but still somewhat lower than the α value of the originally developed scale (.88).

3.1.3.1.3 Procedure. A three-part message was posted on five physical activity forums on the Internet. These were: *misc.fitness.aerobic*, *rec.sport.martial-arts,* *rec.sport.swimming*, *rec.sport.triathlon*, and *alt.rec.dance.* In the first part of the message the purpose of study and the criteria for participation were described. The second part asked for subjects' characteristics (Table 3.5) and the reason for which they have started and maintain (at the time of the study) their chosen activity. The third part of the Internet posting contained the questionnaires. The study was posted once every week for 12 consecutive weeks. While repeated posting was necessary to access as many new readers as possible and to increase the number of received responses by at least 100 as compared to Szabo et al. (1996), the 12-week period-limit was set in advance to minimize annoyance to the participants in these discussion forums and to those participants who have already responded to the call. All the replies were solicited by electronic mail (e-mail), in ASCII format.

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Table 3.5. Subjects' characteristics; means and standard deviations (SD) in parenthesis.

Measure	Men (n = 141)	Women (n = 87)
Age (years)	33.5 (14.7)	32.3 (8.9)
Height (cm)	179.3 (7.2)	165.3 (6.6)#
Weight (kg)	78.8 (11.7)	64.6 (17.3)#
Activity history (months)	104.1 (93.7)	85.9 (84.2)
Activity frequency/week	4.8 (1.5)	4.6 (1.4)
Activity duration (min)	90.0 (41.0)	97.5 (47.3)
Trait anxiety (STAI)*	34.2 (7.5)	35.2 (8.2)
Deprivation sensations (DSS)*	30.1 (9.2)	33.7 (9.4)#
Commitment to activity (CPA)*	50.9 (5.1)	52.7 (5.8)#

NOTE: *These scores were obtained with the tools described in section 3.1.3.2. # = Significant gender-related differences in DSS and CPA as well as in height and weight ($p < .05$).

3.1.3.2 Results

Univariate analyses of variance (ANOVA) revealed group differences in weekly frequency ($F(4,222) = 12.8$, $p < .001$) and duration of activity ($F(4,221) = 11.6$, $p < .001$). The former was due to more frequent weekly training by those who participated in triathlon training than subjects in the other four groups ($p < .001$), as well as to less frequent weekly physical activity reported by dancers in contrast to people in the other four groups ($p < .05$), as revealed by Tukey's post hoc-tests. The latter difference was attributed to longer dance-sessions reported by dancers than people in the other four groups ($p < .001$), and to a difference between the duration of the workouts of the swimmers and martial-artists ($p < .01$). These results are summarized in Table 3.6.

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Table 3.6. Group characteristics showing the means and standard deviations (SD) in parenthesis; FC=fitness conditioning, SW=swimming, MA=martial arts, TR=triathlon, and DN=dance). Scores are rounded to integers.

Measure	Exercise/ Physical Activity Groups				
	FC	SW	MA	TR	DN
Activity history (months)	87(81)	110(110)	91(66)	115(83)	87(103)
Weekly frequency	5(1)	5(1)	5(1)	*6(1)	*4(1)
Duration (min)	83(36)	#71(34)	98(38)	92(44)	*135(50)
Trait anxiety (out of 80 max)	36(8)	37(9)	33(8)	32(7)	36(7)
Deprivation sensations (out of 63 max)	31(10)	33(9)	32(10)	31(9)	30(10)
Commitment (out of 60 max)	51(6)	51(6)	51(5)	52(4)	54(5)
Total of cases	65	36	57	43	27

NOTE: *Significantly different from all other groups. # Significantly less than MA and DN.

A group by gender ANOVA for DSS has only revealed a gender main effect ($F(1,215) = 7.5$, $p < .007$). Accordingly, women reported more intense deprivation sensations, for the periods when they cannot perform their chosen activity, than men, but the effect size (Cohen's d) was relatively small ($d = .39$; for the means refer to Table 3.5). A similar analysis for CPA also yielded a gender main effect ($F(1,216) = 4.5$, $p < .04$), indicating that women were more committed to their preferred activity than men, but again the effect size was rather small ($d = .32$; means and SD in Table 3.5). No exercise group main effects or interactions were found and, therefore, exercise group was not included in the subsequent analyses.

The reasons given by the subjects for starting and maintaining their activity were classified into two categories: health (R1) and any other (R2) reason. This classification was based on the therapeutic and mastery exercise notions of Robbins and Joseph (1985), same as in the study by Szabo et al. (1996). An R1 by gender ANOVA yielded an interaction ($F(1,219) = 5.4$, $p < .02$) for DSS. Tukey's post-hoc test revealed that the interaction was due to stronger deprivation sensations reported by women ($p < .001$, $d = .77$) who became active for health reason(s) ($n = 48$, mean =

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35.1, SD = 8.9) than men who became active for the same reason (n = 67, mean = 28.5, SD = 8.1). The same test for R2 only yielded an R2 main effect with a small effect size ($F(1,218) = 4.9$, $p < .03$, $d = .27$), indicating that people who continued to be active for health reason (n = 98, mean = 32.9, SD = 9.7) reported stronger deprivation-feelings than those who maintained their activity for another reason (n =127, mean = 30.3, SD=9.1). The reasons for starting and maintaining the adopted activity were not related neither to trait anxiety nor to commitment to the activity.

Bonferroni corrected correlations between the three dependent measures have revealed a significant positive relationship between the degree of commitment to the activity and deprivation sensations ($r =.19$, $p < .01$). The intensity of deprivation sensations at times when one cannot fulfil the need to be active was also directly correlated with trait anxiety ($r = .21$, $p < .006$). However, the coefficient of determination ($r^2 = .04$; 4%) was so small that these correlations were virtually meaningless. Trait anxiety and commitment were not related to one another.

3.1.3.3 Discussion

Retrospectively reported psychological feelings of deprivation, for the times when one cannot fulfil the need of a chosen activity, appear to be *non-specific* as indicated by the lack of differences between the five groups. These findings replicate the results obtained by Szabo et al. (1996). In that inquiry bowlers reported lesser feelings of deprivation for the times when they cannot attend bowling. However, in the here reported work they were replaced with dancers, that is a more energy demanding physical activity and may be comparable to the other exercises that were scrutinized in the work. For example, a while ago Léger (1982) showed that the energy cost of a 90-minute bout of disco dancing may be around 4350 kJ for men and 2850 kJ, respectively, for women when the activity is performed at about 60% and 70% VO_2 max. Léger concluded that disco dancing could be an ideal activity for increasing aerobic fitness level and for controlling weight. However, the respondents from the dance group in this study were involved in folk, rock, ballet and ballroom dancing the energy cost of which is lower (Léger, 1982). Nevertheless, dance is more physical than bowling and it also requires more frequent practice sessions than bowling, which makes it similar and comparable to the other activities studied here. In the study conducted by Szabo et al. (1996) bowlers reported three bowling sessions per week, while the dancers here practiced four times every week. Indeed, in spite of the fact that dancers trained or practiced one day less less frequently per week than the others, their sessions were longer than those of the other four physical activity groups (refer to Table 3.6).

Overall, this inquiry showed that highly committed people involved in different forms of physical activities report deprivation sensations that are equal in intensity. Even the differences in exercise frequency and duration, that separated the triathlon and dance group from the others, could not produce significant group-differences in this regard. It should be noted that matching the findings reported by Szabo et al. (1996) respondents in all the groups were highly committed to their activity on the basis of comparison norms provided for runners (Carmack & Martens, 1979).

Women reported, in general, greater - or more intense - deprivation sensations than men. Again, due to lack of research with other subjects, this finding is only comparable to previous research with runners that also revealed similar gender differences (Harris, 1981b; Robbins & Joseph, 1985; Summers et al., 1983; Szabo et al., 1997). One explanation forwarded for this

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finding was that women may be more open to report perceptions of feelings than men (Summers et al., 1983). An alternative explanation was associated with the level of commitment to the activity. In the here reported work, contrary to previous reports with runners (Carmack & Martens, 1979; Robbins & Joseph, 1980; Summers et al., 1983), women were more committed to their activity than men. Unlike in the Internet-based study with runners (Szabo et al., 1997), here a higher level of commitment was related to the intensity of the reported deprivation-feelings, which could have contributed to the gender differences observed in the reported feelings of deprivation. Nevertheless, the explanation should be viewed as tentative, because in spite of the statistical differences in the level of commitment between men and women, the effect size was very small, rendering the meaningfulness of the differences questionable. Furthermore, the correlation disclosed here, between the level of commitment and intensity of the deprivation-feelings, was almost meaningless because the two variables had less than 4% of their variances in common.

The reasons for physical activity, placed under two general categories of health and other motives, appeared to play an important role in the perception of the deprivation sensations. Subjects who maintained their usual physical activity for health reason(s) have reported stronger deprivation-feelings than those who continued to be active for other reasons. These findings replicated the results of Szabo et al. (1996) and they also agree with the findings of Robbins and Joseph (1985). These researchers have suggested that people who rely on their activity as a method of mastery of their health, lose their principal coping resource (exercise) at times of forced inactivity and, therefore, perceive deprivation sensations as more intense than others.

While with regard to the maintenance of the activity, health reasons were not related to gender, women who reported starting their physical activity for health reasons also reported greater deprivation sensations than males starting for the same reason. These findings also match the results obtained by Szabo et al. (1997) with runners. One possible explanation is that women rely more strongly on their activity for health benefits than men, if the starting reason was health related. But these findings should be viewed cautiously, because of the memory distortion in the recall of the most appropriate reason for starting up the given activity, that takes place over time.

The here disclosed association between trait anxiety and the magnitude of self-reported deprivation sensations has not been previously reported. However, this connection was weak, because the two variables had only about 4% of the variance in common. Therefore, these findings should be viewed as tentative.

Overall, the results support and expand on previous findings by demonstrating that: 1) deprivation sensations and commitment to a physical activity are comparable across five forms of exercise, 2) females report more intense deprivation sensations than males, 3) people who are active for health reasons report stronger feelings of deprivation when they cannot exercise, 4) higher commitment and higher trait anxiety are both directly, but weakly, linked to the intensity of deprivation sensations, and 5) the gathering of cross-sectional data on public access networks appears to be both feasible and reliable. The latter point is substantiated by the fact that the internal consistencies (refer to Materials section) of the three questionnaires ranged from good to very good in this sample. Indeed, they were comparable to the reports furnished by the developers.

A few cautionary statements, because of the novelty of the data-acquisition method, ought to be emphasized. At the time of the study public access to the Internet was common and increased daily, but only in some technologically advanced societies. Even in these areas, at that time, the access was limited to the advantaged individuals. Therefore, research findings gathered via this methodology were restricted to the upper social class in developed nations. Indeed, in the here reported study more than 80% of the respondents were from North America. These factors are important, especially when social class and cultural issues could bias the results. In this study, neither commitment to activity nor the intensity of deprivation-feelings could be linked to class or cultural issues on the basis of previous research. However, it is advised that the readers keep in perspective the limitations, given that public access computer network research was only in its early developmental stage. A more thorough discussion of what was learned from these relatively new (at the time) Internet studies will be presented in the next section of the dissertation (3.2).

3.1.3.4 Contribution to the advancement of knowledge

Testing nearly 100 more participants than Szabo et al. (1996), but using the same protocol and assessment tools, and examining different exercisers, the here reported work has successfully replicated one of the first studies that used the Internet for scholastic data collection. The results of the survey showed that women reported stronger deprivation sensations and commitment than men. Participants who maintained their activities for health reasons also reported more severe deprivation sensations than respondents who continued to be active for another reason. No group differences were disclosed in any of the studied variables, in other words, deprivation-feelings occur in all committed exercisers, regardless of the form of exercise they perform.

3.1.3.5 The take-home message of the study

Psychological feelings of exercise deprivation occur in all committed exercisers, are greater in women, and are linked to exercise motives. Internet-based cross-sectional survey research can be successfully replicated, showing that the Internet is a promising medium for scholastic research.

3.2 Bridging Conventional Science and Internet Research

Computers and other technological devices, like tablets and smartphones, that could be linked to the Internet are common household objects today, even in the developing nations and certainly in most developed countries. In fact, not long after 2003 there were more devices connected to the Internet than people living on the planet, and in 2010 around 12.5 billion devices were connected to the Internet (Evans, 2011). This figure yielded an average of 1.84 devices per person (Figure 3.3). While the Internet use has spread at a remarkable rate, in 1996-97 - at the time of the three studies presented in section 3.1 above - in the developing nations access to the Internet was limited to some major organizations, private companies, and the wealthy citizens, while in the developing nations it started to become an accessible commodity (Szabo & Frenkl, 1996). The consideration of research on the Internet has started in the 1990s because the new medium brought scholars together from around the world. They quickly realized that large samples from *specific* target populations like various athletes, for example, can be reached easily to conduct surveys on various topics. This great opportunity represented a quick, inexpensive, and efficient new research

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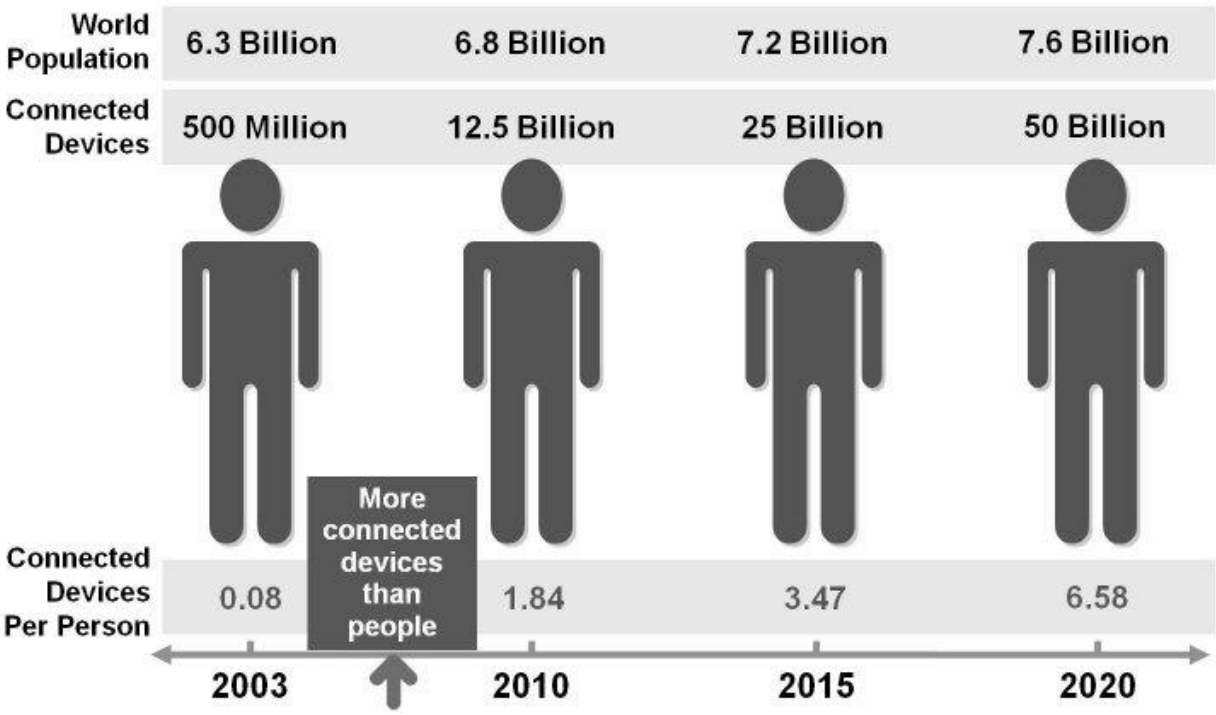
method, because the data collection could proceed over 24-hr a day, throughout the world, without the physical presence of the scholar (Michalak & Szabo, 1998; Szabo & Frenkl, 1996).

Figure 3.3. The relationship between the World's population and technological devices that are connected to the Internet. (Source: Cisco IBSG, April 2011).



However, apart from access to the Internet, language was another significant barrier of communication in the late 1990s between scholars and potential survey research participants (Michalak & Szabo, 1998). These facts rendered the validity and reliability of the first Internet studies questionable, since the majority of the respondents to a research call were representing the English speaking upper-middle class. Indeed, the bulk of responses received by Szabo et al. (1996, 1997) and Szabo (1997) were from the United States of America (USA), United Kingdom (UK), and Canada. However, even today, regardless of the type or form of research, most *published* scholastic papers emerge from these nations (Szabo, 2014) in the area of sport and exercise psychology (Figure 3.4 and 3.5). It is almost common sense, that most scholars from these three nations publish results obtained with research participants from their own country, unless they report findings from Internet-based studies that is still rare in this specific area of psychology.

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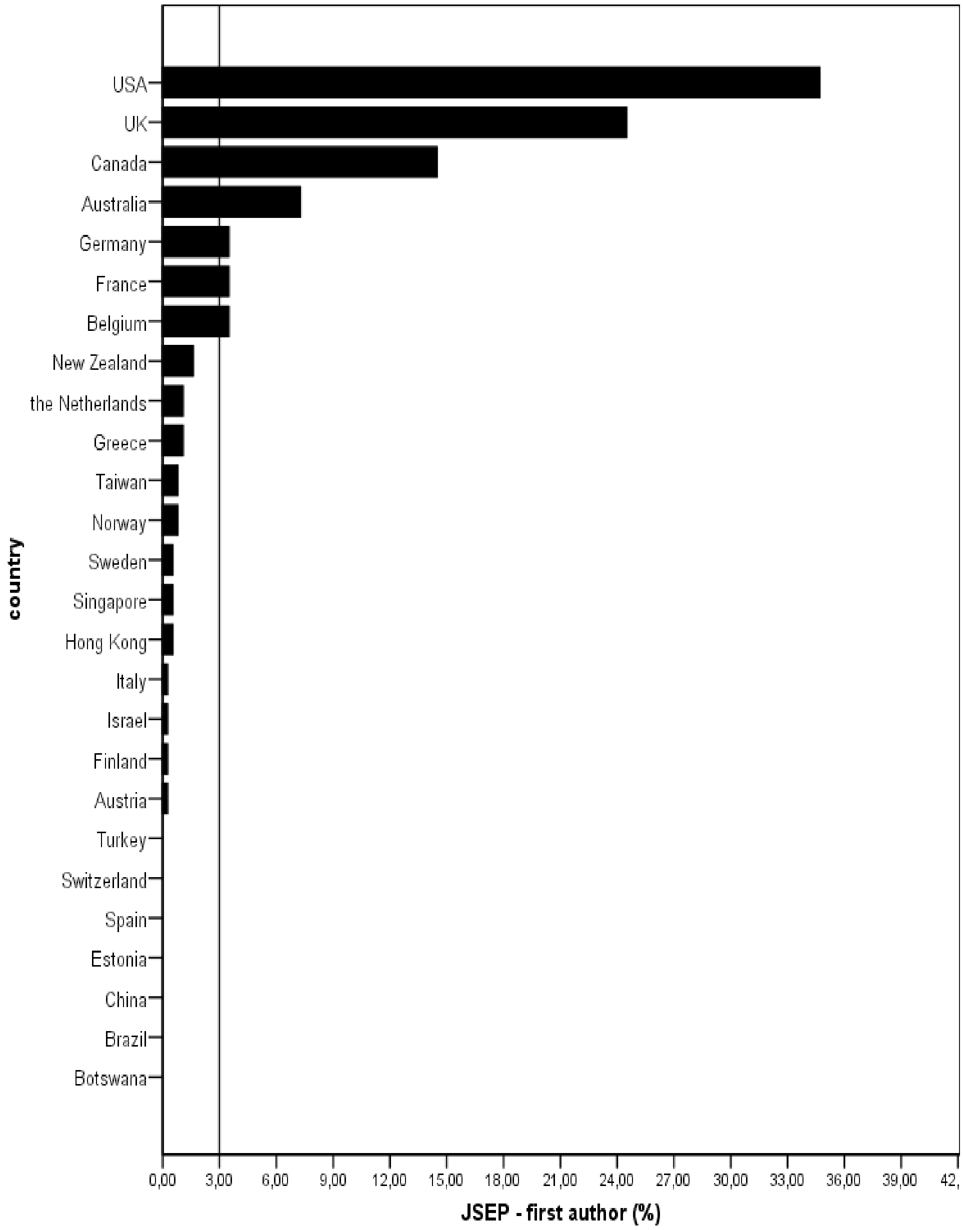
Figure 3.4. Percent of first authors in the US-based international publication "Journal of Sport and Exercise Psychology" (JSEP; IF 2013=2.593), between 2000-2011 ranked by national affiliation.



Adapted from: Szabo, A. (2014). Sport and exercise psychology research and Olympic success: An analytical and correlational investigation. *European Journal of Sport Science, 14*(3), 273-278. doi: 10.1080/17461391.2013.827241

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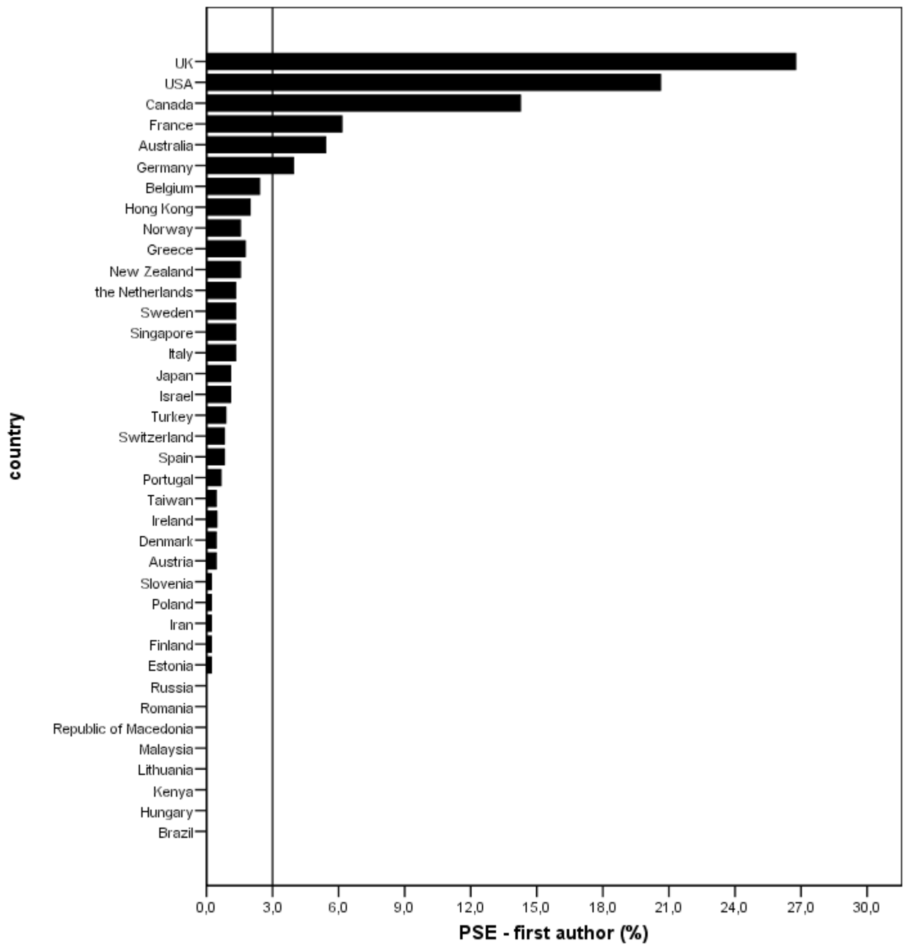
Figure 3.5. Percent of first authors in the UK-based international publication "Psychology of Sport and Exercise" (PSE; IF 2013=1.768), between 2000-2011 ranked by national affiliation.



Adapted from: Szabo, A. (2014). Sport and exercise psychology research and Olympic success: An analytical and correlational investigation. *European Journal of Sport Science, 14*(3), 273-278. doi: 10.1080/17461391.2013.827241

The early, and perhaps the first, surveys on the Internet that were reported by Szabo et al. (1996, 1997) and Szabo (1997) in section 3.1, supported and also expanded the results obtained in the traditional paper and pencil, face-to-face, research. The reliability of the used questionnaires was as good as that of the original tools validated in conventional research. Results obtained in an Interned study could be replicated (Szabo, 1997), that supports the reliability of Internet research. As much as the results of these early studies is concerned, all the three reports in section 3.1 have clearly shown that committed exercisers report withdrawal symptoms, or deprivation sensations, associated with the inability to fulfil a planned bout of exercise, that is more intense in people who exercise for health reasons and in women. To date, these findings were not challenged or contradicted in the literature, although the social-class and language may be issues of concern. In conclusion, our three relatively pioneering studies reported in section 3.1 showed that the survey studies can be successfully conducted on the Internet.

3.3 Investigation of the Psychological Effects of Planned Exercise Deprivation[12]

3.3.1 Psychological effects of training deprivation in martial artists

There are several reasons why habitually active people may need to stop or reduce their physical activity or sport-training regimens. For example, conflict with other responsibilities and tasks, adverse weather conditions, temporary lack of training facilities or the unavailability of an instructor may be some of the causes why people have to disrupt their physical activity routine. A temporary halt or reduction in habitual exercise has been shown to adversely affect the well-being of the individual (Aidman & Woollard, 2003; Antunes et al., 2011; Berlin et al., 2006; Baekeland, 1970; Szabo, 1995). Many exercisers retrospectively report a number of negative symptoms for the times when they cannot exercise for involuntary reasons. Some of the most commonly reported responses to episodes of exercise deprivation are presented in Table 3.7.

Table 3.7. Frequently reported symptoms for periods of exercise deprivation.

Symptoms	Reported by:
Anxiety/Anger	Acevedo et al., 1992; Baekeland, 1970; Robbins & Joseph, 1985; Wingate, 1993
Confusion	Mondin et al., 1996
Decreased Vigour	Mondin et al., 1996; Wittig, Houmard, & Costill, 1989; Wittig, McConell, Costill, & Schurr, 1992
Depression/Tension	Blumenthal et al., 1984; Carmack & Martens, 1979; Morris et al., 1990; Mondin et al., 1996; Robbins & Joseph, 1985; Thaxton, 1982; Wingate, 1993
Guilt	Acevedo et al., 1992; Blumenthal et al., 1984; Carmack & Martens, 1979; Harris, 1981a,b; Robbins & Joseph, 1985; Summers et al., 1982
Fatigue	Robbins & Joseph, 1985; Wingate, 1993
Fatness	Acevedo et al., 1992; Harris, 1981b
Irritability	Blumenthal et al., 1984; Carmack & Martens, 1979; Robbins & Joseph, 1985; Sachs & Pargman, 1979, Summers et al., 1982; Wingate, 1993
Lack of energy	Carmack & Martens, 1979; Harris, 1981a,b; Summers et al., 1982
Physical symptoms	Gauvin & Szabo, 1992; Morris et al., 1990
Restlessness	Robbins & Joseph, 1985; Sachs & Pargman, 1979
Stress or anxiety	Acevedo et al., 1992; Robbins & Joseph, 1985; Sachs & Pargman, 1979
Sluggishness	Carmack & Martens, 1979; Wingate, 1993
Total Mood Disturbance	Mondin et al., 1996; Wittig et al., 1989; Wittig et al., 1992

[12] *Based on:* ***Szabo, A.,*** *& Parkin, A. M. (2001). The Psychological Impact of Training Deprivation in Martial Artists. Psychology of Sport & Exercise, 2, 187-199. doi:10.1016/S1469-0292(01)00004-8*

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The impact of exercise deprivation is difficult to study experimentally (Szabo, 1998; to be discussed later) and this is why there are only a few systematic studies reported in the literature. They will be reviewed in detail in the subsequent section of the dissertation. From the survey studies reported in section 3.1, it is clear the forced abstinence from exercise is associated with negative psychological feelings (Szabo, 1997; Szabo et al., 1996, 1997). However, respondents and participants in research know that *they should not feel good* when an activity that is rewarding to them is prevented. Therefore, retrospective investigations may assess what people think about how they should feel when exercise is not possible instead of the experienced psychological states.

In contrast to previous experimental studies on exercise deprivation, Mondin et al. (1996) tried to avoid expectancy effects by giving 'neutral' instructions with regard to what results may be expected. When asked, these authors told participants that the existing knowledge on exercise deprivation is unclear. However, participants in exercise deprivation studies 'know' that negative, rather than positive, effects are expected (Szabo, 1998). In trying to overcome this major dilemma, a possible solution is to present the deprivation period as a needed *rest period* for the subjects. This would drive the cognitive interpretation of the event in the positive direction, thus resulting in positive expectations associated with a layoff period ("rest" in subjects' mind) from exercise. If in spite of the induced positive anticipation the results still disclose negative psychological feeling states, then those findings can be taken as reliable indices of the psychological effects of exercise deprivation.

In an earlier investigation, Crossman et al. (1987) studied exercise deprivation under such circumstances in juvenile runners and swimmers. They found that exercise deprivation had no overall negative impact, but young men and athletes competing at higher levels exhibited more negative moods than girls and the athletes competing at lower levels. Consequently, athletic experience and the sex of the person may mediate the experience of deprivation sensations. The findings of Crossman et al. (1987) were in contrast to survey studies that found that women tend to report stronger deprivation sensations, in general, than men (Harris, 1981a; Robbins & Joseph, 1985; Summers et al., 1983; Szabo, 1997; Szabo et al., 1997). However, these authors studied a very specific and young athletic sample that may respond differently from the average committed adult exerciser.

The here presented work was designed to address shortcomings of research on exercise deprivation. First, the targeted participants were advanced martial artists because survey research indicates that this group experiences a strong mood disturbance at times of training deprivation (Szabo, 1997; Wingate, 1993). Consequently, the experimental examination of this population was warranted. Second, since survey studies have suggested that women report stronger and/or more deprivation sensations than men (Harris, 1981a; Robbins & Joseph, 1985; Summers et al., 1983; Szabo, 1997), the experimental investigation of sex differences is called for. Third, experimental studies performed till the present work have used a training-deprivation-training (A-B-A) format in their repeated measures design consisting of pre-, during- and post-measurement periods. Since the former may be affected by 'anticipation' effects and the last by 'residual' effects of exercise deprivation (Gauvin & Szabo, 1992), the adoption of a separate baseline period, in addition to the usually studied three periods, may prove to be useful. Consequently, in this field experiment, we have formulated three directional research hypotheses:

1. Martial artists will exhibit strong deprivation sensations during a one-week rest period.
2. Women participants will report more intense feelings of exercise deprivation than men.
3. Affect in pre- and post-deprivation periods will differ from a ‘normal baseline’ period.

3.3.2 Materials and methods

3.3.2.1 Participants

Participants were recruited from among 80 martial artists training in Shotokan karate at black belt or close to black belt level. They were approached by the second author, who was a well-known instructor, to volunteer for the study. Prospective participants were told that the instructor wished to examine the changes in their physical and emotional states after a one-week rest period with a view to include regular rest intervals into their training routine before major competitions. This strategy is employed in certain sports, such as swimming (Wittig et al., (1989). Recruitment proceeded on an ongoing basis until 10 men and 10 women volunteered to complete the study. All participants signed an informed consent form at the beginning of the study. Eighteen volunteers trained at black belt level and two at the brown belt level. Their mean age was 28.4 years (SD = 6.6), they trained an average 3.6 times a week (SD = 1.1) for a total of 6.5 hours (SD = 2.5) per week. The participants were strongly committed to their martial art as indicated by their high score (mean = 50.7, SD = 4.9) on the 'Commitment to Martial Art’ scale. This scale was modified from Carmack and Martens’ (1979) Commitment to Running Scale (CRS; Appendix C). Several studies have shown that the replacement of the word 'running' in this scale with a word describing another exercise or the word ‘exercise’ / ‘physical activity’ does not affect the psychometric properties of this tool (Corbin et al., 1987; Gauvin & Szabo, 1992; Szabo et al., 1996). The volunteers were in regular contact with the second author who persistently motivated them to adhere to the study and who also collected the booklets containing the questionnaires at the end of the second and fourth week of the inquiry. All 20 participants completed the study.

3.3.2.2 Instruments

The Well-Being Questionnaire (WBQ) used by Gauvin and Szabo (1992; Appendix N), complemented by the abbreviated version of the POMS (Grove & Prapavessis, 1992; Appendix E), were the two instruments of choice to obtain comparable measures to the other experimental studies on exercise deprivation. The former tool consists of eight negative psychological feeling states of affect that were referred to as "mood adjectives" (angry/hostile, irritated, frustrated, guilty, stressed, depressed, unhappy, and anxious) and six positive psychological states (happy, pleased, energetic, joyful, relaxed and having fun). It is believed that these states represent the dimensions of positive and negative affect (Diener & Emmons, 1985; Gauvin & Szabo, 1992). In addition to these mood adjectives, the WBQ includes ten physical symptoms (headache, stomach pain, cough or sore throat, chest pain, acne or pimple on the skin, nasal congestion, dizziness or vertigo, breathlessness, muscle tension or soreness and cold symptoms) based on the works of Pennebaker (1982) and Emmons and King (1988). Both the mood/affect states and the physical symptoms presented on the WBQ are to be rated on a seven-point rating scale, ranging from not at all (1) to extremely much (7).

The abbreviated version of the POMS inventory (Grove & Prapavessis, 1992) is a 40-item tool that has been well validated. It has seven subscales: anger, confusion, depression, self-esteem, fatigue, tension and vigour. Five of the subscales reflect negative moods and two of them identify positive moods. Hence, they complement the dimensions of negative and positive affect on the WBQ. The POMS also yields a total mood disturbance score (TMD), which is obtained by the subtraction of the sum of ratings on the two positive subscales from the sum of ratings on the five negative subscales (Grove & Prapavessis, 1992). In this research, the 40 items were rated from 1 (not at all) to 5 (very strongly).

3.3.2.3 Procedure

The study lasted for 28 consecutive days (four weeks), which were divided into two 14-day waves. One wave consisted of a two-week baseline period, and the other wave consisted of a four-day pre-deprivation period, a seven-day deprivation period and a three-day post-deprivation period. The two waves were counterbalanced among the 20 participants who all took part in both waves (Figure 3.6). Participants did not train at all during their 'rest' for one week and were also asked not engage in strenuous physical activities, but if they would still do so, to record those instances in a diary. Participants completed 28 copies of the two questionnaires, which were bound into a booklet. One questionnaire was completed every evening immediately before bedtime so that the completion of the questionnaires represented their last activity on that day. The martial artists were instructed to consider their 'average' feelings throughout the day during the completion of the questionnaires. Further, they were asked not to browse the already completed pages before they complete the questionnaire for the day. Finally, they were asked not to complete the questionnaires a posteriori if they could not complete it on the target day, or if they had consumed a substance that could have impaired their judgment (i.e., drugs or alcohol). However, there were no missing data for any of the participants.

3.3.2.4 Data reduction and analyses

The questionnaires were hand scored and double-checked. Every person completed 28 sets (with 64 ratings per set) resulting in 1792 ratings. The data were averaged for the studied four periods. This method yields reliable and stable scores for the studied intervals (Gauvin & Szabo, 1992; Rushton, Brainerd, & Pressley, 1983). After calculating the TMD, 12 dependent measures were obtained. They were analysed separately, as also done previously (Gauvin & Szabo, 1993; Mondin et al., 1996), whilst the Greenhouse-Geisser correction for repeated measures and the Bonferroni correction for multiple tests were employed. This yielded a stringent alpha of 0.004. For the follow-up paired t-tests the alpha was set at 0.01. The results were only considered meaningfully significant if the effect size (ES; Cohen's d) was 0.5 or greater. An ES of 0.2 reflects small, 0.5 medium, and above 0.8 large differences between means (Cohen, 1969).

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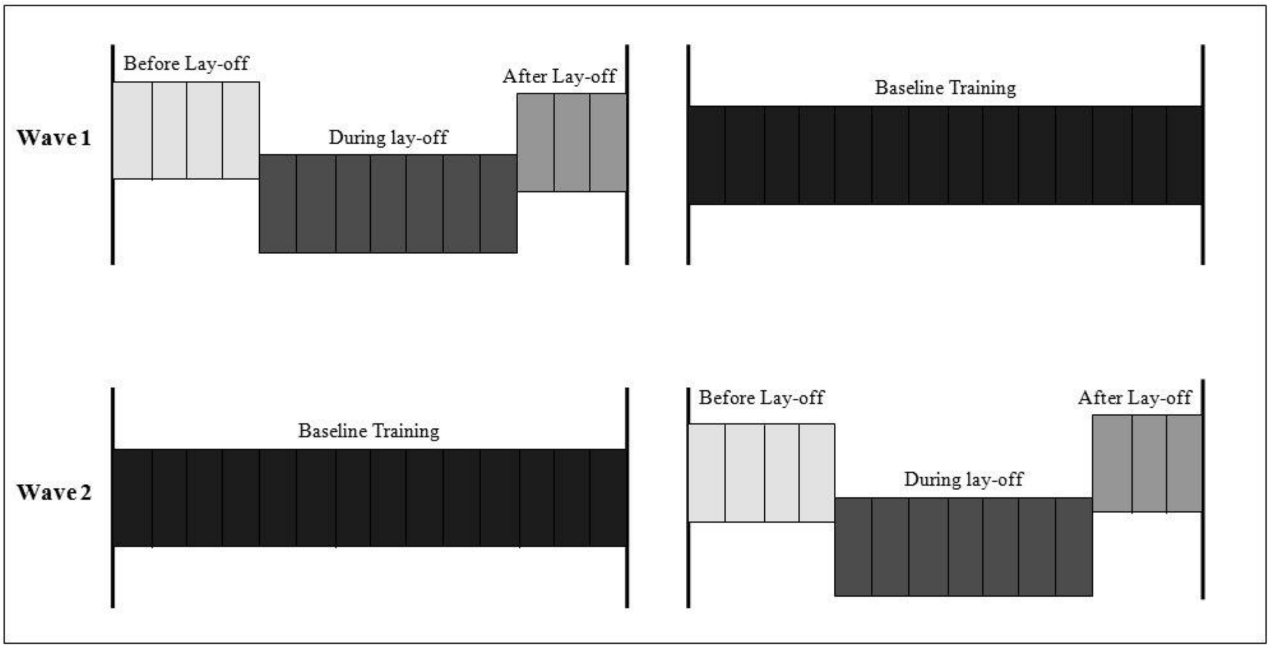
Figure 3.6. Diagrammatic representation of the four time periods and the order in which each wave comprised them. This method allows the cross-sectional examination of the four time periods, in particular between ‘Baseline’ & ‘During’; ‘During’ & ‘After’; ‘Before’ & ‘Baseline’ and ‘Before’ & ‘After’.



3.3.3 Results

The 12 dependent measures were analysed with a two (gender: male and female) by four (periods: baseline, pre-deprivation, deprivation, and post-deprivation) mixed model repeated measures analysis of variance (ANOVA). Neither a main effect for gender nor a gender by period interaction was detected in any of the tests. While period main effects emerged for 10 out of the 12 measures, only five of them reached the adjusted level of significance ($p < .004$). These were: positive affect (PA), negative affect (NA) gauged with the WBQ and anger (ANG), tension (TNS) and TMD assessed with the POMS. The results on vigour and depression POMS subscales only approached the Bonferroni corrected alpha ($p < .008$ and $p < .005$, respectively) but these results were followed up to examine their meaningfulness in terms of ESs. An ANOVA summary table for the period main effects is presented in Table 3.8

Follow-up paired t-tests were performed for seven dependent measures. None of these tests yielded differences between the baseline, pre-deprivation and post-deprivation periods. The differences between the baseline and the deprivation periods reached statistical significance ($p < .01$) in all instances, except for vigour, which only approached the accepted level of significance ($p < .05$). However, for vigour the comparison of the deprivation period with the pre- and post-deprivation periods were significant ($p <.007$; both) although there was no statistical significance between the baseline and pre- and post-deprivation periods. Means, standard deviations, t-values for the baseline-deprivation period differences, their probability and ES (Cohen's d) are illustrated in Table 3.9. Figure 3.7 shows the percent difference from baseline.

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Figure 3.7. Percent (%) difference from baseline (0 on the graph) during the deprivation period in seven measures that were significant: PA = positive affect; NA = negative affect; ANG = anger; VGR = vigour; TNS= tension; DPS = depression; TMD = total mood disturbance.

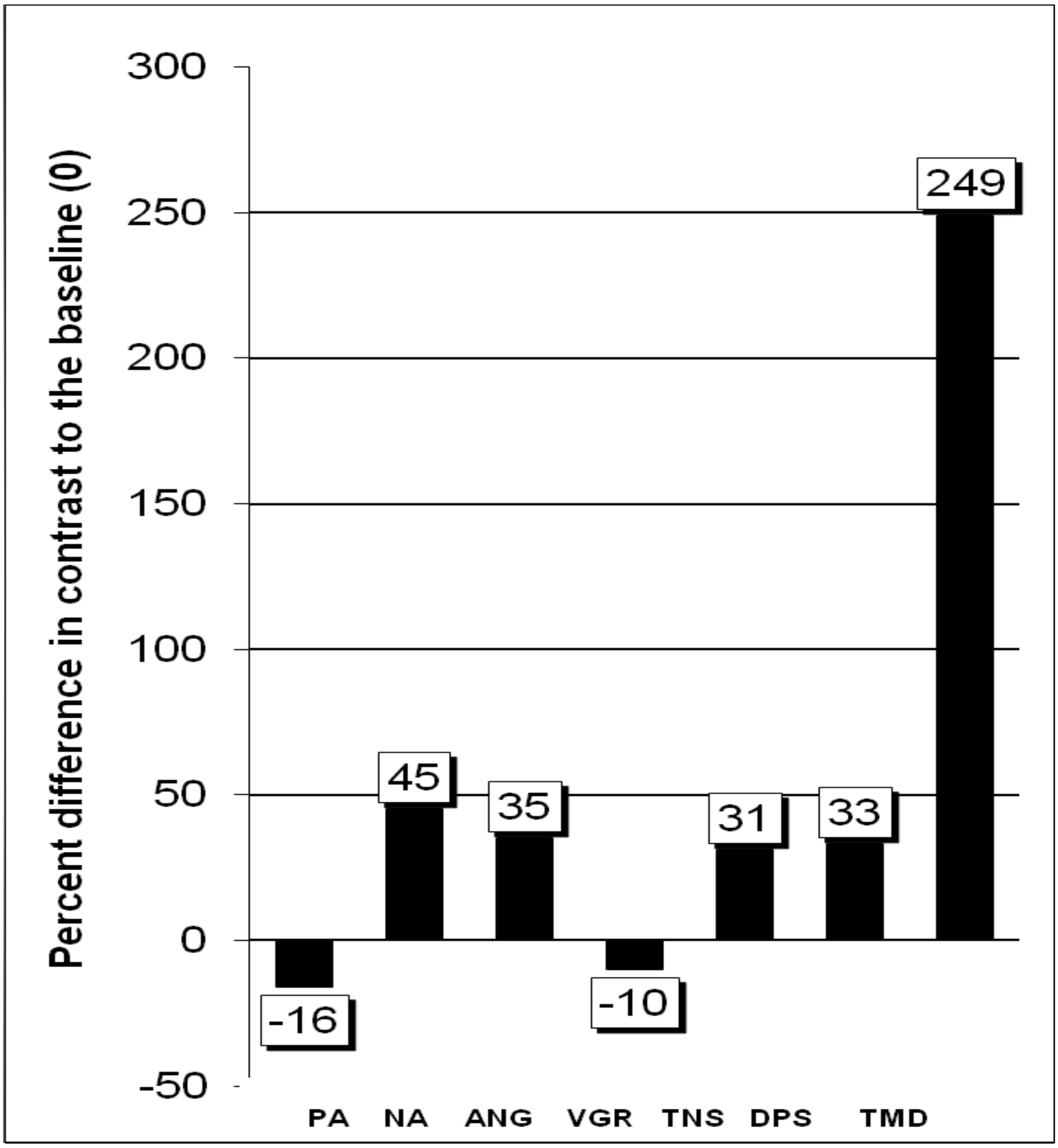

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Table 3.8. Summary table for the repeated measures analyses of variances (ANOVAs) 'period' main effects, after the Greenhouse-Geisser correction, for the 12 dependent measures.

	ANOVA Table		SS	df	MS	F	p <
WBQ	Positive affect	Period	235.2	2.7	85.8	5.7	.003
		Error	744.5	49.4	15.1		
	Negative affect	Period	513.0	2.4	210.1	7.2	.001
		Error	1279.4	44.0	29.1		
	Number of physical symptoms	Period	6.5	1.8	3.7	2.0	NS
		Error	57.5	32.1	1.8		
	Intensity of physical symptoms	Period	4.8	2.2	2.2	2.1	NS
		Error	41.9	39.5	1.1		
POMS Inventory	Anger	Period	198.8	2.1	96.8	8.5	.001
		Error	422.4	37.0	11.4		
	Confusion	Period	27.2	2.6	10.3	3.8	.02 *
		Error	128.9	47.3	2.7		
	Depression	Period	72.9	2.5	29.2	5.4	.005 #
		Error	242.0	45.0	5.4		
	Esteem	Period	23.2	2.5	9.2	3.9	.02 *
		Error	107.0	45.3	2.4		
	Fatigue	Period	75.1	2.4	31.5	4.2	.02 *
		Error	320.5	42.9	7.5		
	Tension	Period	111.6	2.5	44.8	5.7	.004
		Error	354.4	44.9	7.9		
	Vigour	Period	122.3	2.7	45.4	4.6	.008 #
		Error	480.5	48.5	9.9		
	Total Mood Disturbance (TMD)	Period	3679.1	2.6	1478.2	6.9	.001
		Error	9580.8	46.7	205.2		

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Table 3.9. Means and standard deviations for the measures obtained on the WBQ and the POMS inventory, presented along with the t values, their probability and effect sizes (ES; Cohen's d) of difference between the baseline and deprivation periods (between the shaded columns).

		Pre-	Deprivat.	Post-	Baseline	t(19)	p <	ES (d)
WBQ	Positive affect[1]	24.0 (6.7)	19.5 (6.4)	23.0 (6.3)	23.3 (6.0)	-2.9	.009	.63
	Negative affect[1]	13.3 (6.1)	19.6 (8.0)	15.5 (5.2)	13.5 (3.9)	3.3	.004	1.6
	Phys. symptoms 1	1.6 (2.0)	2.3 (2.2)	1.9 (1.9)	1.7 (1.3)	-	-	-
	Phys. symptoms 2	1.6 (1.6)	2.2 (1.1)	1.8 (1.1)	1.7 (0.8)	-	-	-
POMS Inventory	Anger[1]	10.3 (3.9)	13.9 (5.1)	10.3 (3.5)	10.3 (2.6)	3.14	.005	1.4
	Confusion	6.9 (2.7)	8.1 (2.9)	7.3 (2.7)	6.6 (1.7)	-	-	-
	Depression[1]	8.3 (3.3)	10.1 (3.9)	8.0 (3.0)	7.6 (1.8)	2.9	.009	1.4
	Esteem	18.5 (2.4)	17.2 (1.7)	18.2 (2.1)	18.5 (2.2)	-	-	-
	Fatigue	8.8 (3.8)	10.8 (3.3)	8.3 (2.9)	8.7 (2.3)	-	-	-
	Tension[1]	9.3 (4.2)	12.2 (4.4)	9.9 (3.3)	9.3 (3.0)	3.0	.007	.94
	Vigour[2]	18.9 (5.3)	15.8 (4.3)	18.8 (4.6)	17.6 (3.7)	-3.0	.007	.65
	TMD[1]	6.2 (21.7)	22 (20.7)	6.6 (17.5)	6.3 (12.9)	3.3	.004	1.2

NOTE: Phys. symptoms 1 and 2 refer to the number (1) and the intensity (2) of physical symptoms reported on the WBQ; 1 = deprivation period differed significantly from all the other three periods (p < .01); 2 = for vigour, the deprivation period only differed (at p < .01) from pre- and post-deprivation periods, but not from baseline; (-) = no follow-up tests were called for.

3.3.3 Discussion

Experimental studies on exercise deprivation are difficult to undertake (Szabo, 1998). In this study, the exercise deprivation period was presented in a rather positive way to the martial artists as a rest period with possible beneficial effects on subsequent performance. Moreover, the aims of the inquiry and the protocol were presented and overlooked by a respected instructor, a role model, with whom the potential participants could associate easily, unlike in other studies conducted by an ‘unknown’ experimenter. Indeed, before focusing on the quantitative results, it should be emphasized that in this inquiry all volunteers completed the study and no missing data occurred although that would be expected in long-term deprivation studies. For example, Gauvin and Szabo (1992) lost 5 of 29 participants and another three did not comply with experimental protocol, resulting in a total loss of eight (38%) participants. The adherence to the present study could have been facilitated by both the disciplined nature of martial arts at advanced levels (Wingate, 1993) and by the characteristics of the instructor-experimenter, a national champion in the martial art style of the participants. These observations are important because they suggest that the presentation of the study purpose and/or the experimenter’s relationship to the participants may influence the conformity of the participants with the experimental procedure. This notion is very important in this unexplored research area (Szabo, 1998). Therefore, further inquiries should test systematically the role of these possible mediating factors in adherence to deprivation studies.

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The results of this research demonstrate that martial artists experience distressing levels of emotional disturbance at the times when they refrain from training for one week. Considering the robust methods of analyses adopted in this study, clearly distressing self-reports were observed in: negative and positive affect, anger, depression, tension, and total mood disturbance. Apart from positive affect, that yielded a moderate to large effect size (Table 3.9), most other effect sizes were large (ES >. 8). The finding that the volunteers' total mood disturbance (TMD) score was 249% higher than during the baseline period merits attention. The main reason is that these findings are in discord with Gauvin and Szabo's (1992) results, which showed no emotional distress for the one-week exercise deprivation period, but revealed significant changes in the number of physical symptoms reported for the deprivation period. The opposing findings may be attributable to at least two factors. First, Gauvin and Szabo studied 12 experimental participants who were enrolled in a number of *different exercises at different levels* in contrast to a specific physical activity, performed at an advanced level, by the participants in the present study. Consequently, for the black belt martial artists their 'exercise' could be more a lifestyle than exercise performed for fitness and fun. Any interference with it could, therefore, result in psychological disturbance. This explanation also limits the generalizability of the findings to an advanced martial artist population. It is important to highlight that several factors, for example, commitment, history of participation, weekly exercise and values attached to the activity can contribute to how one responds to exercise deprivation (Szabo, 1995; 1998). Therefore, apart from activity-specificity and level of practice, other factors may also contribute to incongruent findings in this area of research.

Another explanation relates to the research method of data gathering. Gauvin and Szabo (1992) have used the experience sampling method, gathering participants' momentary feelings in contrast to the daily sampling method used for measuring participants' average feelings for the day in the here reported study. First, average momentary feelings may not represent the 'average' feelings. Second, in the former only a mentally quick surface analysis is required, whereas in the latter a deep retrospective analysis is needed, which yields a more global image that may be affected by memory distortions, personal values and desires. Nevertheless, people still appraise the quality of their day in light of the latter rather than the former. Indeed, the latter answers the question: 'How was your day?' as opposed to the question: 'How do you feel right now?' Both questions are equally important, but, in light of this explanation, deprivation studies most often may reflect exaggerated responses. The extent to which this contention is valid needs to be tested by directly comparing the two methods of inquiry.

Apart from the Gauvin and Szabo (1992) study, there were two other inquiries that have used one-week or longer deprivation periods. The current results agree with those obtained by Wittig et al. (1992) in which a reduction in the volume and the intensity of exercise triggered significant mood disturbance, as assessed with the POMS, in runners. The present findings also agree in part with the findings of Morris et al. (1990) revealing increased depression after exercise deprivation in runners. However, they also disagree with it because no increases in physical symptoms were recorded in this study in contrast to Morris et al.'s (1990). It should be appreciated, however, that both of the above studies examined runners and both have based their results on only a few assessments in contrast to this study. Consequently, no reliable comparison can be made between the previous studies and the current research.

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Apart from the above noted discrepancies, the results of this inquiry are in tune with the conclusion of the bulk of research on exercise deprivation. They disagree, however, with those that report gender differences in the intensity and/or frequency of deprivation-feelings (Harris, 1981a; Robbins & Joseph, 1985; Summers et al., 1983; Szabo, 1997). This is most likely due to the fact that women in this sample performed a martial art at an advanced level. Their reason for participation may be different from those of runners or aerobic exercisers who are primarily active for health reasons. The motives for participation in exercise have been linked to the reporting of exercise deprivation emotions, with those participating for health reasons reporting more deprivation than those participating for other reasons (Robbins & Joseph, 1985; Szabo, 1997; Szabo et al., 1996). Values and training practices at black belt level in martial arts may override possible gender differences that may exist at a lower or beginners' level due to the development of traits or characteristics fostered by the tradition of martial arts.

The third hypothesis examined in this inquiry, regarding the adequacy of pre- and post-deprivation periods as a baseline, showed that under most circumstances there were no differences between these periods and an additional baseline obtained over a regular two-week training period. However, a note of caution emerged when the vigour subscale scores on the POMS were considered. More precisely, the accepted level of statistical significance was not reached when the difference between the deprivation (rest) week and the baseline was calculated. However, when the deprivation week was compared to the pre- and post-deprivation periods, both comparisons yielded statistically significant results. Since most research conclusions are based on statistical outcomes, in this inquiry the decrease in vigour during the deprivation period would have been declared significant in lack of a separate baseline value. Yet in fact, these results (as illustrated in Table 3.9) suggest that vigour was slightly higher during the pre- and post-deprivation period than during the baseline. While they were statistically not significant, the trend was sufficient to produce a potentially erroneous conclusion in the absence of a baseline. Albeit it may be speculative, the trend in vigour could be attributed to an intensification of training prior to deprivation, because participants knew that they would rest for a week, and to the intensification of training after the rest to compensate for the loss in training during this period. Alternatively, participants may have expected positive changes in their training after the rest period, which could have been reflected through their ratings on the vigour subscale. However, considering the issue of baseline, this point is neither significant nor as important as the fact that slight variation in the pre- and post-deprivation period could jeopardise the accuracy of the statistical conclusions as seen in this study. Therefore, it is recommended that a separate baseline period, that is relatively unaffected by experimental procedure-related anticipation or carry-over effects, be adopted in all psychological inquiries of a similar nature.

In conclusion, advanced martial artists report psychological disturbance of considerable magnitude when deprived of training, even if the deprivation period is presented as a rest period that may have subsequent benefits in their performance. The observed effects were unrelated to the sex of the martial artists in this study. Although the results reported here are quite powerful, caution should be exercised when attempting to generalise them. For example, the martial artists studied here represent only those who practice the Shotokan karate form of art, and even among them only those who train at either black or brown belt level. Furthermore, the association of the participants with one experimenter may have influenced the conformity demonstrated by them as much as the values and the traditions of martial arts may have done. Finally, one cannot determine clearly whether the psychological disturbance reported here reflects symptoms of exercise deprivation (related to the physical aspect of martial art training) or whether it is more a reflection of an unfilled emptiness, or change in lifestyle, resulting from the temporary elimination of training, in the advanced martial artists' lifestyle.

3.3.4 Contribution to the advancement of knowledge

Negative psychological feelings, resulting from exercise deprivation, occur even in life-situations in which the exercise-interruption period is presented as a possible advantage to high-level martial arts practitioners. Therefore, by manipulating participants' expectations the current study shows that the subjectively reported negative psychological effects of exercise deprivation are unlikely to be a consequence of nocebo effects fuelled by subjects' expectancy. Indeed, considerable increases were observed in anger, depression, negative affect, tension, and total mood disturbance. The latter increased by 249% during the one-week deprivation period. Therefore, brown and black belt martial artists report a severe mood disturbance during a one-week period of abstinence from training, which is independent of the gender of the individual.

3.3.5 The take-home message of the study

Even a positive expectation-generating research intervention of exercise abstinence results in negative psychological feeling states in martial artists.

3.4 A Review of Research on Exercise Deprivation[13]

In this section I will present an overview of the exercise deprivation literature. I will not elaborate in much detail the three studies carried out as surveys on the Internet by myself and my colleagues (Szabo, 1997; Szabo et al, 1996, 1997), because they were presented in detail in section 3.1 of this dissertation. Further, those surveys, apart from addressing exercise deprivation-feelings and commitment to exercise from a retrospective perspective, also focused on the feasibility and reliability of conducting academic research on the Internet. Those studies, added new knowledge to the exercise deprivation literature (refer to the "take-home message" section of the three works), but their most important scholastic contribution was the pioneering of scholastic data-collection through a novel telecommunication medium that connected people across nations in a new virtual world. The challenges and benefits of the novel method are discussed elsewhere (Michalak & Szabo, 1998; Szabo & Frenkl, 1996; section 3.2) because they are not directly related to the field of exercise deprivation. Nevertheless, the fact that exercise deprivation research was among the very first topics studied on the Internet should not be depreciated. The field experiment with martial artists, discussed in the previous section (3.3) will not be detailed below. It was treated separately because it was one of my major contributions to the field of exercise deprivation and

[13] *Based on:* ***Szabo, A.*** *(1995). The impact of exercise deprivation on well-being of habitual exercisers.The Australian Journal of Science and Medicine in Sport, 27(3), 68-75.*

also because it studied "rest" in participants' mind rather than a "forced abstinence" from exercise. In this respect, the study was different from the rest discussed below.

3.4.1 The first coincidental observation

The first scientific report about the existence of exercise-linked feelings of deprivation has emerged nearly half a century (Baekeland, 1970). The researcher examined human sleep in the laboratory while observing distorted sleep patterns in volunteers who were athletes and stopped their usual training for the duration of the research. Wishing to examine the noted phenomenon experimentally, Baekeland attempted to recruit exercisers who trained five to six times a week for a study in which these participants would have to stop exercising for a one-month period. In spite of offering monetary compensation, he could not find volunteers fulfilling the criterion for participation. Subsequently, he eased the condition for enrolment in the study and accepted the participation of volunteers who trained only three to four times a week. During the 30-day experimental period, these participants exhibited reduced well-being, increased tension and anxiety, and several nocturnal awakenings. This early research has clearly demonstrated that deprivation from regular or habitual exercise has a discomforting effect on regular exercisers' sleep and psychological well-being. The negative feelings reported by the research participants were similar to withdrawal symptoms observed in chemical addictions (i.e., smoking or drinking).

Subsequently, the presence of withdrawal symptoms prompted scholars to think that exercise may be addictive. Following a relatively quiet period of nearly ten years, studies have started investigating with more focus the effects of exercise deprivation on psychological feeling states. Most research focused on exercise addiction as the key variable, which was then associated with withdrawal symptoms, defined as negative psychological and physical feelings resulting from exercise deprivation (Morgan, 1979; Sachs & Pargman, 1979). Two scholastic terms, *withdrawal* and *deprivation,* were alternately used and referred to involuntary or forced, as opposed to planned abstinence from exercise. However, withdrawal may imply *voluntary* abstinence from exercise, while deprivation may refer to *forced* abstinence to exercise. Therefore, the reader should keep in mind that regardless of the terminology used, the studies presented and examined in this part of the dissertation *refer to forced or imposed exercise deprivation* rather than voluntary abstinence from exercise. Often the prevalence of withdrawal symptoms was assessed with the intention to demonstrate the presence or absence of exercise addiction (Anshel, 1991; Sachs & Pargman, 1979). Simplifying this notion, it was assumed that if one experiences exercise withdrawal, then that person is likely to be addicted to exercise. Moreover, high or exaggerated amounts of exercise were also linked to exercise addiction. Part III of this dissertation will explore the psychology of exercise addiction. In this part, however, the focus will stay on the psychological feeling states associated with exercise deprivation. Surveys were the easiest and fastest means of research to yield new knowledge about the psychological effects of exercise deprivation. Therefore, the next section will examine the contribution of the surveys to the understanding of exercise deprivation.

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3.4.2 Summary of survey research examining exercise deprivation

In two surveys, Harris (1981a; 1981b) asked runners about their well-being at times when they could not run for an uncontrollable reason. A chi-square analysis of the data showed that a greater proportion of runners reported negative changes, than positive ones, during periods of a hypothetical deprivation from exercise. In the first study (Harris, 1981a) 56.8% of the runners felt less energetic, 43.5% felt more guilty, 23.7% felt more depressed, and 12.4% reported other negative feelings when they had to stop running. Further, over 50% of the respondents reported gaining weight and losing shape (or fitness) after the cessation of running. A small percentage of the participants (i.e., less than 10%) reported some sort of positive feelings, while 8.5% reported no changes in well-being associated with running deprivation. In the second survey (Harris, 1981b), the author found that female runners felt guilty, less energetic, fatter, more depressed, and more tense during periods when they could not run. These two studies by Harris have replicated each-other and have revealed that stopping a habitual physical activity, like running, results in subjectively perceived negative feelings.

Approaching the research question from a different perspective, Blumenthal et al. (1984) examined the comparability of personality profiles between compulsory runners and anorectic patients. These authors found that two groups differed on the basis of their Minnesota Multiphasic Personality Inventory (MMPI) scores. Therefore, the similarity between anorectic subjects and compulsory runners were not confirmed. However, 86% of the runners reported that they felt guilty if they did not fulfil their planned exercise and 72% stated that they felt tense, irritable, or in depressed mood when they had to miss a planned session of running. Therefore, this inquiry by Blumenthal and his coworkers apart from reconfirming the existence of deprivation-feelings, also demonstrated that exercise withdrawal symptoms, are not associated with eating disorders. In other word, withdrawal symptoms could be attributed solely to exercise deprivation.

Some researchers could classify deprivation-feelings associated with exercise withdrawal, according to various psychological categories. Robbins and Joseph (1985) found that more than half of a sample of runners reported some sort of deprivation-feelings, including irritability, restlessness, frustration, depression, guilt, and general fatigue, for the times when they could not run for some reason. When subjects were asked to describe their running deprivation sensation in their own words, the descriptions could be grouped into three main categories: 1) anxiousness, 2) depression or disappointment and 3) fatigue. This study reinforced the results of a previous work in which 74% of a large sample of runners reported feelings of discomfort when they missed a run (Carmack & Martens, 1979). These runners too, described their feelings of discomfort in terms of five specific sensations - 1) guilt, 2) irritability, or depression, or bad mood, 3) the losing of training, 4) letting self down, and 5) sluggishness. Using an in-depth interview approach, Sachs and Pargman (1979) also found that runners felt anxious, restless, and irritated when they could not run.

A common denominator, that should be observed, between the above studies is that they all used a "fairly heterogeneous" sample and did not select for long-term and/or addicted runners. The consensus among the above studies suggests that running deprivation, in general, is associated with negative changes in well-being and may not be limited to runners who are addicted to this form of exercise. However, since running experience (time, length, or history) was thought to be

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directly related to addiction (Hailey & Bailey, 1982), it may be speculated that long-term and intense runners may experience the strongest withdrawal symptoms when they are compelled to stop running for a reason. Therefore, it is not surprising that studies which selected long-term and highly committed runners, such as marathoners, have also corroborated the negative psychological impact of running deprivation on the subjective states of well-being.

Summers et al. (1982) asked non-elite marathoners about their feelings when they had to miss a planned run. The results showed that 47% of the runners felt that they let themselves down, 38% felt guilty, 36% felt irritable, depressed or in a bad mood, and 29% felt sluggish during these periods. Further, in another study, Summers et al. (1983) found that 83% of marathoners reported discomfort when forced to miss a run. Long-term runners were more likely to report discomfort than the rest of the participants. In a later study, Acevedo et al. (1992) reported that 84.8% of ultramarathoners expressed some negative feelings related to lack of running. These discomforting feelings included despair, aging, frustration, anxiety, guilt, depression, or feeling trapped, fat, decrease in self-worth, and decrease in self-confidence.

Using an interview approach, Gauvin (1990) took in consideration one's adopted exercise characteristics and examined participants who were either autonomous exercisers, exercisers in a fitness program, dropouts from an organized fitness program, or inactive sedentary individuals. The participants performed different types of physical activities. When asked how they felt at times when they missed their exercise bout, all subjects, except those in the sedentary group, reported feeling guilty. However, dropouts did not express this feeling as frequently as exercisers. Further, autonomous exercisers felt angry, irritated, that something was missing, or that they could make up later for the missed workout. Exercisers in the organized fitness program reported that the initial guilt has decreased after repeated absence, whereas dropouts reported less guilt and more pleasure in performing something else. Similar to findings from other surveys, these results provided an insight into specific subjective feeling states linked to exercise deprivation.

In her doctoral work, Wingate (1993) designed a 10 item deprivation sensation inventory and tested 102 karate participants. Exercise deprivation was conceptualized as missing two or more workouts. Wingate (1993) found that the intensity of deprivation sensations was related to the coping resources of the individual. Participants who scored higher on the deprivation sensation inventory scored lower on a coping resources inventory and vice versa. In the second phase of her study, Wingate (1993) also interviewed a sub-sample (i.e., 20) of her subjects. These participants associated missing workouts with feelings of depression, anger, frustration, tension, irritability, fatigue, sluggishness, and sleep difficulties. The interview data suggested that karate participants did not associate the deprivation sensations with addiction to exercise. Participants in this study viewed deprivation sensations as "*natural physical and psychological reactions*" (Wingate, 1993; p. 213). Wingate (1993) interprets deprivation sensations in terms of negative reinforcement which is a motivational factor for continued participation: "*Knowing that not training will result in feelings of guilt or decreased physical and mental energy helps participants get themselves to the Dojo when they really don't feel like going.*" (p. 214). This author was perhaps the first to link deprivation-feelings to motivational incentives for exercise using a behaviouristic perspective.

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3.4.2.1 Brief analysis of survey-research in exercise deprivation

More than a third of published research, that present research data on exercise deprivation, have adopted the survey type (ST) approach (Table 3.10). In these inquiries, the subjects received either open-ended or structured questions asking them about their feelings during periods when they cannot exercise. At first it may be striking to realize that most of the survey studies examined runners and only a few of them (e.g., Anshel, 1991; Gauvin, 1990; Szabo, 1997; Szabo et al, 1996; Wingate, 1993) examined subjects involved in other type(s) of exercise. Regardless of research methodology, there may be two good reasons for studying runners. The first is that running is popular and runners may be reached at races and in public running areas. The second reason is related to the fact that exercise deprivation was studied with a view on, or link to, exercise addiction. This phenomenon was more commonly reported in runners in the early research work.

Survey research points in the same direction and suggest that exercise deprivation has negative impact on the subjective experiences of well-being (Table 3.10). Beside such a general consensus, it may be of special interest to note that most negative symptoms, reported in these studies in relation to exercise deprivation, are "typical" and both physical and psychological in nature. The most common symptoms reported in survey studies are guilt, depression, irritability, and tension (Acevedo et al., 1992b; Blumenthal et al., 1984; Carmack & Martens, 1979; Gauvin, 1990; Harris, 1981b; Summers et al., 1984). Survey research may have limited value in a scientific perspective, but it is an easy means of knowledge-gathering, as discussed later in the paper.

3.4.3 An overview of cross-sectional research examining exercise deprivation

Another way to study exercise deprivation is by examining the profiles of exercisers forced into abstinence due to some injury. One major limitation of this method should be recognized. This limitation is the confound between the response to injury and to the lack of exercise. Partial control for reducing the impact of this confound is to ensure that the injury does not result in loss of abilities other than exercising. Such a method was used by Chan and Grossman (1988) who selected a group of runners unable to run for a minimum of four weeks due to injuries that did not interfere with their usual activity routine (walking, working, sleeping, etc.) and did not cause pain under conditions other than running. They compared this group of "prevented runners" to a group of "continuing runners" who ran without interruption. It was found that the former showed significantly more symptoms of psychological distress, including anxiety, depression, confusion, over-all mood disturbance, and lower self-esteem, than the continuing runners.

Anshel (1991) studied whether abstinence from regular exercise has a negative impact on subjective states. In this study males and females, who participated in different exercise regimens, were classified on the basis of their exercise volumes. After missing a workout, heavy- or intense-exercisers reported more depression, anxiety, and anger than moderate-exercisers. This study, however, relates psychological states during a missed workout to the dose of exercise. Therefore, the results are insufficient to answer the question whether exercise deprivation, in general and regardless of effort, may be directly associated with negative psychological states.

Table 3.10. Summary of exercise deprivation research (1970-2015). List of abbreviations in the table: avg = average; BS = Between Subjects; CX = Cross-Sectional; DIR = Direct; IND = Indirect; EXP = Experimental; hrs = hours; QTR = Questionnaire; mi = miles; n = number of subjects; Sex: m = male, f=female; ST = Survey Type; wk = week; WS = Within Subjects; Abbreviations of various questionnaires in the "Measures" column can be also found in the "List of Abbreviations" of the dissertation.

Year	Author	n & Sex	Age (yrs)	Exercise Form	Amount of Exercise	Length of Deprivation	Measures	Type of Inquiry	Findings
1970	Baekeland	14 m	<30	Mixed	3-4 times per week	1 month	Develope d own QTR	DIR/ EXP/ WS	Negative feelings, anxiety & sexual tension
1979	Carmack & Martens	315 m,f	28.8	Running	5,4 times per week	When they are unable to run	Open-ended questions	IND/ ST	Negative feelings to 74% of the subjects
1979	Sachs & Pargman	12 m	23-48	Running	Varried	When they are unable to run	In-depth interview	IND/ ST	Negative feelings to most of the subjects
1981	Harris (a)	411 m,f	10-71	Running	Varried, 1 to 120 miles per wk	When stopped running	Halt of running QTR	IND/ ST	Negative feelings to >80% of the subjects
1981	Harris (b)	156 f	11-54	Running	19 mi/wk (avg)	When they are unable to run	Designed own 7-point QTR	IND/ ST	Negative feelings to most of the subjects
1982	Summers et al.	363 m,f	36.1	Running	15-20 mi/wk (mini-mum)	When they are unable to run	Designed own QTR	IND/ ST	Negative feelings to most of the subjects
1982	Thaxton	33 m,f	36	Running	30 min/day (min.)	1 day	POMS	IND/ EXP/BS	Negative feelings to those who did not run
1983	Summers et al.	459 m,f	31.7	Running (avg?)	15 mi/wk run	When they are unable to run	Designed own QTR	IND/ ST	Negative feelings to most of the subjects
1984	Blumenthal et al.	43 m,f	34/ m 28/f	Running	≤100 mi/wk	When they are unable to run/exercise	Designe own QTR	IND/ ST	Negative feelings to 72-86% of runners

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Year	Author	n & Sex	Age (yrs)	Exercise Form	Amount of Exercise	Length of Deprivation	Measures	Type of Inquiry	Findings
1985	Robbins & Joseph	345 m,f	(?)	Running	23 mi/wk (median)	When they are unable to run	Designed own QTR	IND/ST	Negative feelings to most of the subjects
1985	Tooman et al.	40 m,f	18-53	Running	3 to 7 days/wk	2 days	POMS, STAI, and EMG	DIR/ EXP/BS	Negative feelings in general
1987	Crossman et al. (Study I)	31 m,f	13 to 26	Running	42 mi/wk (avg)	1 day	Anxiety & mood QTRs	DIR/ST	More negeative feelings at high competition level
1987	Crossman et al. (Study II)	20 m,f	10 to 29	Swim-ming	8 km/wk (avg)	5 days	Anxiety & mood QTRs	DTR/ EXP/ WS (?)	> negative feelings at high levels of comp'tion
1988	Chan & Grossman	60 m,f	15-50	Running	20 mi/wk mini-mum	4 weeks	POMS, Zung & Rosen-berg QTRs	DIR/ CX/BS	Negative feelings to deprived subjects
1989	Wittig et al.	10 m	32	Running	80 km/wk	Partial deprivation	POMS	DIR/ EXP/ WS	No effects or positive changes to the POMS
1990	Gauvin	78 m,f	18-60	Mixed	Varried	Missing a workout	Interview	IND/ST	Negative to the exercisers, but not to dropouts
1990	Morris et al.	40 m	37	Running	10 mi/wk (min.)	2 weeks	Zung & health QTRs	DIR/ EXP/BS /WS	Negative feelings to the deprived subjects
1991	Anshel	60 m,f	27.8	Mixed	50%>15 h/wk 50%<5h /wk	Missing a workout	Designed own QTR	IND/ CX /ST	Related to gender & exercise volume
1992	Acevedo et al.	112 M,f	40.2	Running	(?)	When they are unable to Run	Open-ended questions	IND/ ST	Negative feelings to 84,8% of the subjects

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Year	Author	n & Sex	Age (yrs)	Exercise Form	Amount of Exercise	Length of Deprivation	Measures	Type of Inquiry	Findings
1992	Gauvin & Szabo	21 m,f	23.6	Mixed	7.5 hours per week	7 days	Well-being QTRs (4 times/day)	DIR/ EXP/BS /WS	Number of physical symptoms doubled
1992	Wittig et al.	10 m	(?)	Running	(?)	Partial deprivation	POMS	DIR/ EXP/ WS	Negative changes to the POMS
1992	Szabo & Gauvin	16 m, 8f	23.5	Mixed	8.25 hours per week	7 days	HR and mental arithmetic	DIR/ EXP	No change in heart rate or math performance.
1993	Wingate	102 m,f	33.2	Martial arts, Karate	3 times per week	Missing ≥2 workouts	Designed own QTR & interview	IND/ ST	Negative feelings to most of the subjects
1994	Conboy	51 m, 10f	(?)	Running	(?)	10 days of running, 2 days lay-off	POMS	IND/ ST	Neg.to less committed-high dependents
1996	Mondin et al.	10 6m, 4f	27.4	Swimming, cycling, running	6-7 days a wk, at least 45 min	3 days	POMS + other QTRs	DIR/ EXP/ WS	Negative feelings to most of the subjects
1996	Szabo et al.	130 m,f	28-35	Aerobic, weight-training, crossfit, fencing, bowling	3-5 times /wk, 70-155 minutes each time	When they are unable to exercise	3 QTRs: STAI, DSS, CPA	IND/ST /BS (on the Internet)	Negative to all, less in bowling, and also linked to health reasons for exercise
1997	Szabo	141 m, 87f	33.5	Fitness, swim-ming, martial arts, triathlon & dance	> 4.5 times /wk, 71-135 minutes each time	When they are unable to exercise	3 QTRs: STAI, DSS, CPA	IND/ST /BS (on the Internet)	Negative to all, more so for women and for those who exercise for health reason
1997	Szabo et al.	74 m, 25f	34.9	Running	4.9 days a week, 4.6 hrs/wk	When they are unable to run	3 QTRs: Affect, CRS, ORQ	IND/ST /WS (on the Internet)	Negative to all, more so for women and those who ran for health reason

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Year	Author	n & Sex	Age (yrs)	Exercise Form	Amount of Exercise	Length of Deprivation	Measures	Type of Inquiry	Findings
1998	Szabo	10 6m, 4f	(?)	Running	Not asked	Hypothetical	Willing-ness to take part in depri-vation studies	IND/ST	4/10 would not take part the 6 others would take part conditionally
2001	Szabo & Parkin	10 m, 10f	24.8	Martial arts, Karate	6.5 hrs/wk	1 week (the lay-off period was presented as "rest period"	Well-being QTR & POMS	DIR/ EXP/ WS	Negative mood has increased by 249%.
2003	Aidman & Wollard	30 m, 30f	24.2	Running	5 training sessions /wk	1 day	POMS	DIR/ EXP/BS	Negative feeling link to exercise addiction
2004	Glass et al.	18 7m, 11f	25.2	Mixed aerobic exercise	>4 hrs/wk, avg 5.73 hrs/wk	7 days	Many QTRs	DIR/ EXP /WS	Specific responses linked to stress
2006	Berlin et al.	40 15 m, 25f	31.3	Mixed aerobic exercise	>30 min at least 3 times /wk	14 days	POMS Beck QTR	DIR/ EXP/BS	Negative outcome after the 1st week
2007	Weinstein, Deuster & Kop	15 m, 25f	31.3	Mixed aerobic exercise	>30 min at least 3 times /wk	14 days	POMS Beck & Fatigue QTR	DIR/ EXP/BS	Neg. psych. effects, linked to heart rate variability
2008	Niven, Rendell & Chisholm	58 f	26.1	Mixed	At least 4 times/w k	3 days	Several QTRs	DIR/ EXP/BS	Negative effects, body dissatisfac-tion
2008	Hausenblas Gauvin, Downs & Duley	14 m, 26f	20.5	Mixed	At least 30 min most days	3 days	Exercise Induced Feeling Inventory	DIR/ EXP/ WS	Positive changes linked to exercise dependence
2008	Kop, Weinstein, Deuster, Whittaker, & Tracy	15 m, 25f	31.3	Mixed aerobic exercise	>30 min at least 3 times/ wk	14 days	POMS Beck & Fatigue QTR	DIR/ EXP/BS	Negative psychol. effects but inflamma-tory markers not affected

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Year	Author	n & Sex	Age (yrs)	Exercise Form	Amount of Exercise	Length of Deprivation	Measures	Type of Inquiry	Findings
2011	Poole, Hamer, Wawrzyniak & Steptoe	26 m,f	25.5	Habitual exercise	≥30 min at least 3 times / wk	14 days	GEQ, POMS & iflama-tory markers	DIR/ EXP/BS	Negative psychol. effects linked to decreased IL-6
2013	Ablin et al.	87 m,f	(?)	Mixed exercise	(?)	10 days	Mood and physical indices	DIR/ EXP/BS	Deprivation resulted in fatigue only
2014	Fogaa Leite et al.	16 m	31.9 ± 4.3	Running and triathlon	At least 5 times /wk	14 days	Brunel Mood Scale and biochem. indices	DIR/ EXP/ WS	Negative changes in affect and in biochemical markers

The two cross sectional studies, replicating each other (Szabo, 1997; Szabo et al., 1996), were the only cross-sectional studies in the exercise deprivation literature to compare the presence and/or intensity of deprivation-feelings associated with involuntary abstinence from exercise in different forms of exercise or physical activity. While retrospective research and data may be less reliable because of possible memory distortions and/or subjective values embedded in them, the two studies showed clearly that deprivation periods are associated with negative psychological states *in most* physical activities. However, bowling, that was linked to a lesser physical effort and fewer weekly sessions (but longer episodes), was associated with less intense deprivation-feelings than the other forms of exercises. It is regrettable that no experimental investigations were carried out to compare the effects of various physical activities. It is possible that light, or even very light exercises, like tai chi or yoga, could result in strong exercise deprivation when the activity cannot be performed, because these activities appear to have greater acute psychological benefits than other more intense aerobic exercises (Gothe et al., 2012; Szabo et al., 1998).

It is evident that many studies addressed only indirectly the impact of exercise deprivation on subjective states. To address this issue directly, experimental inquiries need to be carried out. However, there is one major obstacle in planning such studies: subject recruitment. As Baekeland (1970) noted in his pioneering work, some individuals, especially those who exercise on a daily basis, would not stop exercising for any incentive. I have studied regular exercisers' willingness to participate in experimental studies involving exercise withdrawal (Szabo, 1998) and confirmed Baekeland's dilemma. I will present this work in a section below. Nevertheless, there are a number of experimental studies, especially lately, that examined the effects of exercise deprivation on the psychological feeling states of regular exercisers. In fact, after the year 2000 only experimental studies were published in this area of research (refer to Table 3.10). These studies provide reliable results toward the understanding of the impact of exercise deprivation on subjective well-being.

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3.4.4 Experimental studies investigating the effects of exercise deprivation

Although experimental studies adopted different lengths of deprivation periods, examined subjects in different age-groups involved in different exercise regimens, and also used a wide variety of methodologies, they project a general consensus. They corroborate the findings from anecdotal accounts, survey research and cross-sectional studies pointing to the negative impact of exercise deprivation on subjective states (Table 3.10). In appreciating these studies, it should be realized that that the experimental investigation of exercise deprivation is extremely difficult and it may not be flawless, because an artificially induced deprivation period is practically not possible or it is unreliable. For example, the readers may appreciate that any hobby or habit adopted in the daily life of a person has a strong value in fulfilling the needs of that individual. Therefore, giving up something, needed, pleasant or heavily relied-on simply for the sake of scientific investigation is a highly unlikely. An analogy would be to ask smokers, to quit smoking for a day or more to allow scholars to study their psychological response to the deprivation from smoking.

3.4.4.1 Summary description of the experimental work on exercise deprivation

The negative effects of exercise deprivation on psychological states first emerged in the pioneering work of Baekeland (1970), mentioned at the beginning of Part II of this dissertation. The study was initially designed to determine physiological changes resulting from one-month exercise deprivation. However, near the end of the experimental period the subjects expressed psychological hardship. Baekeland (1970) quickly realized the importance of these complaints and designed a 25-item questionnaire to trap the distressing sensations. The questionnaire consisted of four parts that were intended to measure the quality of sleep, mood, tension or anxiety, and aggressive and libidinal drive immediately at the end of the deprivation period. Baekeland (1970) could not gauge subjective states on a daily basis, because the subjects started to complain near the end of the experimental period only. The results of the work reveal that exercise deprivation evoked negative changes in sleep patterns, increased anxiety, increased nocturnal awakening, increased sexual tension, and increased the need to be with others, in students accustomed to regular exercise. This work provided strong evidence for the subjectively experienced negative changes in one's well-being, in addition to physical changes, as a result of exercise deprivation.

More experimental support for the negative impact of exercise deprivation on well-being comes from a study by Thaxton (1982). In that study, 33 habitual runners were examined. Half of the runners have abstained from running for 24 hours while the other half maintained their usual running schedule. Reported depression score, based on the Profile of Mood States (POMS) and on galvanic skin responses, was higher in subjects who missed their run. It should be noted that an elevation in depression occurred after only 24 hours of abstinence. This finding led Thaxton (1982) to conclude that even a minor disturbance in the usual running schedule has a negative impact on the mood states of habitual runners. Similar to the results obtained by Baekeland (1970), the study also provides evidence for negative changes in psychological feeling states (beside physiological) resulting from exercise deprivation.

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Tooman et al. (1985) examined exercise deprivation from a different aspect. In their research 20 competitors and 20 recreational runners were studied. Participants ran at least three times a week, for not less than 30 min each time, and for at least two months prior to the study. On day one of the inquiry subjects completed the Spielberger State and Trait Anxiety inventory (STAI) and the POMS before and after their usual run. State anxiety, tension, anger, depression, and confusion scores decreased significantly from pre- to post-run condition. On days two and three subjects abstained from running. The positive changes in mood and anxiety, noticed after the running session on day one, persisted during the first day of exercise deprivation (day two of the study), but they have subsided, or had returned to pre-run levels, by the second day of exercise deprivation (day three of the study). Upon resumption of running, on day four of the inquiry, the positive changes in mood and anxiety emerged again. In this study no differences were found between competitive and recreational runners with regard to changes in mood and anxiety. The single physiological variable assessed in this study, muscle tension, was not affected by changes in running schedule. In terms of dissipation of positive changes, associated with acute exercise, this study provides valuable information. It should be noted, however, that studying exercise deprivation from this perspective involves the assumption of positively "inflated" subjective states resulting from regular exercise. Accordingly, deprivation effects represent "deflation" of these states that occur when the inflating stimulus (i.e., exercise) is removed.

In two congruent studies, Crossman et al. (1987) studied the mood responses of competitive runners to a one-day exercise deprivation and of competitive swimmers in a planned five-day training lay-off. Their results, in general, did not support the hypothesis that exercise deprivation has a negative influence on mood, as no significant changes were observed. However, males and athletes competing at higher levels of competition reported more negative moods during lay-off than females and athletes competing at a lower level. It should be noted, however, that the subjects in this study were younger (i.e., teenagers) than in other studies and were involved in structured competition. For these subjects brief periods of exercise lay-off may have represented some sort of psychological *relief* (Crossman et al., 1987). Furthermore, the exercise layoff period was planned. Therefore, the subjects were able to prepare for alternative activities. Planning is an important point in exercise deprivation, because the psychological preparation for the activity may play a significant role in the manifestation of deprivation sensations. For example, when a planned run is obligatorily missed, a runner may experience negative sensations, because of the psychological preparation associated with that specific (planned) run. Indeed, perhaps most evidence, in regard to the psychological impact of exercise deprivation, may refer to deprivation from planned activities, because they are associated with some specific and time-locked (Sachs & Pargman, 1979) subjective rewards.

Later, Morris et al. (1990) examined the effects of long term two-weeks deprivation from running on subjective reports of physical symptoms, social dysfunction, anxiety, and depression. Middle-aged male runners completed weekly questionnaires of physical symptoms and mood on Sunday evening for six consecutive weeks. At the end of the second week, subjects were randomly assigned to exercise deprivation and control groups. The exercise deprivation group refrained from the customary running for two weeks while subjects in the control group maintained their regular level of activity. Results indicated that after the first week of running deprivation experimental subjects reported more physical symptoms, anxiety, insomnia, and

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feelings of being under strain. Following the second experimental week, running deprived subjects experienced more depressive mood than controls. Thus, this study suggests that some subjectively perceived symptoms may arise earlier in the exercise deprivation period than other complaints. One shortcoming of the study, however, is that the results were based on single-weekly measurements.

Gauvin and Szabo (1992) examined the effects of one-week exercise deprivation on subjectively perceived physical symptoms and psychological profiles of university students strongly committed to different forms of exercise. This inquiry employed the experience sampling methodology (ESM), or *in situ* data collection. Accordingly, subjects filled out questionnaires during their usual daily routines at *four random times a day* in response to the tone of a pager for 35 consecutive days. All subjects exercised at the usual rate and pace during the first 14 days of baseline period, when they were randomized into either experimental (exercise deprivation) or control groups. Experimental subjects refrained from exercising between Days 15 and 21 of the procedure, whereas those in the control group maintained their usual levels of physical activity. On day 22, experimental subjects resumed their exercise. Sampling continued until day 35. In comparison to the control group and to their pre-deprivation baseline, exercise-deprived subjects reported twice as many physical symptoms both during and following the week of exercise deprivation. Therefore, this study suggests that subjective reports of physical discomforts may not be restricted to the deprivation period, but they may be carried over into the first part of the resumption period as well. However, in contrast to other studies, the subjective psychological states were not altered during exercise deprivation. It may be possible that the deprivation period was short in this study to yield psychological discomfort. It is also possible that deprivation sensations are not as prominent when sampling is continuous (they are buffered by other life events) and direct focus on exercise deprivation - as is the case in survey type research - in not maintained. Still another possibility is that the instruments used by these authors were not sensitive enough to gauge psychological deprivation sensations.

In another laboratory work by the same authors (Szabo & Gauvin, 1992) the effects of one week exercise layoff were studied on heart rate reactivity and subjective response to mental stress in university students highly committed to different forms of exercise. Participants were tested on two occasions, one week apart, that is before and after the exercise deprivation period. The 7-day exercise withdrawal did not influence the heart rate reactivity to laboratory stress that consisted of mathematical tasks of increasing difficulty. Second exposure to the stress, in fact, resulted in lower heart rate response, that was attributed to a habituation effect by the authors. A higher pre-task resting heart rate was also seen during the second testing, which was ascribed to anticipation of the performance. No changes in task performance and subjective measures were observed from test-session one to test-session two. This experimental work demonstrated that neither heart rate response to mental challenge or cognitive performance on a mental task is affected a period of one week exercise deprivation. Therefore, the study by Szabo and Gauvin shows that heart rate and cognitive performance are unlikely to be affected by a period of one week exercise deprivation.

In another experimental work, in which the participants were aware of the length of the deprivation period, Mondin et al. (1996) studied the effects of a 3-day of exercise withdrawal period in habitual aerobic (swimming, cycling, running) exercisers. Participants were six males and four females who exercised almost every day (6 to 7 days a week) for at least 45 min each time. The authors assessed state anxiety and mood, and specifically depressive mood, with various psychometrically validated questionnaires, including the POMS. They also used a questionnaire that gauged sleep, food intake, and general feeling states over the past 24 hours. The study was conducted on five consecutive days (Monday through Friday) and from Tuesday to Thursday the participants refrained from their exercise routine while also limiting physical activity in the daily life. On Monday and Friday the participants engaged in their regular exercise routine. Subjects completed the questionnaires in the laboratory on Monday and Friday within 15-20 minutes following exercise. During the 3-day deprivation period the participants returned to the laboratory and completed the questionnaires at the same time as on Monday and Friday. The results revealed that that total mood disturbance (TMD) has increased on Tuesday, was the highest on Wednesday (2nd day of deprivation), then decreased slightly on Thursday, while returning to the Monday-measured baseline on Friday. It was concluded that exercise deprivation negatively affected mood, tension, and depressive states in regular exercisers. A methodological issue, apart from the small sample size studied, warrants attention in this work. The participants knew that the length of the deprivation period and their feeling states emerged accordingly. Increase on the first day, peak on the second day, and lowering on the third day, a pattern that can be ascribed to the cognitive appraisal of the deprivation interval. For example, mood disturbance on the third day was lower in contrast to the second day, because the subjects knew that the third day is the last in deprivation period. This finding illustrates to some extent the artificial nature of the experimentally induced exercise deprivation periods. (In a research presented in full detail - as part of my work - in section 3.3 above (Szabo & Parkin, 2001) - we overcame this problem of artificiality.)

Aidman and Woolard (2003) researched the connection between the self-reported exercise addiction among competitive runners and their physical and psychological response to a one-day exercise deprivation period. The authors used a random selection to exercise-deprived and control groups from among 60 club-level runners who trained at least five times every week. Half of the subjects received a very short (24-h) notice to refrain from running for one day, while the control group could continue with their normal running schedule. All participants completed the Profile of Mood States (POMS), Running Addiction Scale (RAS), and also had their resting heart rates measured before and after the experiment. The results revealed that the exercise-deprived group reported significant withdrawal-like symptoms of depressed mood, reduced vigour and increased tension, anger, fatigue, and confusion (as measured by POMS). In contrast to Szabo and Gauvin (1992) who did not find changes in heart rate after a one-week period of exercise layoff, these authors found that resting heart rate was elevated in the exercise-deprived group in contrast to the control group. The discrepancy between this and Szabo and Gauvin's work may be linked to the level of exercise (committed students versus club runners) and also to the length of the deprivation period (one week versus one day). Aidman and Wollard also found that the negative changes in mood and resting heart rate were linked to the self-reported exercise addiction scores. After using a median split of the latter scores, the authors found that people who scored below the median reported significantly less mood disturbance and exhibited lesser heart rate increases than those runners who scored above the median. The authors also disclosed a set of correlations between self-reported scores of exercise addiction and the magnitude of mood disturbance and heart rate increase, ranging from 0.46 to 0.58. While in their report the authors concluded that self-reported exercise addiction moderates emotional and heart rate responses to a 24-hr exercise deprivation,

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and, therefore, the changes in these measures may be early indices of exercise addiction, as I have noted in several of my works (to be presented later in this dissertation) the self-reported scores of exercise addiction may often represent a higher level of commitment to a recreational or a leisure activity without the implication of any morbidity. Higher commitment means greater importance to the self, and the more important events are missed with deeper feelings and emotional reactions at times when those are removed or become inaccessible to the individual.

An intervention study by Glass et al. (2004) examined the effect of exercise deprivation on the surfacing of physical symptoms related to fibromyalgia and chronic fatigue syndrome. The authors studied 18 regularly exercising (≥4 hrs/week) healthy men and women who refrained from physical activity for one week. The dependent measures were the symptoms of fibromyalgia and chronic fatigue syndrome. The results indicated that eight out of the 18 participants reported an increase in one or more of the symptoms (pain, fatigue, mood) following one-week of exercise deprivation. The researchers noted that these individuals had lower baseline cortisol levels prior to a VO_2 max test, lower immune (natural killer cell response to venipuncture), as well as lower heart rate variability prior the exercise deprivation period than the participants who did not develop the symptoms. The authors conjecture that exercisers who show symptoms may have a phsiologically hypoactive stress-defence system and engage in exercise, perhaps subconsciously, to increase the function of the system and to suppress the symptoms. These people may develop multi-symptom illnesses like fibromyalgia and chronic fatigue syndrome when their exercise routine is disrupted. In spite of the interesting findings, it should be noted that the sample size was relatively small in this study, in addition to the fact that the reported symptoms increased only around 10%. The physiological distinction between the two types of responders, however, merits further attention not only in the context of the psychological correlates of exercise deprivation, but also in relation to the aetiology of exercise addiction.

Since Gauvin and Szabo (1992) only one other investigation (Hausenblas et al., 2008) used the experience sampling method (ESM; Csikszentmihalyi & Larson, 1987, 2014) to determine the psychological impact of exercise deprivation. The authors experimentally reduced the habitual exercise-pattern of 40 exercising students to assess changes in *positive* - rather than negative - mental feeling states. Participants maintained their usual exercise pattern for three days and then they were deprived of their scheduled workout for another three days. Using the ESM, the participants recorded their feeling states before and after their exercise and at four random times every day, upon a random pager-signal from the experimenters, on the Exercise-Induced Feeling Inventory (EFI). The data were exposed to a multi-level modelling analyses that controlled for diurnal variations in feeling states. This analysis revealed that positive feeling states were elevated on the exercise deprivation days as compared to the regular (not experimentally induced) no-exercise days. People with lower exercise addiction scores, as based on an initial questionnaire assessment, felt better during exercise deprivation in contrast to non-exercise days. Participants with higher exercise addiction scores felt about the same in the deprivation period as during no-exercise days. These findings replicated the study by results obtained by Aidman and Wollard (2003) in context of the link between feeling states and addiction scores. But again, questionnaire scores are not diagnostic tools and the level of answer may reflect commitment rather than addiction. In terms of psychological feeling states, the findings failed to reveal negative psychological feeling states, that is in contrast to Aidman and Wollard, even after three days of

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deprivation. However, the participants were students rather than affiliated runners, and details of exercise forms and/or intensities of these participants are not provided.

In a relatively recent study, the authors (Niven et al., 2008) examined the effects of a three-day exercise withdrawal on affect and body dissatisfaction in healthy women. Participants were habitual exercisers who worked out at least four times a week. Randomization was used to form two groups, a deprivation and a control group. The former stopped exercising for three days, while the latter continued with the accustomed exercise routine. At the beginning of the study, all participants completed a psychometrically validated mood adjective checklist and a body dissatisfaction scale. Three days later, affect and body image for both groups were measured again. Compared to the control group, the exercise-deprived group exhibited a significant increase in negative affect and body dissatisfaction from pre- to post-intervention. The study added further support to past research that revealed the negative psychological effects of exercise deprivation. Further, this work expanded on the extant knowledge by showing that a three-day abstinence from exercise is sufficient to yield an increase in body dissatisfaction in regularly exercising women.

A series of three publications have emerged from a group of researchers who carried out a larger study and reported the results in three different publications. In a first report (Berlin et al., 2006) the scholars examined the effects of exercise deprivation on depressive mood and fatigue in the context of reduced fitness levels. Therefore, they used a 14-day exercise deprivation protocol in which half of the 40 participants were randomly assigned to a deprivation and the other half to a control group. Deprivation from exercise was ascertained by using an ambulatory actigraphy. Questionnaire scores obtained with the Profile of Mood States (POMS), Beck Depression Inventory (BDI), and Multidimensional Fatigue Inventory (MFI), were the dependent measures. Fitness levels were assessed by using cycle-ergometer tests. The results revealed that fatigue and somatic depressive symptoms emerged after the first week of the exercise deprivation and that predicted the development of cognitive depressive symptoms at two weeks. An increase in negative mood correlated with a decrease in fitness level, but the coefficient of determination was small (<13%). The authors also found an inverse relationship between fitness and fatigue. The negative changes in psychological measures, especially fatigue, were attributed to decreased levels of fitness in the exercise-deprived individuals.

In a report published one year later (Weinstein et al., 2007), from the same dataset, the authors tried to link the negative psychological effects of exercise deprivation to the function of the autonomic nervous system (ANS). In this publication, in addition to the protocol described above in the 2006 study, the authors also reported the measures taken for the ANS activity that consisted of heart rate variability (HRV) analyses via the recording of low-frequency (lf - 0.04-0.15 Hz) and high-frequency (hf - 0.15-0.40 Hz) domains. The lf/hf ratio was used for the index of sympathovagal balance. In addition to negative psychological changes reported in the 2006 paper, the authors found that resting lf/hf ratios correlated with the negative psychological symptoms in the exercise-deprived group. However, the coefficient of determination (r^2) was only about .16 (16%). The changes in ANS measures were not statistically significant over the two week study period in either group. While the authors concluded that the lower parasympathetic activity may predict the development of negative psychological changes attributed to exercise deprivation, the link between the two - as disclosed by the rather low coefficient of determination (shared variance of about 16%) - renders this conclusion tentative.

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Finally, in a paper published one year later (Kop et al., 2008) the authors have released data on inflammatory markers obtained in the above reported study. The authors tried to examine whether these markers are connected to the negative psychological changes and the ANS activity reported in the previous two studies. These inflammatory markers consisted of interleukin-6 (IL-6), C-reactive protein, fibrinogen and soluble intercellular adhesion molecule-1, and were measured at weekly intervals. Their results failed to make a connection between inflammatory markers, negative psychological changes in response to exercise deprivation or ANS activity during the exercise deprivation period. These findings were in contrast to the results of a later study that also employed a 14-day exercise deprivation period and apart from disclosing negative psychological feeling states - as based a GHQ and the POMS - also revealed that after the 14-day deprivation period IL-6 levels were lower in the exercise-deprived subjects than in the controls (Poole et al., 2011). The authors also revealed that psychological changes correlated with changes in IL-6 concentration, thus disclosing a connection between deprivation-feelings and IL-6 levels. The discrepancy in the two studies concerning IL-6 levels remains a mystery, because even the subjects' characteristics were similar in the two studies. Further, both studies were meticulously conducted and genuine control for exercise deprivation was ensured with accelerometers in both works.

In summary, the study reported in three separate publications (Berlin et al., 2006; Kop et al., 2008; Weinstein et al., 2007) was a carefully controlled exercise deprivation inquiry with 20 experimental and 20 control participants. Scholars collected psychological, electrophysiological, and biochemical data to examine the changes in response to exercise deprivation over a period 14 days and to study the relationship between the dependent measures during exercise withdrawal. Their results, however, demonstrated only weak associations between ANS activity, fitness level, and psychological variables. Nevertheless, this line of inquiry, especially the control over physical activity and deprivation intervention, adds substantial value to the work in this area.

The effects of sleep and exercise deprivation were studied jointly in a recent work (Ablin et al., 2013). The authors randomly assigned regular male and female exercisers (running daily, 5.14 hrs/week; n = 87) who reported 7-9 hours sleep at night into four groups: 1) sleep restriction (max. 6 hours nightly), 2) exercise deprivation, 3) both, and 4) control (neither). A 10-day reduced sleep pattern resulted in increased somatic symptoms while exercise deprivation was only linked to fatigue. The authors found no connection between exercise cessation and sleep restriction, except that men reported more somatic symptoms when deprived of both sleep and exercise (additive effect) in contrast to only sleep or only exercise deprivation. Women reported more somatic symptoms than men. These findings disagree with the ESM results of Gauvin and Szabo (1992), showing that physical symptoms have doubled during the week of exercise deprivation. One major difference between the two studies is that the results of Ablin et al. (2013) were based on limited pre- and post-deprivation measures, while Gauvin and Szabo (1992) obtained several daily records through the ESM data collection. The former is like comparing two photographs while the latter is like watching a video clip.

In a very recent experimental inquiry (Fogaa Leite et al., 2014) the effects of a 14-day exercise deprivation period, on mood and biochemical markers, was studied in 16 well-trained men. Measures were obtained at baseline and on 7th and 14th day of the deprivation period. A decrease in both dependent measures was seen after the first, as well as after the second week. The authors concluded that a 14-day exercise deprivation period results in adverse psychological and biochemical effects. Using proper control for exercise deprivation, this study strengthened the bulk of the published reports concerning the psychophysiological effects of exercise deprivation.

Finally, only two inquiries have addressed the question whether partial deprivation, or simply a reduction in training volume, of regular exercise may influence subjective feeling states (Wittig et al., 1989; Wittig et al., 1992). In one of these studies (Wittig et al., 1989), the training volume of runners was reduced by 70% for a period of three weeks. In the other study (Wittig et al., 1992), the process involved the reduction of both the training volume by 66% and the training intensity to below 70% of the maximal aerobic power for a period of four weeks. A four-week regular training period, adopted as baseline, preceded the experimental periods. The subjects completed the POMS once a week. Surprisingly, the results of the former study (Wittig et al., 1989) showed positive changes in mood as a result of the reduced training volume. In the second inquiry (Wittig et al., 1992), however, when training intensity was also reduced the changes in mood were in the negative direction. These two studies raise a question concerning the role of training volume (amount) versus training intensity in studies examining the effects of exercise deprivation on the psychological states of habitual exercisers.

3.4.4.2 What is the consensus of the experimental work on exercise deprivation?

There is a general agreement that exercise deprivation has a negative impact on subjective states of well-being. However, still numerous factors associated with exercise deprivation remain unknown. For example, experimental work comparing the effects of different forms of exercise is lacking. The link between personality and reported deprivation-feelings is also missing. The work is heading in the right direction though. Over the past 15 years only experimental studies were published in the area. The latest investigations have incorporated sophisticated control for caloric expenditure and bodily movement (Berlin et al., 2006; Fogaa Leite et al., 2014; Kop et al., 2008; Poole et al., 2011; Weinstein et al., 2008) to increase the reliability of the results. In spite of the advances in the field, numerous methodological concerns also need to be resolved via carefully controlled experimental inquiries. To date, the only consensus of the experimental studies is that exercise deprivation yields negative psychological states in people committed to their exercise.

3.5 General Analysis of the Exercise Deprivation Literature

3.5.1 Conceptual concerns

The greatest limitation in this area of research is subject recruitment, as noted before. However, the fact that some very highly committed exercisers cannot be recruited for these studies should not be regarded as a deterrent of exercise deprivation investigations, but rather as an obstacle for exercise addiction studies. As it will be discussed in Part III of this dissertation, only a small proportion of exercisers may be classified as exercise addicts. These individuals, however, experience very severe withdrawal symptoms during forced abstinence from their exercise routine. Therefore, they will surely not take part in exercise deprivation research. It should be noted that the committed tennis player, swimmer, walker, martial art performer, etc., may also experience discomforts during periods of involuntary exercise deprivation. The underlying causes or triggers for the discomforts experienced by non-addicted exercisers are likely to be different from the psychophysiological causes in addicted exercisers. The former, may experience discomfort for reasons of: 1) social deprivation, if their exercise is in a social context, 2) inability to give time to the self, in case of exercisers who engage in an exercise activity for the sake of contemplation or reflections, 3) inability to cope with stress, in case of exercisers who adopt an activity for the sake of coping with daily hassles and challenges, 4) inability to maintain proper weight, in case of exercisers who participate in activities for a weight maintenance, and 5) involuntary change in a usual lifestyle routine. While it may be argued that exercise addicts may experience withdrawal symptoms for similar reason(s) than non-addicts, the very fine line between the two should be observed. The former will continue exercising even when contraindicated, while the latter will not do so. People addicted to exercise will jeopardize family and work relationships to meet the need of exercising, but healthy exercisers will not do so (Morgan, 1979). Exercise addicts will not take part in exercise deprivation studies (Baekeland, 1970), whereas the latter may be interested in this type of investigations either for the sake of intellectual curiosity or for better understanding of the meaning of exercise for them. Therefore, the key point is that exercise deprivation should be studied independently of exercise addiction, but also as a part of it, inasmuch as the severity of the reported withdrawal symptoms is concerned. Indeed, most moderate or healthy exercisers may experience deprivation sensations when their exercise is not possible, and considering the surmise that exercise addiction may affect less than 3% of the exercising population (Berczik et al., 2014; Mónok et al., 2012; Szabo & Griffiths, 2007), the healthy exerciser is the more representative the physically active population.

However, there is more to say about the subjects' participation in exercise deprivation studies. Until recently, there was no control over the deprivation intervention. Morris et al. (1990) and Gauvin and Szabo (1992) tried to overcome this major problem by contacting the subjects on a regular basis and reemphasizing the need for adherence to the treatment. Furthermore, while in these studies the subjects were asked to stop exercising, they were told that it was on a voluntary basis, so if they feel that they have to exercise they may do so without negative consequences (this measure was introduced to avoid or at least minimize deception). In addition, Gauvin and Szabo (1992) used an indirect "psychological control" through estimating subjects' aerobic fitness (VO_2 max) before and immediately after the exercise deprivation period. This intervention was intended to lead subjects to believe that noncompliance may be assessed by the experimenters via observing certain changes in their level of physical fitness. Nowadays, more accurate control can be exerted over the experimental deprivation periods by using, for example, easily accessible accelerometers. These tools are helpful in experimental work and may have contributed to the fact that since the year 2000 only experimental investigations were published in this field.

Another major concern in the data interpretation of exercise deprivation studies should be emphasized. Participants in this type of research are aware of the beneficial effects of exercise and, consequently, they may associate periods of exercise deprivation with negative subjective states. These beliefs may be conveyed, through their responses, in the data. In experimental studies, it is almost impossible to blind subjects from the research hypothesis. The extent to which the knowledge of the hypothesis may influence the results remains to be determined (perhaps by gathering qualitative data, through in depth interview techniques, after the conclusion of the

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study). Another, method of dealing with this issue is to present the deprivation period in a positive perspective, such as rest, revitalization, or energy conservation for an upcoming major event or competition, and, hence, trying to create positive expectations. This method was used by Szabo and Parkin (2001), but the degree to which the method worked remains unknown. Indeed, even though the subjects were presented with a rest period in the positive sense, the way they perceived the actual intervention was not determined in the course of the work.

Another major problem in the data gathering process is the adoption of single or weekly measurements employed by most of the studies in the field. It is a fact that most inquiries, except two (Gauvin & Szabo, 1992; Hausenblas et al., 2008) which used the ESM, employed single or weekly questionnaires in the assessment of the subjective states during deprivation periods. Szabo and Parkin (2001) used single daily measurements, that could be more complete than isolated pre- and post-intervention measures. However, results obtained by that method may also reflect only momentary (i.e., experienced in the evening) subjective states as opposed to general, or typical, states experienced during the days of the deprivation and baseline periods. Indeed, an overall *good day* may be spoiled by some negative events before bedtime - preceding the time of completion of the questionnaires - and bias the ratings (answers) given by the subjects. The ESM, may overcome this concern. The wider application of multiple in-situ sampling in this area of research could lead to the gathering of more reliable data, because it is like a moving picture instead of a photograph. Three forms of data collection methods: 1) pre- to post-deprivation, 2) single daily appraisals of psychological states in the evening, and 3) experience sampling several times a day, may yield answers to three different questions: 1) How one felt at the moment before and after deprivation?, 2) How do the subjects appraise their days in the deprivation and exercise periods?, and 3) What sort of psychological states are projected by the aggregate measures that were taken at random times in the daily life of the individual? It may be apparent, that comparability of findings from studies using different methods of data collection is difficult, if not impossible.

Comparability across studies is also made difficult by the fact that studies in the field have adopted different instruments in gauging the effects of exercise deprivation (refer to Table 3.10). Definition of the subjective state, as conceptualized here, is broad and involves any physical or psychological factor ranging from mood to anxiety, from health to discomfort, and the likes. However, operationalization of well-being in terms of affect and perceived physical symptoms (Gauvin & Szabo, 1992), and the reduction of the general subjective states to states of well-being and the usual deprivation sensations (Robbins & Joseph, 1985), may lead to more consistent and easier comparable results in the field. Scholars need to differentiate between *mood* lasting several hours if not days, *affect* that changes within minutes or seconds in response to life events, and the relatively autonomic, body language/facial expression-manifesting, *emotions* (Ekkekakis, 2013). Some instruments may measure one in a certain situation and the other in another situation. For example, when the EFI is used for momentary assessment (i.e. "...please indicate how do you feel *at this very moment*") likely will yield measures of affect, but if it is used for the retrospective evaluation of one day (i.e. "...please indicate how you felt *during the past 24 hours*") then it becomes a measure of mood. Researchers make a mistake by interchangeably using the three terms (Batson, Shaw, & Oleson, 1992). However, scholars and readers who are aware of the differences in the meaning could appraise easily what the results the reported studies may convey.

In many life settings the accustomed exerciser is not forced into complete abstinence, but only into a reduced exercised regimen. The question then is whether partial exercise deprivation elicits similar effects to total deprivation? Wittig et al. (1989; 1992) studied this question with runners and came to the conclusion that while reduced volume had a positive impact, reduced intensity had a negative impact on mood. Does this finding imply that negative subjective states may be avoided, when less time is available for exercise, if the training intensity is maintained or increased? Indeed, the exercise volume and its components, frequency, duration, and intensity, may be important determinants of the psychological response to exercise deprivation. However, early cross-sectional survey reports did not produce evidence for this surmise (Szabo et al., 1996; Szabo, 1997). In lack of experimental work, it remains the task of future research to elucidate on the link between exercise characteristics and the psychological response to exercise deprivation.

Often mild injuries may interfere with the usual exercise routine, as it was reported by Chan and Grossman (1988), but not with other daily activities. Would then the substitution of the usual form of exercise with another form of exercise (i.e., running with swimming) prevent the surfacing of negative changes in subjective and/or physiological states? For example, if Chan and Grossman (1988) would have had half of their *prevented runners* assigned to a regular cycling or swimming regimen during injury, how would these subjects compare with the inactive runners?, or with continuing runners? In the real life, exercisers who are unable to perform their primary exercise activity, often engage in other possible activities to keep fit or in shape. They may be affected to a lesser extent by the negative psychological states due to exercise deprivation.

Alongside the dimensions of addiction and commitment to exercise, prospective research should examine the motives for adoption of, and participation in, regular exercise. For example, Robbins and Joseph (1985) found that runners who relied on running for a method of coping with stress experienced sleeping problems, irritability, depression, muscle tension, and fatigue during periods when running was not possible. Survey data obtained by Szabo et al. (1996, 1997), as well as Szabo (1997), supported the findings of Robbins and Joseph, showing that not only runners, but several other exercisers who started or maintained their activity for health motives had a harder time during periods of exercise deprivation. It appears that people who engage in, and adhere to, a physical activity regimen for health reasons (i.e., losing and/or maintaining weight, dealing with stress, controlling hypertension, etc.) may really experience more severe distress during periods of forced abstinence than those who exercise for fun, social reasons, or a simple change in the daily activity routine (Thornton & Scott, 1995). However, these studies used survey methodologies and retrospective data collection. Therefore, their findings should be considered tentative. More robust scholastic evidence may emerge through carefully controlled experimental work.

It is unclear how the feelings of deprivation from exercise may compare to psychological symptoms associated with deprivation from other recreational or leisure activities (e.g., chess, gambling, playing pool or bingo, watching television series, etc.). Prevented hobby activities, like video games, may also generate deprivation sensations (Grüsser, Thalemann, & Griffiths, 2006). However, an Internet-based cross-sectional inquiry suggested that regular bowling was associated with *less intense* feelings of deprivation than a few other, more physical effort-requiring activities (Szabo et al., 1996). The deprivation sensations associated with exercising are quite specific and among many others include: guilt, frustration, anger, and sluggishness. According to Wingate (1993) there are some specific reasons for these sensations. Feelings of guilt may emerge when exercisers are not doing something that is so important to them, or something that they ought to be doing. Frustration and anger may surface when they are unable doing something they want to do, and sluggishness may emerge in response to the organism's need for the activity to which it has been accustomed (Wingate, 1993). It remains to be tested the extent to which these sensations and their underlying causes are comparable to the deprivation sensations experienced during cessation or interruption of other habitual - but not addictive - behaviours.

The concerns noted above are only part of the vast number of questions that may still be raised for the better understanding of the effects of exercise deprivation on the subjective states of well-being. Further important questions may relate to gender differences. For example, are women more vulnerable to exercise deprivation effects than men? Tentative survey results, reinforcing the validity of this question, already exist (Harris, 1981b; Robbins & Joseph, 1985; Summers et al., 1983; Szabo, 1997; Szabo et al., 1997). Age differences may also play an important role. For example, a negative connection was disclosed between runners' age and their obligatory running scores that may justify further research in this context. Indeed, young or novice exercisers may have greater difficulty in dealing with the periods of abstinence than experienced exercisers who have already faced a number of layoffs from their habitual activity and have developed some sort of "coping strategies" to deal with such episodes. Wingate (1993) provided support for the role of coping resources in the experience of deprivation sensations. Further, in competitive exercisers deprivation or exercise layoff may elicit different subjective states than in the non-competitive voluntary exercisers. The former may see this period as a relief (Crossman et al., 1987), or an opportunity for recreation, as opposed to the latter who may indeed feel *deprived* of something rewarding. Voluntary versus involuntary or planned versus unplanned exercise deprivation may be important concepts in these investigations. As noted earlier, it is likely that involuntary exercise deprivation is the most powerful element in creating negative subjective sensations. The type of exercise, frequency, and intensity of training, energy expenditure, and so on may also act as mediating variables in the surfacing and intensity of deprivation sensations. Most of these issues could provide valuable information about the impact of exercise deprivation on well-being of individuals who have adopted exercise as a regular component of their lifestyle.

Finally, in light of a work by Blair et al. (1989) physical activity is a key component of the modern healthy lifestyle. The widespread movement promoting physical activity encourages an active lifestyle that may be different from *exercise* in form and intensity. People who assume a wider range of activities, as opposed to a single modality exercise, may be less likely to encounter severe deprivation sensations, either because of the availability of one or more alternative activity, or because of a lesser *bond* developed with one particular activity. In future research, deprivation sensations may need to be explored at this level too, because possibly a larger number of people will fall in this category in contrast to the groups represented by leisure exercisers or athletes.

3.5.2 Methodological concerns[14]

Understanding the physical and psychological effects of deprivation from regular exercise, in committed exercisers, is an important issue because today exercise is a not only a personal but

[14] *Based on:* ***Szabo, A.*** *(1998). Studying the psychological impact of exercise deprivation: Are experimental studies hopeless? Journal of Sport Behavior, 21(2), 139-147.*

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also a social and economical striving. Researchers who venture in this field of study may quickly become discouraged when they realize how limited is the literature in the area. Citation indexes and well compiled computerized databases are virtually void of studies on the effects of exercise deprivation. What may be the reason for the shortage of work in this field? The answer is simple: People exercise for some sort of benefit(s). No matter what that benefit may be, from a personal perspective, it is most often - if not always - greater than the benefit derived from participation in an exercise-deprivation study. Therefore, highly devoted exercisers are unlikely to enrol in deprivation studies even if there were some alluring incentives involved (Baekeland, 1970).

Since the year 2000 several experimental studies have examined the psychological impact of exercise deprivation and only a dozen or so opportunistic or survey-type studies (Szabo, 1995) make a considerable contribution to the field. The latter studies looked at the problem of exercise deprivation only indirectly and retrospectively. Therefore, the data presented in surveys reflected one's expectation about how she or he *should feel* at times when exercise is prevented for some reason. More precisely, these studies examined the concept in relation to *exercise addiction* based on the presumption that negative emotions during episodes of exercise deprivation are reflections of addiction to exercise (Anshel, 1991; Szabo, 2010). Accordingly, the primary objective in these studies was not the understanding of how or what people feel during intervals of exercise deprivation, but rather whether they are or are not addicted to exercise (Anshel, 1991; Gauvin, 1990; Sachs & Pargman, 1979). The exception to this aim were two Internet-based cross-sectional studies (Szabo, 1997; Szabo et al., 1996). However, again, due to the retrospective nature of the work, the results may have reflected certain expectations or thoughts about how a person may or should feel when deprived of the habitual exercise, rather than actual feelings of deprivation. Therefore, the examination of the effects of exercise deprivation in the literature has been often secondary to the analysis of issues related to exercise addiction. The need to separate exercise deprivation from addiction was stressed clearly (Szabo, 1995, 2010; Wingate, 1993). This separation is necessary in formulating experimental work aimed at the understanding of how regular (but not addicted) exercisers feel when they are deprived of their usual exercise. The psychological states associated with exercise deprivation should not be examined as merely a *side-effect* of exercise addiction, because they affect a significantly larger proportion of the exercising population than the pathological form of the behaviour.

3.5.2.1 The subject-recruitment dilemma

As noted earlier, only a few people are likely to volunteer for exercise deprivation studies. Those who are willing to take part in these studies may be different in some way from those who do not take part in similar investigations for any incentive (Baekeland, 1970). How different? In fact volunteers for exercise deprivation inquiries may represent *a totally different population* than the population from which they are assumed to be. An example of this assertion stems from my postdoctoral research experience in Canada. Recruitment leaflets calling for participation in an exercise deprivation study were distributed among more than 5000 participants in the Montreal marathon. Only 24 people (<0.5%!) showed interest in participating by replying to the call. In terms of probability, as based on this observation, it may be estimated that less than five marathon runners in a thousand may be interested in volunteering for exercise deprivation studies. But who are those five people? How are they different from the others? Do they possess some unique personality characteristics? Or it is their relationship with their exercise that is unique? Regrettably, no answers are available to these questions at this time. One can speculate, but only the empirical testing of these questions could shed light on the differences.

While it may be argued that marathoners do not represent the general exercising population and that the above figure may be different in subjects committed to other forms of exercise, the key point that merits attention is commitment. Other exercisers may be as committed to their form of exercise as runners (Gauvin & Szabo, 1992), but they were not studied as intensively as runners (Szabo, 1995). When deprived from their adopted activity, all committed exercisers may experience hardship (refer to Table 3.10). Therefore, the unwillingness to take part in deprivation studies, observed in runners, may be comparable to the general *exercise-committed* population at least until more exercise-specific data will be available.

To elucidate further on why people are reluctant to take part in exercise deprivation studies, I sought the attitudes of runners on the Internet. A message, asking runners, whether or not they would take part in an exercise deprivation study, was posted on the Internet newsgroup "rec.running". (The procedure was not intended to represent a scientific inquiry, but rather to probe into runners' viewpoint and to use their opinion as an aid in the current discussion.) A brief summary of the answers given by the 10 runners who replied to the message is presented in Table 3.11. Clearly, none of the runners expressed unconditional will for taking part in a deprivation study. One vivid reason for this resistance was phrased by one of the runners: "*Life is too short not to do the things you like to do...*". (Szabo, 1998, p.141)

Table 3.11. Ten runners' thought about participating in an exercise deprivation study.

Runner #	Gender	Willingness to participate
1	male	definitely not
2	female	most likely not
3	male	yes, depending on the length of deprivation
4	male	yes, depending on the length of deprivation
5	male	yes, depending on the season of the year
6	female	yes, for monetary incentive
7	male	yes, depending on the season of the year
8	male	probably not
9	female	not even for money
10	female	yes, for monetary incentive

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3.5.2.2 Incentives for participation

Incentives in deprivation research may play an important role. Some people may be attracted by some incentives, especially monetary offers. However, the experimenter(s) competes against what has become a fundamental *basic need* (Maslow, 2013) for the person, when such incentives are offered. A *hooked* runner (Lewis, 1984; Mickel, 1979; Szabo 2010) or exerciser may be compared to the *hooked* smoker. For the smoker, lighting up a cigarette or a cigar has evolved into a basic need. Many will avoid long-flights out of fear of not being able to cope with the smoking restriction on the aircraft. These people may be allured by certain incentives and for a moment genuinely believe that they can comply with the requirements of a deprivation protocol, but once started their willpower may collapse by the strong craving for the behaviour to which they are hooked. If they do not satisfy those strong needs or urges, especially on a longer term, various illnesses may strike (Maslow, 2013). Therefore, the prepared researcher may be faced with the chance of non-compliance and, unless there are some control measures, the reliability of the data may be shattered. To assign weight to this dilemma a statement made by one of the runners ought to be reproduced. "*If by chance, I did say yes, (to participation in a deprivation study) it would be very difficult not to cheat.*" (Szabo, 1998, p. 142).

It may be argued that people who are not offered an incentive for participation may also become non-compliant. However, these people have almost nothing (i.e., an important incentive) to lose if they are not conforming to the requirements of an experimental protocol. Therefore, they may be less likely to become dishonest, because the incentive-based temptation is not present. Monetary incentives are not as critical as incentives that may bind more strongly, such as grade points offered to university students (Gauvin & Szabo, 1992) in exchange for their participation. Such incentives may become crucial for some people (i.e., students needing the credit) and assume the a role of a strong need as the behaviour for which they are examined. When two strong needs collide, the subjects' compliance is extremely unpredictable, which shatters data-reliability.

3.5.2.3 The length of deprivation

As learned from the responses in Table 3.11, apart from monetary reward, the length or the duration of the deprivation period was another condition stated by two runners who showed interest in participating in an exercise deprivation study. Beyond doubt, the longer the deprivation period the harder may be the adherence to the requirements of the inquiry. However, to estimate the consequences of exercise deprivation in real life settings, the deprivation period in experimental studies should mimic the naturally occurring deprivation periods. Clearly, short periods of deprivation, lasting one (Thaxton, 1982) or two days (Tooman et al., 1985), may coincide either with a planned or an opportunistic rest period. An example of this assertion stems from an inquiry by Crossman et al. (1987). In that work the authors concluded that exercise deprivation had no negative effect on teenagers who had a break from running for one day or from swimming for five days. However, the subjects knew in advance about their training suspension. When the interruption is planned it can no longer be classified as exercise deprivation. Quoting another runner may illustrate this point: "*I often schedule time off from running and experience*

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little discomfort from that time off. In fact, it puts running into perspective and keeps other aspects of my life healthier" (Szabo, 1998, p. 143). Therefore, short-duration inquiries have limited value in exercise deprivation literature, because they are biassed by diurnal variations in mood or affect (Clark et al., 1989), planned time-off, and by the arising opportunities to fulfil other obligations or to participate in other activities. However, the status of exercise deprivation literature was poor before the year 2000, because only six studies involved deprivation periods that lasted one week or longer over a 30 year period. In the new millennium, this figure has improved and eight studies, reported over a period of 15 years, have adopted a deprivation period lasting more than one week (see Table 3.10). While it is clear that there is a need for similar inquiries, their actual realization may be extremely hard. For the issues raised above, the reliability of the studies, apart from those using some control measures for the deprivation period, may be questionable. The future, however, may look brighter in this area of research, because by using accelerometers (Berlin et al., 2006; Fogaa Leite et al. 2014; Kop et al., 2008; Weinstein et al., 2007) scholars have more control over compliance with the protocol.

3.5.2.4 The season

In some forms of exercise the season plays an important role. Running is a good example. Season was the condition put forward by two interrogated runners in my survey. It goes without explanation that it is easier to commit oneself to a training interruption when the season does not favour an adopted activity. However, the season, chiefly in the case of runners, is not only tied to weather, but also to the time of public races. In northern regions running races are less frequent in the Winter than in the Summer. Some people may even take a couple of weeks or months of break from their exercise when both weather and lack of opportunity for challenge decline. These people could become candidates for exercise deprivation studies in that season. However, their participation may be biassed by the previously discussed notion of *planned* versus unplanned training-interruption. Opportunistic studies may take advantage of planned exercise layoffs, but these inquiries cannot answer key questions regarding the effects of coercive exercise deprivation.

3.5.2.5 Mission impossible?

It may be obvious from the above discussion that recruitment of subjects for experimental studies on exercise deprivation is a difficult problem. Further, volunteers are most likely different from the non-volunteers for reasons that remain to be tested. Moreover, the difficulties are topped by the fact that the offering of incentives for participation and/or the acceptance of certain conditions put forward by the subjects can distort the genuine answer to the research question. There may be three possible solutions for solving the issue of reliability. However, two of these solutions also harden participant recruitment and one of them may answer a different question.

The first possible solution for gathering reliable data in exercise deprivation studies is the direct observation of subjects in an isolated or confined environment. However, this method gives rise to a new confound which is the impact of isolation. In institutional settings (i.e., prisons, army, re-adaptation centres, etc.), where people are habituated to confinement, an overt control for exercise deprivation is possible, but people in these settings may not represent the general population (Szabo, 1995). Therefore, the direct observation strategy remains a theoretical, rather than practical, solution in the area of exercise deprivation.

The second conceivable solution is the employment of Caltrac equipment that gauge caloric expenditure by vertical displacement. The monitoring of caloric expenditure could also control for the substitution of one activity with another, that may be a confound in deprivation studies. However, the obstacle is that the use of such apparatus may be costly and some of them are ineffective in certain activities, such as stationary bicycling, weight lifting, and other types of exercises without vertical displacement. Indeed, the reliability of the accelerometers may vary and only a few may be suitable for experimental purposes (Westerterp, 2014). Therefore, the use of accelerometers has a promising, but not utter, value in assuring the reliability of the experimental data in exercise deprivation research.

Finally, a third possible solution is the granting flexibility (as opposed to rigidity) for subjects with regard to the adherence to the protocol (e.g., Morris et al., 1990; Gauvin & Szabo, 1992). Accordingly, subjects may be told that they should try (instead of must) to stop exercising, but if they have an urge to exercise, they may do so without negative consequences. In these conditions the subjects record their exercise so that the volume of the actual deprivation can be contrasted with the target volume. Such a "flexible" approach may generate a less coercive atmosphere and also stimulate subjects' adherence, but it will most likely result in the gauging of a reduction in training as opposed to exercise deprivation. Therefore, this *soft* method may be useful to some extent, but it is not the optimal method for investigating the psychological effects of exercise deprivation in highly committed individuals.

It appears that thorough control in experimental studies, addressing the issue of exercise deprivation may be in its infancy. This is not to say that experimental studies seem to be useless or unreliable, but simply to emphasize that most control measures may not resolve the problem of subject-related confounds. These confounds should be recognized at the planning stage of research and dealt with in the most appropriate manner. Therefore, future experimental studies should be developed in such a way that these confounds are accounted for in advance and highlighted in the data interpretation of the results. Perhaps one of the most puzzling problems, begging for scrutiny, is the characterization of the participants, in contrast to non-participants, in exercise deprivation studies. Qualitative - interview based - research is needed to shed light on this dilemma.

3.5.2.6 The weight of descriptive and opportunistic research

Descriptive data may not yield accurate results, because of distortions in memory and lack of proper comparison standards, but they are certainly helpful in dealing with the key problem: subject recruitment. Although they are often appraised as being limited in value, descriptive inquiries are and will be important resources of knowledge in exercise deprivation studies in spite of the fact that such reports have not been published over the past 15 years or more. Their utility should not be underestimated in this particular field of study. Indeed, cross sectional studies comparing the psychological effects of exercise deprivation in the various segments of the exercising population may be aided by survey research. What people say reflects their expectation regarding exercise deprivation. It represents how they should feel, that actually may manifest - indirectly - as a self-fulfilled prophecy. However, carefully formulated opportunistic research may

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be even more helpful. Chan and Grossman (1988) examined exercise deprivation by using such an approach. These authors studied a group of injured runners whose injuries did not interfere with any other routine activity than running. The latter is of paramount importance in separating the observed psychological effects that are due to injury *per se*, or to exercise deprivation. These types of opportunistic studies may be carried out easier than experimental studies, but the interpretation of their findings must take in consideration the source of the psychological hardship.

3.6 Conclusion

To date, the psychological effect of exercise deprivation was studied sparsely. There is an average of less than one study per calendar year. The difficulty of subject recruitment could be the main cause for the lack of sufficient work in this area. Further, participants may be different, in yet unknown way(s), from the non-participants, and consequently the results of the studies cannot be generalized. Studying exercise deprivation is important for several reasons. First, when exercise is adopted as part of the everyday life, its absence yields a psychological void that, as revealed by most research (Table 3.10), manifests itself in negative states of affect and mood. However, other biopsychological functions may also be affected as shown by a decrease in inflammatory markers (Poole et al., 2011) and body dissatisfaction (Niven et al., 2008). When exercise assumes a high priority in a person's life, it becomes a necessity or a basic need. Maslow (2013) pointed out that unfulfilled needs may surface as a disease. Therefore, long term exercise deprivation may have ill effects on the individual's overall health. Another reason for studying exercise deprivation, is that severe feelings of deprivation could be a sign of exercise addiction, which is although rare, may have serious adverse effects. As stated earlier, the severity of psychological symptoms associated with exercise deprivation may be an index of healthy or morbid patterns of exercise. Thus, in spite of the methodological difficulties, significantly more scholastic research is needed in this area.

I will conclude this part with an important message that should be considered carefully in the examination of exercise behaviour. Deprivation-feelings and withdrawal symptoms are not the same. Habitual exercisers will exhibit deprivation-feelings reflecting that they *miss* their exercise, but those who *suffer* as a result of their missed exercise will exhibit withdrawal symptoms that are indicative of a loss of control over one's exercise behaviour. Consequently, the severity (or the dimness, as I have labelled Part II of this dissertation) of the exercise deprivation sensations may represent a grey area in which a transition from healthy to unhealthy exercise pattern takes place.

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Part III.

The Dark Side: Psychology of Exercise Addiction

4.0 Can a Health Behaviour Turn Pathogenic: Exercise Addiction?[15]

4.1 Inactive Lifestyle and Overactive Exercise Style

4.1.1 Too little exercise is bad for your health

A physically inactive lifestyle characterizes the much disputed sedentary behaviour in the health and human welfare literature. In contrast to the earlier generations, before the technological revolution, contemporary humans are living a more comfortable and physically effortless lifestyle. Unfortunately, the sedentary lifestyle does not occur only at home, work and commuting, but also at leisure, encompassing a large number of recreational activities (Ábrahám et al., 2012). Mounting scholastic evidence demonstrates that a physically inactive lifestyle could be an independent health-risk factor for several diseases (Thorp, Owen, Neuhaus, & Dunstan, 2011). Indeed, sedentary behaviour is linked to coronary heart disease (Warren et al., 2010), colon and rectal cancer (Howard et al., 2008), ovarian cancer (Patel, Rodriguez, Pavluck, Thun, & Calle, 2006), breast cancer (Dallal et al., 2012), diabetes, and all cause mortality (Dempsey, Owen, Biddle, & Dunstan, 2014).

There is clearly a strong link between physical activity, energy expenditure, and general health (Haskell et al., 2007). The health concern is justified knowing that many adults spend more than 70% of their waking hours sitting and/or being inactive (Owen, Sparling, Healy, Dunstan, & Matthews, 2010). However, the human body has evolved for movement, to face and deal with physical challenges such as hunting, hiding, building shelters, and so on (Jones & Weinhouse, 1979; Péronnet & Szabo, 1993). Since the technological revolution takes place at an extremely fast pace, to the extent that many human activities and even social encounters are often carried out in the virtual space (Facebook for example; Ryan, Chester, Reece, & Xenos, 2014), evolutionary biology of the human organism cannot adapt to the rapid shift from physically active to physically inactive lifestyle. Therefore, it cannot preserve its healthy or *natural* state of equilibrium in lack of physical challenges (Péronnet & Szabo, 1993). The only conceivable remedy for compensating for the lost physical activity that were *natural* aspects of human survival activities, even a few decades ago, is to become increasingly more active in leisure-type activities. Indeed, in many industrialized nations, noteworthy effort is invested in promoting exercise and physical activity, which is associated with healthy, positive, or even 'politically correct' forms of behaviour (Edwards, 2007). The physical and psychological benefits of physical activity are almost undisputed. There is a strong consensus in the scholastic literature about the need to integrate physical activity in people's everyday lifestyle (Bouchard, Shephard, & Stephens, 1994; Warburton, Nicol, Bredin, 2006). According to the 2007 guidelines of the American Colleges of Sports Medicine (ACSM) and the American Heart Association (AHA), to promote and maintain health, adults aged 18 to 65 years should engage in moderate-intensity aerobic or endurance exercises at least five times a week for at least 30 minutes on each occasion or high-intensity aerobic exercises three times a week for a minimum of 20 minutes each time (Haskell et al., 2007). Nevertheless, a combination of moderate- and high-

[15] *Based on:* ***Szabo, A.*** *(2010) Exercise Addiction: A Symptom or a Disorder? Hauppauge, NY: Nova Science Publishers. ISBN: 978-1-60876-789-2*

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intensity exercises could also be adopted to meet the recommendations. For example, an individual can meet the recommendation by jogging or running 20 minutes twice a week and then walking briskly or cycling at a leisure rhythm for 30 minutes on two other days in the same week. Moderate-intensity aerobic exercise that is generally equivalent to a brisk walk, and noticeably increases the heart rate, could be accumulated to achieve the 30-minute minimum by performing separate bouts, each lasting about 10 to 15 minutes, at different times of the day (Haskell et al., 2007). High-intensity exercises are represented by physical activities like jogging or running (depending on the person's physical condition), fast swimming, speed skating, or effortful cycling and, to qualify as such, they should cause rapid breathing and a substantial increase in heart rate. In addition to aerobic activities, every individual should perform physical exercises that maintain or increase muscular strength and resistance a minimum of twice every week. Finally, Haskell et al. (2007) suggest that since there is a dose-response relationship between physical activity and health (but only to a certain point; author's note)**,** individuals may be better off *exceeding the minimum recommended amounts* of physical activity to further augment fitness, maintain or reduce weight, and to reduce the risk of various diseases.

In another later consensus work, published as a position stand (Garber et al., 2011), by the American College of Sports Medicine (ACSM) new guidance is provided for developing and maintaining aerobic (endurance, cardio-respiratory), anaerobic (musculoskeletal), and neuromotor fitness in healthy adults across the lifespan. The position statement spells out loudly and clearly that the current scientific evidence demonstrates the beneficial effects of exercise that outweigh the risks of exercise-related injuries in most adults. A regular exercise regimen comprising aerobic, resistance, flexibility, and neuromotor exercises, in addition to physical activities involved in the daily routine, are essential for maintaining fitness and health in most people. The ACSM recommends that people engage in moderate-intensity aerobic exercise training for at least 30 minutes, five days a week, for a total of at least 150 minutes every week, or vigorous-or high-intensity aerobic exercises for at least 20 minutes per day, on three days of the week, but accumulate at least 75 minutes of high-intensity exercise every week (Garber et al., 2011). The two workloads of aerobic exercises (moderate and high-intensity) may be combined, but is is essential to gather a total energy expenditure of ≥500-1000 metabolic equivalent of task (MET) minutes per week. However, healthy adults should also perform anaerobic or resistance exercises for each of the major muscle groups, as well as neuromotor exercises that develop balance, agility, and coordination. For maintaining a healthy joint range movement, flexibility exercises are also essential for the major muscle-tendon groups for at least 60 seconds per exercise, and that should be performed at least two times a week. The position stand also recommends that the physical activity program should be modified according to the person's exercise habits, physical abilities, general health status, specific exercise responses, and various personal goals (Garber et al., 2011).

Considering these guidelines and their clear public statement, such as: "*Because of the dose-response relation between physical activity and health, persons who wish to further improve their personal fitness, reduce their risk for chronic diseases and disabilities or prevent unhealthy weight gain may benefit by exceeding the minimum recommended amounts of physical activity*" (Haskell et al., 2007, p. 1081), which has been cited over 5000 times in less than 10 years (!), a relatively larger dose of exercise seems to be justified. Haskell et al. (2007), however, warn that increasing the dose of the physical activity beyond the recommendations of the ACSM also

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increases the risks of injury and even cardiac problems. In spite of such warning, the positive correlation between the amount of exercise and general health may be misinterpreted and in *some* cases (a key term to remember throughout this part of the dissertation is: some or *isolated cases,* or *very rare cases*) physical activity may be abused to lead to harmful and/or morbid physical and psychological states. Indeed, too much exercise may not only result in severe physical injuries, but also in irreversible adverse health effects or even fatal consequence (Cumella, 2005).

4.1.2 How is it called when too much of the good exercise thing turns bad?

Overexercising to the point where one *loses control* over her or his exercise routine and walks on the path of self-destruction is referred to as *exercise addiction* (Griffiths, 1997; Thaxton, 1982). The same concept is also often described as *exercise dependence* by a number of scholars (e.g., Cockerill & Riddington, 1996; Hausenblas & Symons Downs, 2002a). Further, some academics refer to the condition as *obligatory exercising* (e.g., Pasman & Thompson, 1988), probably by hinting to the compulsive aspect of the behaviour. Indeed, in the public or mass media the condition is frequently termed as *compulsive exercise* (Eberle, 2004), *obsessive exercise* (Boone, 1990), or as *exercise abuse* (Davis, 2000). It is important to note that all these synonymous words, theoretically are intended to label the *same* psychological condition (Table 4.1). However, there are several reasons for which alternating the terminology naming the same phenomenon may be unproductive.

There is a sound argument for differentiating addiction from dependence (O'Brien, Volkow, & Li, 2006). While the term *dependence* is often carelessly used as a synonym for addiction, the latter includes the former, and also includes *compulsion* (Goodman, 1990). Accordingly, the general formula for addiction may be: *addiction = dependence + compulsion.* Goodman specifies that not all dependencies and compulsions may be classified as an addiction. Therefore, in this part of the dissertation I will use the term *exercise addiction*, because I consider it to be the most appropriate for describing the morbidity, since it incorporates both, dependence and compulsion.

Table 4.1. The various terms alternately used to label the pathological exercise behaviour.

Terms used	In number of articles (Appendix O)
Compulsive exercise	15
Exercise abuse	3
Exercise addiction	47
Exercise dependence	28
Obligatory exercise	7
Obsessive exercise	1

4.1.2.1 Confounding commitment to exercise with exercise addiction

Glasser (1976) believed that too much of a good thing is better than too much of a bad thing. Therefore, he has introduced the term *positive addiction* in the scientific literature to describe the personal and social benefits of regular and persistent exercise behaviour in contrast to some self-destructive behaviour like tobacco, drug, or alcohol abuse. The p*ositive* prefix in conjunction with the term addiction led to the widespread and careless use of the term *exercise addiction* within both athletic and scientific populations. Indeed, a number of runners have claimed that they were *addicted* to running while they only referred to their high level of commitment and dedication to their chosen exercise. In fact, they wanted to express their very high level of commitment to running by using the word *addicted*. Morgan (1979) has acknowledged that this is a semantic problem, because the *positive* prefix deters attention from incidences where a transition occurs from high levels of commitment to exercise to a problematic behaviour. Therefore, to discuss the negative aspects of exaggerated exercise behaviour, he has introduced the term *negative addiction* as an antonym to Glasser’s positive addiction. The fact is, however, that all addictions represent a dysfunction and, therefore, they are *always* negative (Rozin & Stoess, 1993). Morgan's term simply addressed the misconception in the literature and mass media, by trying to differentiate between healthy and morbid patterns of exercise behaviour.

Indeed, Glasser's (1976) *positive* notion referred to the benefits of *commitment* to physical exercise (a healthy behaviour) in contrast to the negative effects of *unhealthy* addictions. Positive addiction in sport science and psychology literature may be perceived as a synonym for *commitment to exercise* (Carmack & Martens, 1979; Pierce, 1994; Szabo, 2010). However, when 'commitment' to exercise is used as a synonym to *exercise addiction* or to *exercise dependence* as termed by some scholars (Conboy, 1994; Sachs, 1981; Thornton & Scott, 1995) a major conceptual error is emerging. For example, Thornton and Scott (1995) reported that they could classify 77% of a small sample (n = 40) of runners as moderately or highly addicted to running. Such a figure is enormous if one thinks that among twenty thousand runners in a marathon race, for example, more than three quarters of the participants may be addicted! The figure is obviously exaggerated (Mónok et al., 2012; Szabo, 2000, 2010). Therefore, some scholars have realised this problem and have attempted to draw a line between commitment and addiction to exercise (Chapman & De Castro, 1990; Summers & Hinton, 1986; Szabo, 2000, 2010; Szabo et al, 1997).

Commitment to exercise is a measure of how devoted an individual is to her/his activity. It is a measure of the strength of adherence to an adopted, healthy or beneficial activity that is a part of the daily life of the individual. For committed people, satisfaction, enjoyment, and achievement derived from their actions, are the incentives that motivate them to stick to their sport or exercise (Chapman & De Castro, 1990). Sachs (1981) believed that commitment to exercise results from the intellectual analysis of the rewards, including social relationships, health, status, prestige, or even monetary advantages, gained from the activity. Committed exercisers, according to Sachs: 1) exercise for extrinsic rewards, 2) view their exercise as an important, but not the central part of their lives, and 3) may not experience major withdrawal symptoms when they cannot exercise for any reason (Summers & Hinton, 1986). Probably the key point is that committed exercisers *control* their activity (Johnson, 1995) rather than being controlled by the activity. In contrast to committed exercisers, addicted exercisers: 1) are more likely to exercises for intrinsic rewards, 2) are aware that exercise is the central part of their lives, and 3) experience severe deprivation-feelings when they are prevented to exercise (Sachs, 1981; Summers & Hinton, 1986). I also added another distinction (discussed in more detail below) in the context of motivation for exercise. Addiction to exercise is compulsive, which by definition is a *must* (strong urge), that should be satisfied or else negative feelings may surface. These forms of behaviours are motivated by negative reinforcement. Healthy exercise occurs in is a wanted or wished (rather than *must*) form to do something, because the activity is pleasurable or enjoyable.

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This form of motivation is fuelled by positive reinforcement (Bozarth, 1994). Consequently, another distinction between commitment and addiction to exercise is the motive or incentive behind the exercise behaviour.

4.2 The Concept of Exercise Addiction

4.2.1 Conceptualization of exercise addiction

4.2.1.1 Behavioural addictions

Before attempting to define exercise addiction, a general definition of addiction may be necessary. To accomplish that, it is also essential to differentiate between substance- (or chemical) and behavioural addictions. Overall, there is no simple definition of addiction (Johnson, 1994). In Goodman's (1990) view, addiction is a behavioural process that could provide either pleasure or relief from internal discomfort (stress, anxiety, etc.) and it is characterized by repeated failure to control the behaviour (state of powerlessness) and maintenance of the behaviour in spite of major negative consequences. More recently, the American Society of Addiction Medicine (ASAM), a well-respected and accepted authority in the field, provides the following definition:

> "*Addiction is a primary, chronic disease of brain reward, motivation, memory and related circuitry. Dysfunction in these circuits leads to characteristic biological, psychological, social and spiritual manifestations. This is reflected in an individual pathologically pursuing reward and/or relief by substance use and other behaviors.*
>
> *Addiction is characterized by inability to consistently abstain, impairment in behavioral control, craving, diminished recognition of significant problems with one's behaviors and interpersonal relationships, and a dysfunctional emotional response. Like other chronic diseases, addiction often involves cycles of relapse and remission. Without treatment or engagement in recovery activities, addiction is progressive and can result in disability or premature death*." (Source: American Society of Addiction Medicine (2011). Public Policy Statement: Definition of Addiction, p. 1).

Initially, scholars thought that considering a behaviour as addictive ultimately may lead to the conclusion that almost all human behaviour may become addictive, starting from carrot eating to using computers (Shaffer, Hall, & Vander, 2000). However, in contrast to earlier views on addiction, that restricted the behaviour to chemical substances such as alcohol, nicotine, or heroin, today many scholars, especially psychologists, believe that any source of reward, that is capable of stimulating the individual, may become addictive (Alavi et al., 2012). Indeed, evidence suggests that, from a neurophysiological perspective, several behaviours may induce an activation in the reward system of the brain in a similar manner as some drugs or other chemical substances do

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(Albrecht, Kirschner, & Grüsser, 2007). Further, the people affected by behavioural and chemical addictions often respond favourably to the same pharmacological and psychological treatments (Grant, Potenza, Weinstein, & Gorelick, 2010). Fisher (2006) disclosed important evidence through functional magnetic resonance imaging (fMRI) that very intense feelings of love were associated with the activation of the brain's reward centres that were also reacting to cocaine. Scholars have long ago discussed the existence of behavioural addictions (Brown, 1993; Goodman, 1990), and today there is growing neurophysiological evidence for it. In spite of some opposition, the DSM-V now includes a category of behavioural addictions that is, nevertheless, at this time is restricted to disordered gambling (Granero et al., 2014). Its diagnostic criteria are similar to the that used for substance or chemical additions (Grant, et al., 2010). There are several behavioural addictions, among which exercise fails in the category *positive behaviour* (Table 4.2) in the sense that the behaviour (exercise) itself is positive or socially rewarded, so the affected person (the exercise addict) can easily hide behind it (Egorov & Szabo, 2013).

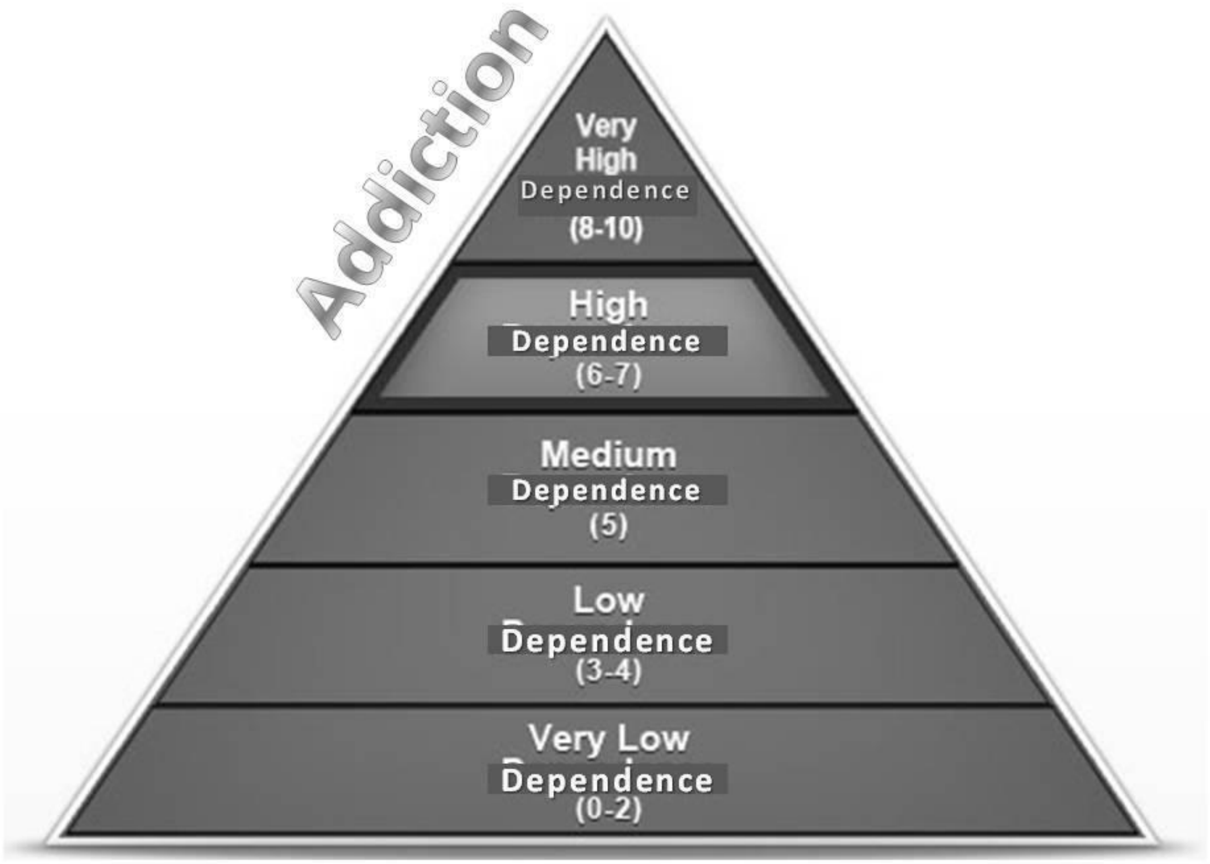
Table 4.2. Classification of behaviours that may become addictive (Egorov & Szabo, 2013)

Gambling	Sensual or erotic behaviour	Positive (or socially accepted and rewarded) behaviour	Technological activities	Eating
Gambling and betting	Love	Work	Internet	Overeating
	Sex Mixed love-sex, partner	*Exercise* Shopping	Mobile phone Television	Starvation-diet
	Pornography	Religion Relationship		

4.2.1.2 Exercise addiction

There was a tendency to conceptualize exercise addiction (and addiction in general) as a continuum and represent it diagrammatically on a pyramid where little or normal (moderate) exercise is at the bottom of the pyramid, then progressively increases to a problematic level, characterized by higher dependence, and peaks at morbidity reflecting the state of addiction (Figure 4.1). This gradual or progressive view gave rise to the devise of scalar questionnaires for identifying the *extent* to which a person may be affected by exercise addiction. However, there is no such continuum and a progressive evolutionary theory of addiction does not hold. I will discuss later, and also present a model, the revolutionary - or suddenly surfacing - signs and symptoms of exercise addiction.

Figure 4.1. An evolutionary, or progressive, conceptualization of exercise addiction on a fictive 10-point Likert scale.



4.2.1.3 Withdrawal symptoms

From Sachs' (1981) criteria mentioned in the previous section it is clear that exercise addiction includes: 1) salience, and 2) withdrawal symptoms. Salience, or high life priority and preoccupation with exercise, accompanied by increased bouts of exercise, are inherent in the term overexercising. The presence of withdrawal symptoms and their intensity, on the other hand, is a distinct manifestation of the problem.

It appears that the presence of withdrawal symptoms is a key feature in the description and definition of exercise addiction. Indeed, long ago Sachs and Pargman (1979) defined the exercise addicts as "*persons who demonstrate psychological and/or physiological dependence upon a regularly experienced regimen of running. In these individuals the unfulfilled need or desire to run produces withdrawal symptoms*" (p. 145). Later Sachs (1981) defined exercise addiction in reference to runners as "*addiction of a psychological and/or physiological nature, upon a regular regimen of running, characterized by withdrawal symptoms after 24 to 36 hours without* *participation*" (p. 118). Similarly, Morgan (1979) thought that exercise addiction is only present when two requirements are met. First, the individual must require daily exercise in order to exist or cope: the runner cannot live without running. Second, if deprived of exercise the individual must manifest various withdrawal symptoms (e.g., depression, anxiety, or irritability (p. 5). Others echo these definitions in the literature (Furst & Germone, 1993; Morris, 1989; Sachs & Pargman, 1984) and strengthen the assumption that withdrawal symptoms are the key aspect of exercise addiction. But a significant question arises from such a contemplation: Could the mere experience of withdrawal symptoms imply or suggest the presence of exercise addiction in a diagnostic way? To answer this question a closer inspection of the literature examining withdrawal symptoms in habitual exercisers is necessary.

The literature reveals that withdrawal symptoms, although marking, are only one of the several symptoms of exercise addiction (Brown, 1993; Griffiths, 1997). Incorrectly, in the past many studies have simply assessed the mere presence, rather than the type, frequency, and the intensity of withdrawal symptoms (Szabo, 1995, 2000, 2010; Szabo et al., 1997). However, most regular exercisers report negative psychological feelings for times when they are prevented from exercise for an unexpected reason (Szabo, 1995; Szabo et al., 1996; see also Table 3.10). Indeed, Szabo et al. (1996) conducted a survey type of research on the Internet and have shown that even participants in physically *light effort* types of exercises, like bowling, reported withdrawal symptoms when the activity (in this case bowling) was prevented, but that was of significantly lower intensity than those reported by the more effort-requiring activity participants. Therefore, it may be assumed that deprivation from of several accustomed behaviours, substances, or even food products like chocolate (Moreno-Dominguez, Rodríguez-Ruiz, Martín, & Warren, 2012), may generate negative feelings. Consequently, the withdrawal symptoms in response to any form of need-deprivation are *natural*, but their severity, and the person's control over them, could be the index of the balance between health and morbidity.

Based on these arguments, it should be appreciated that the mere presence of withdrawal symptoms is insufficient for diagnosing exercise addiction. The *intensity* of these symptoms is a crucial factor in separating committed from addicted exercisers. Cockerill and Riddington (1996) do not even mention withdrawal symptoms in their list of symptoms associated with exercise addiction. In fact the presence of deprivation-feelings or withdrawal symptoms, in many forms of physical activities, suggests that exercise has a positive effect on people’s psychological and physical health. This positive effect is then missed when an interruption in the habitual activity is necessary for an unwanted or unplanned reason.

It may be evident that a sole symptom-based diagnosis of exercise addiction cannot be made simply on the basis of presence or absence of withdrawal symptoms. The inspection of other symptoms, such as salience and tolerance that are common to other form of substance- (e.g., alcohol) as well as behavioural addictions (e.g., gambling), and their co-occurrence need to be evaluated. Indeed, most questionnaires, aimed at the screening of exercise addiction, are symptom-based. Six common symptoms of behavioural addiction were identified through the systematic observation of several addictive behaviours such as exercise, sex, gambling, video games, and also nowadays the Internet. Based on Brown’s (1993) general components of addictions, that were reiterated by Griffiths (1996, 1997, and 2002), there are six common symptom-based components of addiction. Later, Griffiths (2005) proposed a “components” model of addiction, going beyond exercise addiction whilst bringing the latter under one umbrella with other addictions. The model is based on the six most common symptoms of addictions (salience, mood modification, tolerance, withdrawal, conflict [intra and interpersonal] and relapse). Griffiths suggests that addictions are a part of a biopsychosocial process and evidence suggest that most, if not all, addictive behaviours seem to share these commonalities.

4.3. Common Symptoms of Exercise Addiction

4.3.1 Six common symptoms in Griffiths (2005) "components" model

4.3.1.1 Salience

This symptom is present when the physical activity or exercise becomes the most important activity and preoccupation during the daily routine of the persons and dominates their thinking, feelings (urges, cravings) and behaviour (deterioration of social behaviours). For instance, even when people are not actually engaged in exercise they will be thinking about the next time they will be. The mind of the addicted individual wanders off to exercise during other daily activities like driving, having meals, attending meetings, and even between conversations with friends. The closer is the planned time for exercise the greater is the urge and even anxiety or fear from not starting on time. The addicted exerciser is literally obsessed with exercise and regardless of the time of the day, place, or activity performed, her or his mind is directed towards exercise during the majority of waking hours.

4.3.1.2 Mood modification

This symptom refers to the subjective experiences that people report as a consequence of engaging in the particular activity and could be seen as a coping strategy (i.e., they experience an arousing *buzz* or a *high*, or paradoxically tranquillising feel of *escape* or *numbing*). Most exercisers report a positive feeling state and pleasant exhaustion after a session of exercise. However, the person addicted to exercise would seek mood modification not necessarily for the gain or the positive mental effect of exercise, but rather for the modification or avoidance of the negative psychological feeling states that she or he would experience if the exercise session were missed. Fear of not feeling well, or going down (psychologically) is a strong incentive for exercise that is perceived as the vehicle that could prevent the unwanted negative mood experiences.

4.3.1.3 Tolerance

It is the process whereby increasing amounts of the particular activity are required to achieve the former effects. For instance, a gambler may have to gradually increase the size of the bet to experience the euphoric or satisfying effect that was initially obtained by a much smaller bet. The runner needs to run longer distances to experience the *runner's high*[16] (Stoll, 1997), a euphoric feeling state described later. Similarly, the addicted exercises need larger and larger of doses of exercise to derive the effects experienced previously with lower amounts of exercise. Tolerance is the main reason why individuals addicted to exercise progressively and continuously increase the frequency, duration and also the intensity of the workouts.

4.3.1.4 Withdrawal symptoms

These psychological symptoms were discussed in detail in the context of exercise deprivation in Part II of this dissertation. Briefly, they are the unpleasant psychological and physical feeling states, which occur when exercise is discontinued or it is significantly reduced. The most commonly reported symptoms are feelings of guilt, irritability, anxiety, sluggishness, feeling fat, lacking energy, and being in a bad mood or a depressed mood state (refer to Table 3.7 in Part II). The intensity of these states is severe in people affected by exercise addiction to the extent that they really feel miserable when the need of exercise is not fulfilled. The manifestation of these withdrawal symptoms in addicted individuals is clearly different from those experienced by the committed exercisers who simply feel a void, or that something is missing, when exercising is not possible for a reason. Addicted exercisers have to (must) exercises to overcome withdrawal symptoms even at the expense of other more important life obligations. In contrast, committed exercisers look forward to the next opportunity while prioritising their obligations (Szabo, 2010).

4.3.1.5 Conflict

This symptom represents the conflicts between the exercise addicts and others around them (interpersonal conflict), conflicts with other daily activities (job, social life, hobbies and interests) or from within the individual themselves (intra-psychic conflict) which are concerned with the particular activity. Interpersonal conflict usually results from neglect of the relationship with friends or family because of the exaggerated time and preoccupation devoted to exercise. Conflict in daily activities arises because of the abnormally high priority given to exercise in contrast to important survival activities like cleaning, taking care of bills, working, or studying for exams. Intra-psychic conflict occurs when the addicted person has realized that fulfilling the need to exercise takes a toll on other life obligations, but she or he is unable to cut down or to control the exercise behaviour. Often the conflict, whether it is intra- or interpersonal, triggers feelings of stress, which are most frequently handled, by the addicted individual, through even more exercise. Therefore, the exercise behaviour continues to be increased in a vicious circle, generating more stress, which is relieved with more exercise.

[16] *This concept is discussed in Part I, section 2.2 of this dissertation. A pleasant feeling associated with positive self image, sense of vitality, control, and a sense of fulfilment reported by runners as well as by other exercisers after a certain amount and intensity of exercise. The feeling has been associated with increased levels of endogenous opioids and catecholamines observed after exercise.*

4.3.1.6 Relapse

This is the tendency for repeated reversions to earlier patterns of exercise after a break whether that is voluntary or involuntary. The phenomenon is similar to that observed in alcoholics who stop drinking for a period of time and then starts over again and drink as much – if not more – than prior to the break from drinking. Relapse could be observed after injury (which is involuntary) or after a planned reduction in exercise volume as a consequence of a personal decision to put a halt to the unhealthy pattern of exercise behaviour or as a consequence of professional advice. Upon resumption of the activity, addicted individuals could soon end up exercising as much or even more as before the reduction of their volume of exercise. Relapse prevention is one of the greatest challenges in addiction medicine.

4.3.2 Other symptoms observed in exercise addiction

4.3.2.1 Loss of control over life-activities (Griffiths, 1997)

The internal drive or urge for exercise becomes psychologically so intense that it preoccupies attention in the majority of waking hours by dominating the person's thoughts. Consequently, the affected individual is unable to pay attention or to properly concentrate on other daily activities. Until that urge is satisfied, other life-activities are poorly performed or totally neglected. Upon fulfilment of the need to exercise, the affected person may function well and take care of some other mundane obligations, but such a *normal* functioning is limited to the period encompassing the acute effects of the previous session of exercise or until the urge for another bout of exercise starts to rise again. Therefore, these *normal functioning* periods are relatively short due to a lack of control over the urges to exercise.

4.3.2.2 Loss of control over one's exercise behaviour (Cockerill & Riddington, 1996; Johnson, 1995)

This is a phenomenon where self-set resolutions cannot be kept. The exerciser simply cannot resist the strong need to exercise. While she or he may try to set limits in her/his exercise patterns, she/he is unable to respect those self-set limits. In short, lack of control denotes the inability to exercise with moderation. This is a phenomenon also observable in alcoholics (and in most addictions in general) who, after several incidences of heavy drinking, and some severe consequences of such drinking pattern, make the resolution not to get drunk again. However, on the same day later, after making such a resolution, they get drunk again. The inability to keep exercise in control in spite of an inner wish, results in feelings of powerlessness, or loss of willpower, and guilt. Such feelings yield the thought of inability that she or he cannot do it (control it) anyway, so why bother trying to control the habit. This thought process, characterized by guilt and associated learned helplessness (or possibly a feeling of sorry for the self for which the addictive behaviour provides some sort of relief or compensation) then grants a green light to the addicted behaviour.

4.3.2.3 Negative, non-injury related, life consequences (Griffiths, 1997)

Negative life events may occur as a result of overexercising. If life activities are ignored or superficially performed as a result of excessive exercise and too much preoccupation with exercise, on the long term, negative life consequences may emerge involving even loss of employment, poor academic performance, break-up in relationships and friendships, and other consequences generally considered to have undesirable effects on the person's life. Untreated, exercise addiction can lead to the same tragic consequences as any other addiction. A real life case showing how exercise can take over one's life and result in many negative consequences is illustrated by a testimonial in the British Daily Mail newspaper:

> "*I'm addicted to exercise: My fitness regime ruined my holidays, my social life and my marriage... but I just can't stop*" (Source: Daily Mail, 25 September, 2009)

Retrieved April 01, 2015 from:
http://www.dailymail.co.uk/femail/article-1215705/Im-addicted-exercise-How-fitness-regime-ruined-holidays-social-life-marriage--I-just-stop.html

4.3.2.4 Risk of self-injury (De Coverley Veale, 1987; Wichmann & Martin, 1992)

At times of mild injuries the addicted exerciser cannot abstain from exercise and, thus, assumes the risk of self-injury by maintaining her/his physical activity. In more severe cases, the affected individual needs to see a medical professional who may advise the person to refrain from exercising until full recovery takes place. In spite of the medical advice, the person addicted to exercise, will likely resume her or his exercise immediately upon experiencing minor alleviation in the discomfort associated with the injury – or in the early stages of recovery – thus exposing her- / himself to further and possibly more severe injuries triggering often irreversible health damages.

4.3.2.5 Social selection and withdrawal (Cockerill & Riddington, 1996)

This is a behaviour tendency by which the addicted person identifies with others who approve her or his exercise behaviour and avoids the company of those who criticize her/his physical activity pattern. Such a social gravitation is generally observed in individuals suffering from other forms of behavioural (e.g., gambling) or substance (e.g., alcohol) addictions.

4.3.2.6 Lack of compromise (Wichmann & Martin, 1992)

This symptom is closely related to the loss of control described above. Although there may be several warning signs related to the neglect of family or work responsibilities because of excessive exercise, the signs are insufficient to trigger a decision to compromise. Consequently, other life-commitments remain ignored, even though the affected person is aware that the end result may be worse than undesirable.

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4.3.2.7 Denial of a problem or self-justification (Wichmann & Martin, 1992)

This represents a psychological defence mechanism known as rationalization. The person addicted to exercise explains or justifies the problem via a conscious search for reasons why exercise, even in massive volume, is beneficial. The mass media and even scientific reports provide abundant reasons that could be used in the rationalization. The ACSM guidelines for exercise and the positive correlation between the dose of exercise and general health (Haskell et al., 2007) are excellent anchors for justifying the exaggerated amounts of exercise.

4.3.2.8 Full awareness of the problem (De Coverley Veale, 1987)

The exercise addict person may know well that there are problems with her/his exercise behaviour through feedback from other people or from some negative life-events directly resulting from overexercising. However, she/he feels powerless to take action against the problem. This feeling may trigger a *giving-up* and giving-in (to the addiction) reactions eventually resulting in the deterioration of self-image that may be accompanied by feelings of worthlessness.

4.3.3 A more recent and more detailed classification of exercise addiction

Less than a decade ago, two German scholars, Grüsser and Thalemann (2006) presented a newer classification for behavioural addictions, in general, based on some relatively common characteristics noticeable in several forms of addictions. These scholars conjecture that these characteristic symptoms may be signs for the possible diagnosis of a behavioural addiction, also including exercise addiction. Nevertheless, the authors emphasize that cases need to be examined individually to determine whether the heavy involvement with the given behaviour is indeed addictive or just an excessive one (non-pathological or related to another dysfunction). Indeed, symptoms alone may not be sufficient for the correct diagnosis, but a collection of severe typical symptoms in conjunction with the history of negative consequences, due to the excessive indulgence in a given behaviour, may pinpoint the presence of addiction. Grüsser's and Thalemann's criteria, as they apply to exercise addiction, are:

1. The exaggerated exercise behaviour is exhibited over a long period of at least 12 months in an abused, aberrant form, deviating from the norm in frequency and intensity.

2. Loss of control over the exercise behaviour (duration, frequency, intensity, risk) when the behaviour started.

3. Reward effect (e.g., high volume of exercise is considered to be rewarding).

4. Development of tolerance (exercise is performed longer, more often and more intensively in order to achieve the desired effect; in unvaried form, intensity and frequency the desired effect fails to appear).

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5. The exercise behaviour that was initially perceived as pleasant, positive and rewarding is increasingly considered to be an unpleasant obligation in the course of the addiction.

6. Irresistible urge/craving to exercise.

7. Function (exercise is chiefly performed to regulate emotions/mood).

8. The expectancy of effect (pleasant feelings are anticipated to result from exercise).

9. Limited pattern of behaviour (does not wish to try out new things in life).

10. Cognitive or mental preoccupation build-up (execution and follow-up activities that are linked to exercise and the anticipated effects of possibly even higher doses of exercise).

11. Irrational, perception of different aspects of the exercise behaviour.

12. Withdrawal symptoms (both psychological and physical).

13. Continued involvement in excessive exercise behaviour despite already experienced negative consequences (health-related, occupational, social).

14. Conditioned/learned reactions (resulting from the confrontation with internal and external stimuli associated with the excessive exercise and with cognitive occupation with the excessive behaviour).

15. Suffering, pain management (desire to alleviate perceived suffering)

Grüsser's and Thalemann's (2006) list of characteristics is longer than the symptoms contained within the Components Model of Addiction (Griffiths, 2005). However, the list incorporates most, if not all (directly or implicitly), of the six components of addiction proposed by Griffiths. The question is whether fewer but typical symptoms of addiction are sufficient to help health professionals in the identification of the disorder or whether a longer list is needed? Albrecht et al. (2007) believe that clinical orientations, also reinforced by scientific evidence, highlight the commonalities between substance-related and non-substance related behavioural addictions. They believe that a standardized classification should describe all excessive or abused behaviours that meet the criteria of addictions as an addiction disorder and incorporate them into the diagnostic criteria. This approach would facilitate the accurate diagnosis (by using valid and reliable instruments) and also aid in the effective treatment of affected individuals. It is clear then that the proper assessment of exercise addiction is crucial in the identification the addiction as a dysfunction.

4.4 Behavioural Motivation in Exercise Addiction

At several places in this dissertation and in my writings I have emphasized and re-emphasized that commitment to exercise is different from addiction to exercise, regardless of the amount of exercise. Motivation for exercise is another distinguishing characteristic between commitment and addiction. People exercise for specific reasons. The reason is often an intangible reward like being in shape, looking good, being with friends, staying healthy, building muscle, losing weight, etc. The personal experience of the anticipated reward strengthens the exercise behaviour. Scholars, known as behaviourists, adhering to one of the most influential schools of thought in the field of Psychology, postulate that behaviour could be understood and explained through reinforcement and punishment. Accordingly, the *operant conditioning theory* suggests that there are three principles of behaviour: *positive reinforcement*, *negative reinforcement*, and *punishment* (Bozarth, 1994). Positive reinforcement is a motivational incentive for doing something to *gain* a reward that is something pleasant or desirable (e.g., increased muscle tone). The reward then becomes a motivational incentive, which increases the likelihood of that behaviour to reoccur. In contrast, negative reinforcement is a motivational incentive for doing something to *avoid* a noxious or unpleasant (e.g., gaining weight) event. The avoidance or reduction of the noxious stimulus is the reward, which then increases the probability of that behaviour to reoccur. It should be noted that both positive and negative reinforcers increase the likelihood of the behaviour (Bozarth, 1994), but their mechanism is different because in positive reinforcement there is some sort of *gain that follows the action* (e.g., feeling revitalized), whereas in behaviours motivated by negative reinforcement one attempts to avoid something bad or unpleasant *before happening* that otherwise would occur (e.g., feeling guilty or fat if a planned exercise session is missed).

Punishment refers situations in which the imposition of some noxious or unpleasant stimulus or event or alternately the removal of a pleasant or desired stimulus or event reduces the probability of a given behaviour to reoccur. In contrast to reinforcement, punishment suppresses the behaviour and, therefore, exercise or physical activity should never be used (by teachers, parents, or coaches) as a form of punishment. Paradoxically, exercise addiction may be perceived as self-punishing behaviour. It is a very rare form of addiction (compared to alcohol, tobacco or drug abuse) requiring substantial physical effort often to the point of exhaustion. Therefore, exercise addicts may be viewed as either masochistic or self-punishing individuals.

People addicted to exercise may be motivated by negative reinforcement (e.g., to avoid withdrawal symptoms) as well as positive reinforcement (e.g., *runner's high;* Pierce, 1994; Szabo, 2010). However, negative reinforcement, or avoidance behaviour, is not a characteristic of the committed exercisers (Szabo, 2010). Indeed, committed exercisers maintain their exercise regimen for benefiting from the activity. On the other hand, addicted exercisers *must* or *have to do it* or else something will happen to them. Their exercise may become an “obligation” (also reflected by the popular term “obligatory exercise”) that needs to be fulfilled or otherwise an unwanted life event could occur like the inability to cope with stress, or gaining weight, becoming moody, etc. Every time a person undertakes behaviour to avoid something negative, bad, or unpleasant, the motive behind that behaviour may be classified as negative reinforcement. In these situations the person involved *has to do it* in contrast to *wants to do it*. There are many examples in other sport areas where a behaviour initially driven by positive reinforcement may turn into negatively reinforced or motivated

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behaviour. For example, an outstanding football player who starts playing the game for fun, after being discovered as a talent and being offered a service contract with a team, becomes a professional player who upon signing the contract *is expected* to perform. Although the player may still enjoy playing (especially when all goes well), the pressure or expectation to perform is the *has to do* new facet of football playing and the negatively reinforcing component of his (or her) sporting behaviour. Table 4.3 illustrates the differences between the underlying motives in exercises behaviours driven by negative and positive reinforcement.

Duncan (1974) in relation to drug addiction purports that addiction is almost identical with, and semantically is just another name for, avoidance or escape behaviour when the unpleasant feeling is being negatively reinforced by drug taking. People addicted to exercise, in this view, reach for a means - with which they had past relief-inducing experience - that provides them with temporary escape from an ongoing state of emotional distress and struggle, which might be caused by mental dysfunction, or by psychosocial stress, or by a discomforting social or physical environment. In Duncan’s view, all addictions represent similar negatively reinforced behaviours.

Duncan states that negative reinforcement is a powerful mechanism in maintaining high-frequency and long-persistent behaviours. Animals that could have escaped a noxious stimulus or event by pressing a bar (negative reinforcement) will often do so to the point of ignoring other even instinctual activities like eating, sleeping, sexual activity, etc. Avoidance behaviours are highly resistant to extinction and even when they appear to have been finally eliminated, they tend to re-occur spontaneously. Consequently, the relapse rate in addictions, regardless of the form of addiction, is very high. In Duncan's view, the intensity, compulsiveness, and predisposition to relapse, that are important characteristics in addictions, result from the fact that the behaviour is maintained by negative reinforcement.

Table 4.3: *Exercise behaviours driven by positive and negative reinforcement.*

Positive reinforcement	Negative reinforcement
Origin: Behaviouristic school of thought.	*Origin:* Behaviouristic school of thought.
Definition: Positive Reinforcement strengthens a behaviour because a tangible or intangible *gain* is secured as a result of the behaviour.	*Definition:* Negative Reinforcement strengthens a behaviour because a negative condition is stopped and/or *avoided* as a consequence of the behaviour.
Examples:	*Examples:*
“I feel revitalised after exercise” (*gains* good feeling) “I like to decrease my running time on the same distance (*gain* skill and confidence) “I lift weights to look good.” (*gains* physical benefits, good looks)	“I run *to avoid* circulatory problems that my parents had.” “I go to the gym *to avoid* getting fat.” “I have to run my 10 miles every day, or else I feel guilty and irritated.” (*avoids* the feeling of guilt and irritation)

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Although positive reinforcement like the *runners' high* and brain reward systems have been implicated in the explanation of exercise addiction, the motivational incentive in addiction may be more closely connected to the prevention, escape, or avoidance of something unwanted as in some recent models of addiction (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Accordingly, the process of addiction, especially in later or the actual addiction phase, is more likely motivated by negative reinforcement in which the affected individual has to exercise to avoid an unwanted consequence.

4.5 Theoretical Models for Exercise Addiction[17]

Physical exercise is one of the behaviours that benefits people both physically and mentally and, therefore, its regular practice is recommended. The "Exercise is Medicine" movement (Jonas & Phillips, 2012) and others (i.e., Glasser, 2012) view exercise as therapeutic. Recently, Glasser (2012) highlighted that in certain cases the initially beneficial or self-improving behaviours, like exercise or meditation, could become addictive and this form of addiction builds strength in the person and promotes a happier and healthier living. This view, in conjunction with the known cases of diagnosed exercise addiction (Griffiths, 1997), confers a paradoxical role to exercise behaviour. Indeed, habitual and committed forms of exercise may be seen as therapeutic, while crossing the borderline of *moderation* - with the emerging negative consequences - renders the same behaviour pathogenic. In this section, the models forwarded for exercise addiction are considered and an alternative, or complementary, interactional model is offered for the better understanding of the exercise paradox. It must be emphasized that there is some overlap with the models accounting for the psychological benefits of exercise, but the issue is approached from a different perspective. The peculiarity of exercise addiction, similar to and other physical or mental effort-requiring addiction, is not only the paradoxical nature of the addiction, but also the effort or energy investments and time and space demanding aspects of these activities that do not occur in the passive chemical intake or consumption addiction, like substance or alcohol abuse. Therefore, in this dissertation I would like to differentiate between active an passive addiction, that likely characterize different samples or clinical populations. Such an approach is also supported by research evidence. For example, a study has found that youngsters classified as sufferers of Internet addiction exhibited high novelty seeking, high level of harm avoidance, and low level of reward dependence. In contrast, youngsters in a substance use group showed high novelty seeking, low harm avoidance and low reward dependence (Ko et al., 2006). Further, Le Bon et al. (2004) have revealed that personality differences exist even among individuals addicted to different substances. These authors think that knowing about the trait predisposition may give a head advantage in the screening as well as in the treatment phases of various addictions.

In studying the link between personality traits and exercise addiction researchers have found that extroversion, neuroticism, as well as agreeableness could predict the intensity of the symptoms of exercise addiction (Hausenblas & Giacobbi, 2004). Another study revealed that exercise addiction was linked to disordered eating and higher levels of harm avoidance as well as persistence (Grandi,

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[17] *Based on: Egorov, A. Y., & **Szabo, A.** (2013). The exercise paradox: An interactional model for a clearer conceptualization of exercise addiction. Journal of Behavioral Addictions, 2(4), 199-208. doi: 10.1556/JBA.2.2013.4.2*

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Clementi, Guidi, Benassi & Tossani, 2011). Regrettably, there is insufficient work on personality and exercise addiction, but people affected may represent a very specific subtype of sufferers of addiction.

4.5.1 The exercise induced changes in the level of arousal at rest

The apparent lack of understanding of the exercise paradox, begs for sound theory-driven research. In my 2010 work, I have presented two specific models for exercise addiction and several models that try to explain the psychological benefits of exercise, which in turn could be indirectly linked to exercise addiction. In the current dissertation, I only deal with the specific models. The Sympathetic Arousal Hypothesis (Thompson & Blanton, 1987) is a physiological model, suggesting how adaptation of the organisms to regular exercise may lead to addiction. Briefly, adaptation to exercise lowers the body's sympathetic activity. Lower sympathetic activity at rest means a lower level of arousal. This new baseline or resting level of arousal may not be adequate for various daily activities and may be experienced as a lethargic or energy-lacking state. This prompts the person to do something about it to increase the level of arousal. The obvious means to do that is exercise. However, the effects of exercise in increasing arousal are only temporary and, therefore, more and more bouts of exercise may be needed to trigger an optimal state of arousal (Figure 4.2 and 4.3). Further, not only the frequency but also the intensity of exercise sessions may need to be increased due to training effect. Such an increase accounts for the tolerance in the addiction process. The key dilemma with this model is that sympathetic adaptation to exercise is universal, so it occurs in everyone, but only about 3% of the regular exercises become addicted to the behaviour (Sussman, Lisha, & Griffiths, 2011a).

Figure 4.2. Decrease in resting heart rate after training reflecting a reduction in arousal.

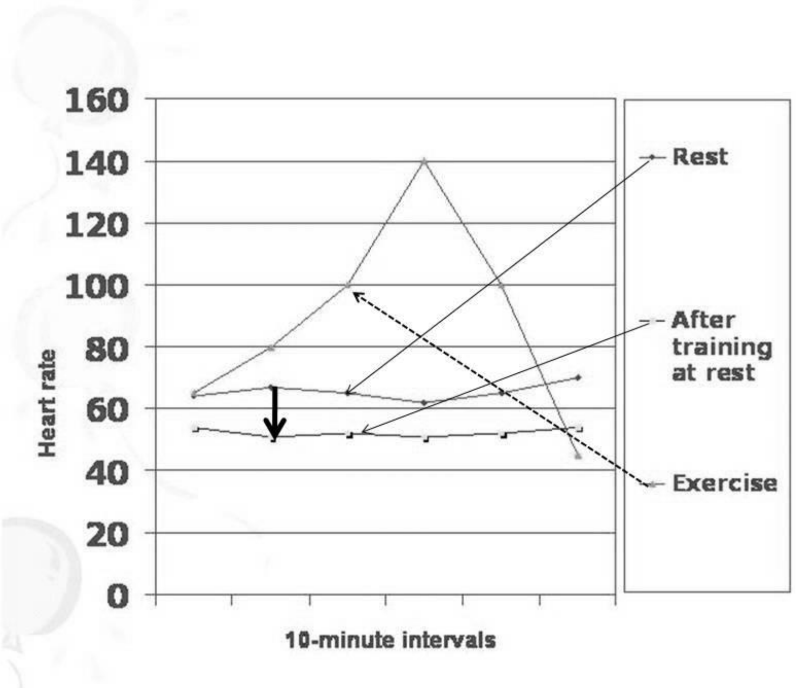

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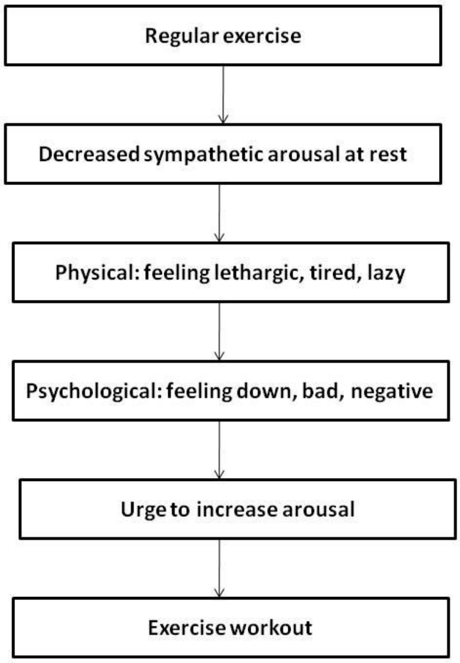
Figure 4.3. The "Sympathetic Arousal Hypothesis" in the explanation of exercise addiction.



4.5.2 A stress regulating model for exercise addiction

Another model that I have proposed 20 years ago is the Cognitive Appraisal Hypothesis (Szabo, 1995). This model takes in consideration life-stress in the addiction model. Some (but not known who) exercisers may try to escape from ongoing or sudden stress by using exercise as the means of coping with stress. Once exercise is used for coping with stress, the person depends on it to function well. She/he expects and believes that exercise is a healthy means of coping with stress based on information from scholastic and public media sources. Therefore, the person is using rationalization to explain the exaggerated amount of exercise that progressively takes a toll on other obligations and daily activities. However, when an interference of exercise with other obligations forces the exerciser to reduce the amount of exercise, psychological hardship emerges, which is known as withdrawal symptoms. In fact, the loss of exercise means loss of the coping mechanism. Consequently, the exerciser loses control, which generates greater vulnerability to stress by further amplifying the negative feelings associated with the lack of exercise. The problem could be resolved only through the resumption of the previous pattern of exercise often at the expense of the other obligations in the daily life (Figure 4.4.). While this model depicts exercise addiction as a means of coping or escape, it only accounts for the maintenance of addiction, but not for its onset.

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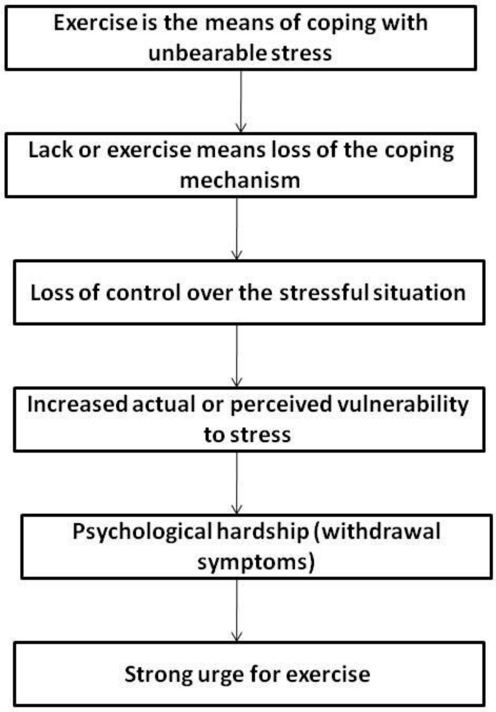
Figure 4.4. The "Cognitive Appraisal Hypothesis" explanation for exercise addiction.



4.5.3 The four phase model for exercise addiction

A 'four phase' model for exercise addiction was proposed recently by Freimuth et al. (2011). The first phase is characterized by the pleasurable activity while the behaviour is under control. There are no negative consequences in general, but rarely muscles soreness or minor strains may occur. In phase two, the psychological beneficence of exercise is realized and the mood-modifying effects may be adopted for coping with hardship. Addiction is most likely to occur when exercise becomes the primary or the sole means of coping with stress. This part of the model may address the onset of exercise addiction, but it does not specify two key issues: 1) a distress must exist, whether progressively mounting or suddenly appearing, and 2) under what conditions or influences will exercise be adopted for coping with the stress? The third phase is characterized by the rigid organization of daily obligations around exercise, negative consequences due to exaggerated exercise, and several forms of exercise either for replacing or complementing the habitual mode of exercise. Further, exercise is performed individually, rather than with friends, in a team, or during scheduled fitness classes. The fourth and last stage contains the typical symptoms of fully manifested addiction like salience, tolerance, conflict, need for mood modification, withdrawal symptoms and relapse. While the model is appealing, it does not account for the choice of coping mechanism and it does not explain who and why - from among the exercisers - will become addicted (Figure 4.5).

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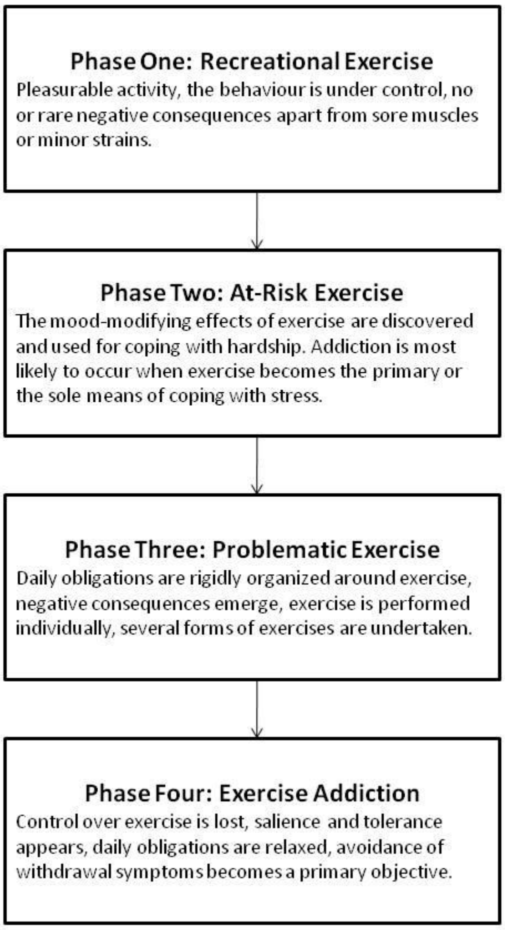
Figure 4.5. The "Four-Phase Model" explanation for exercise addiction.



4.5.4 The "Biopsychosocial" model for exercise addiction.

A "Biopsychosocial" model for exercise addiction in elite athletes was also proposed recently (McNamara & McCabe, 2012). The model is questionable for at least two reasons: 1) "How many chocolate factory workers are addicted to chocolate?" - In other words, if behavioural addictions are means of escape from major stress (Korolenko, 1991), the escape needs to happen when the pain dictates or the urge arises. Elite athletes have a training regimen that is *scheduled* for them, in group settings and at a prescribed intensity. The latter three are not characteristics of exercise- or any other behavioural or chemical addiction, because the compulsive urges that tend to dominate the person's behaviour - after she/he has lost control over the addictive behaviour - need instant(!) gratification. 2) The model has a biologically determined onset, like body mass index (BMI), given as an example by the authors (McNamara & McCabe, 2012). If we consider seriously that most addictions are forms of escape from a painful reality (Korolenko, 1991), then while biological factors affect psychology, the route of addiction(s) may be - most likely -of psychological origin. The biopsychosocial model (Figure 4.6) states that exercise addiction has a biological factor (e.g. BMI) on its route of origin in the elite athletes. Social and psychological processes may interact to determine whether exercise

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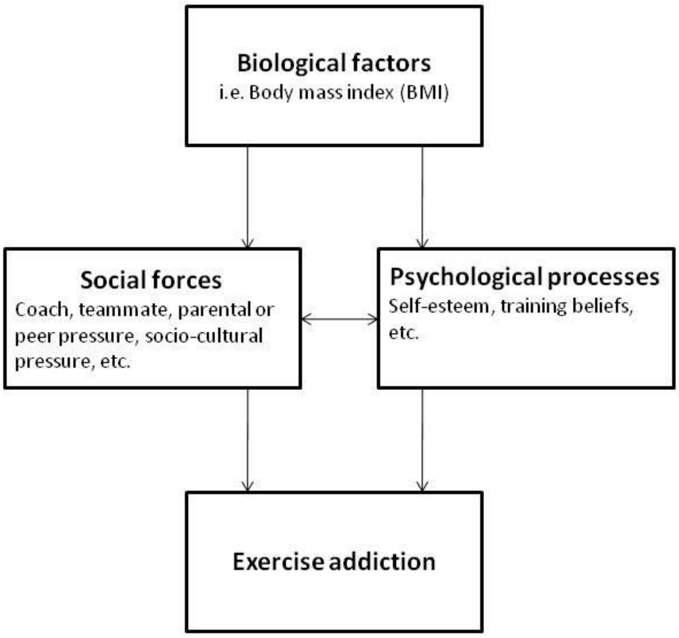
addiction will occur or not. Freimuth et al. (2011) warned that hard training, for long hours, and ambitious strivings in becoming the best of the best that characterizes successful elite athletes, should not be confused with symptoms of addiction in spite of the fact that there is overlap in the latter. This point of Freimuth et al., is fully endorsed for the two principal reasons discussed above.

Figure 4.6. The "Biopsychosocial" explanation for exercise addiction.



4.5.5 The "Interleukin-6 (IL-6)" model for exercise addiction

A theoretical model accentuating the possible role of interleukin six (IL-6) in exercise addiction has been proposed by Hamer and Karageorghis (2007). According to the model, an unidentified trigger causes IL-6 levels to rise and generate cytokine-induced sickness behaviour that is linked to negative affect. In individuals affected by psychological hardship an elevated level of IL-6 could yield even more negative mental state. However, the IL-6 hypothesis may not account for the possibility that some individuals will resort to exercise while others may reach for chemical means of escape. The low prevalence of exercise addiction is ascribed to possible adaptations to exercise, whereas the lack of it may increase vulnerability to exercise addiction (Figure 4.7). Overall, the circumstantial connection between IL-6 and mood is insufficient to justify this model.

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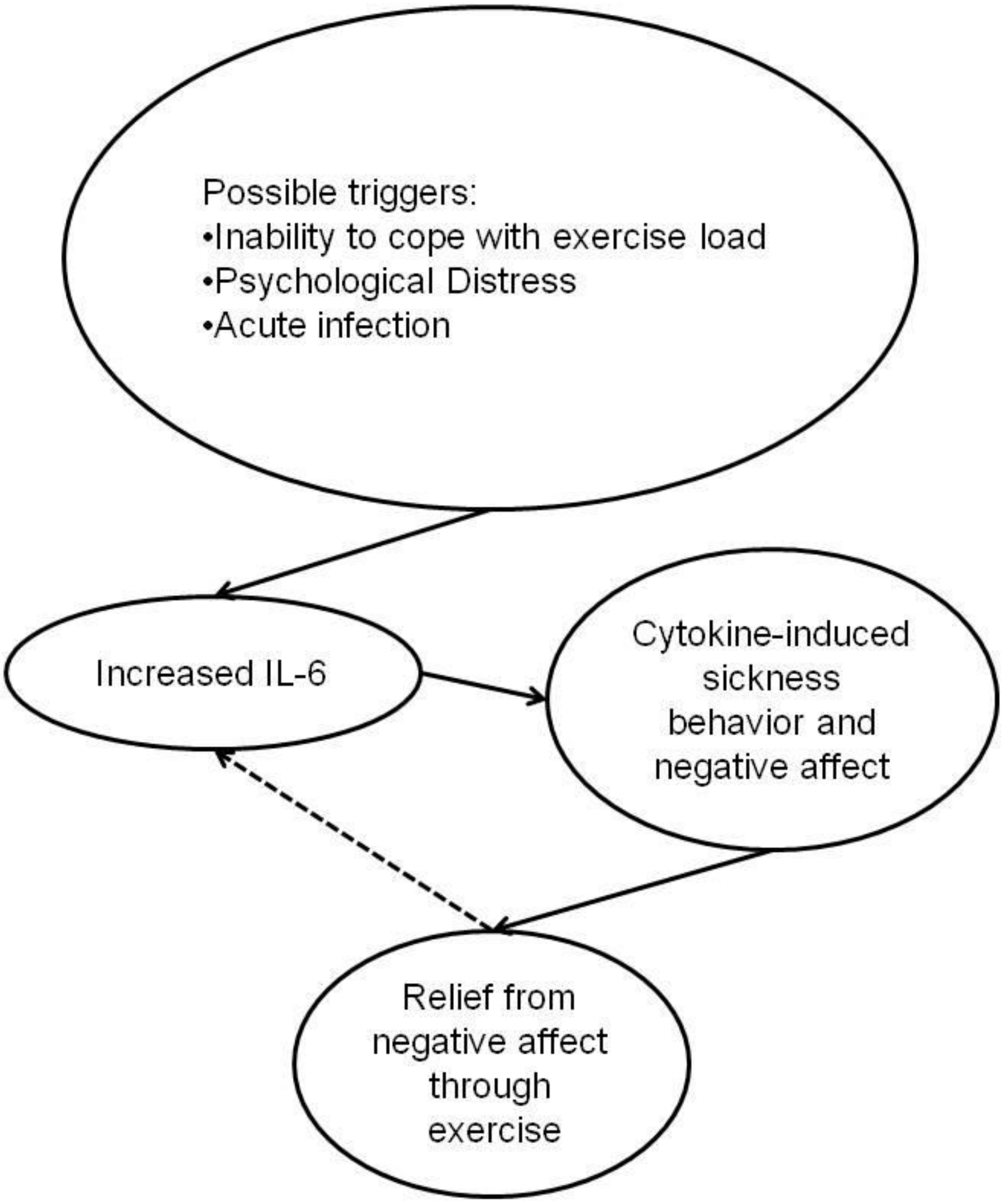
Figure 4.7. The "Interleukin-6 (IL-6)" explanation for exercise addiction.



The review of the extant models that were specifically forwarded for the explanation of exercise addiction clearly reveals that there is inconsistency in the research perspectives from which this behavioural addiction is examined. Simply and perhaps crudely summarized, according to the Sympathetic Arousal Hypothesis most habitual exercisers may be affected by exercise addiction, a fact that is unlikely with a mean estimate of 3% (Sussman et al, 2011a); the Cognitive Appraisal Hypothesis accounts for exercise addiction only after the behavior has been adopted for coping with adversity, and cannot explain who / why chooses exercise as a means of coping; the Four Phase Model is a hierarchical / developmental model, but again it does not address when and who would rely on the mood-moderating effects of exercise for coping and with specific (?) adversities or stress. The way the model may be interpreted is that all exercisers who discover the mood improving and other positive psychological results of exercise may become addicted while coping with stress; The Biopsychosocial model that was developed for elite athletes has unconvincing theoretical background in the context of the freedom of choice to satisfy cravings and urges inherent in addictions. Finally the IL-6 model may be an intermediary in the aetiology of exercise addiction, but it cannot account neither for the trigger in raising IL-6 levels nor in exercise-related consequences, since according to the model some exercisers may be affected while others (with adaptation) may not. Therefore, a model accounting for the adoption, maintenance, and transformation of the behaviour - and therefore addressing the exercise paradox - is needed for a consistent conceptualization and research framework in the understanding of exercise addiction as a clinical morbidity.

4.6 An Expanded Interactional Model for Exercise Addiction

A shortcoming of the existing models for exercise addiction is the determinant(s) of the choice of exercise as a means of escape from hardship. Here it is strongly stressed, that an interaction between personal values, social image, past exercise experience, and life situation jointly determine whether one will use exercise for coping or resort to other means of dealing with stress. The possible number of interactions between personal and situational factors is so large the each case is idiographic in a mindset resembling a secret “black-box”. The box could only be opened after diagnosis with the help of mental health professionals. Indeed, exercise addiction, unlike other chemical and/or behavioural addictions, has a unique characteristic not present in other addictions, which is the physical challenge or work. It was proposed, based on preliminary laboratory evidence, that exercise acts as cathartic-buffer for stress (Szabo & Tsang, 2003). Habitual exercisers when experiencing stress - knowing the mood improving effects of exercise from past experience (Freimuth et al., 2011) - may resort to exercise to cope with the challenge. However, not all exercisers will try to reduce the pain of a novel emotional hardship with exercise, but instead may resort to passive forms of escape behaviours or addiction(s). Therefore, a model taking into account the personal aspects interacting with social-environmental factors may be necessary for the better understanding of the genesis of exercise addiction in the affected individuals. Indeed, a positive relationship was established between exercise addiction risk-scores and trait anxiety (Coen & Ogles, 1993), perfectionism (Cook, 1996), and obsessive compulsiveness (Spano, 2001). Further, it was reported that neuroticism, extraversion, and agreeableness could predict symptoms of exercise addiction (Hausenblas & Giacobbi, 2004). Finally, gender (Cook, Hausenblas & Rossi, 2013) and sex role orientation (Rejeski, Best, Griffith, & Kenney, 1987) may also have mediating roles. The large combination of subjective psychological factors interacting with situational variables may render difficult if not impossible the scrutiny of exercise addiction from a nomothetic perspective.

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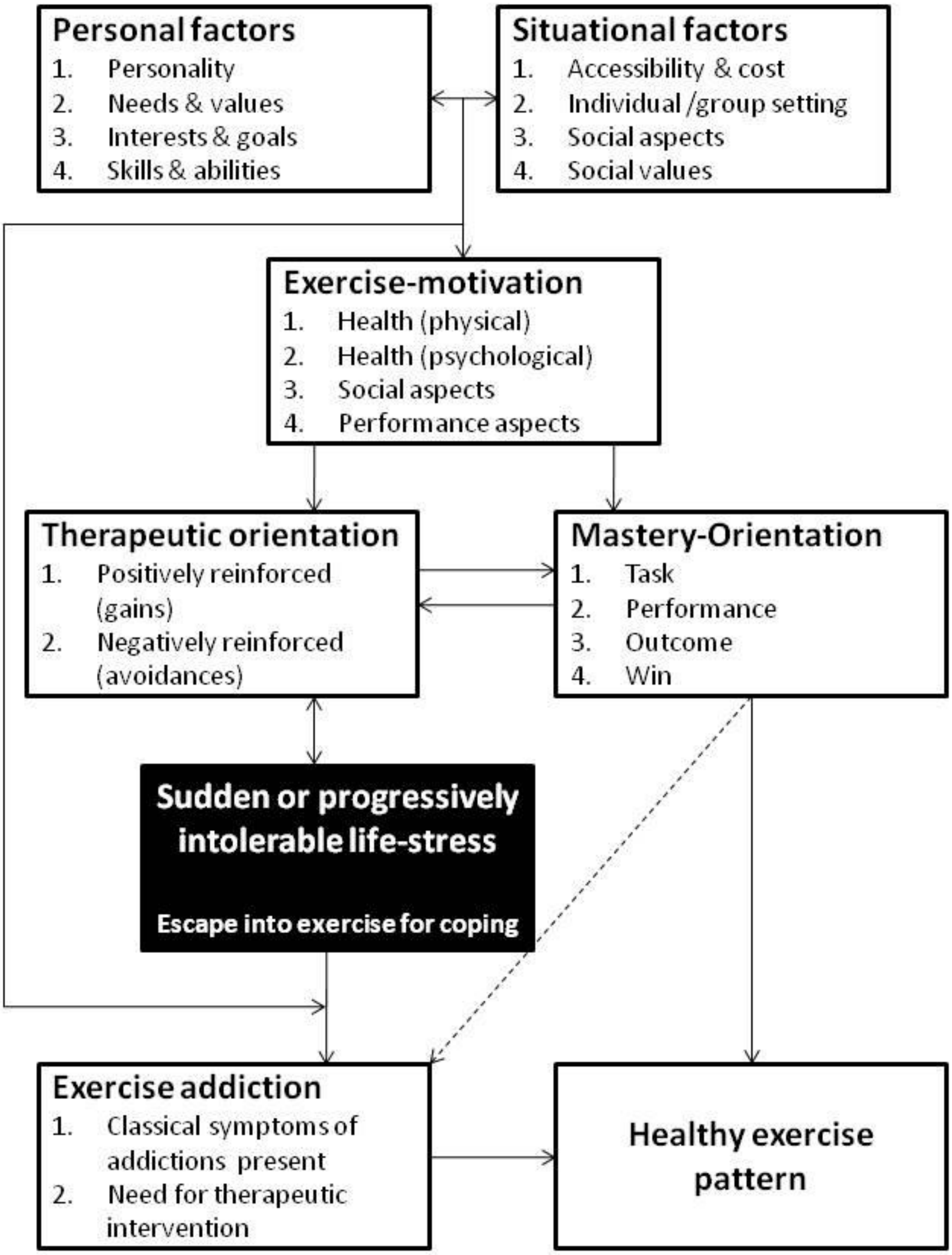
4.6.1 A new model stressing the idiographic nature of exercise addiction

The model presented in Figure 4.8 is an interactional model for exercise addiction (Egorov & Szabo, 2013). It is in line with the proposed PACE (Pragmatics, Attraction, Communication, Expectation) model of addictions in general (Sussman et al., 2011b). In the current model (Figure 4.8) a complex set of personal factors interact with a number of environmental - and/or situational - factors to determine the primary motive for exercise behaviour. These motives diverge in two directions (Robbins & Joseph, 1985). A health (mental or physical) motivated individual, for example, may run for better or improved health (gain health) and/or to prevent ill health consequences like gaining weight, being lethargic, etc. Both incentives are therapeutic in nature. However, health motives could also have a mastery-orientation, like becoming stronger and lifting more weight (performance orientations), or concentrating better and being more productive at work. If better concentration would be the aim, a therapeutic-orientation would be established, but if the expected consequence of the better concentration (productivity) is the objective, then the mastery orientation is the driving force.

The most important component of the here proposed model is the consideration of a suddenly emerging reaction, determined by a set of idiographic (i.e., personal and situational) interactions in the black-box to an ongoing and no longer bearable - or suddenly appearing - life stressor that causes psychological pain over which the individual has no control. This component accounts for the surmise that exercise addiction is not evolutionary, or slowly progressing, but rather revolutionary, or suddenly surfacing (Szabo, 2010). At the moment when the situation gets out of control, a person will "gravitate" towards a means of available coping in accord with the 'Pragmatics' phase of the PACE model (Sussman et al., 2011b - see. Figure 4.9). The choice is determined by conscious and subconscious interactions (in the black-box) between individual aspects, situational factors, and antecedents of exercise behaviour, in accord with the 'Attraction' component of the PACE model, in a similar way as the motivation for exercise is initially determined. Accordingly, even mastery-oriented exercisers may now shift focus to the therapeutic aspects of exercise and get more involved in it to get rid of the painful stress. This attentional cognition is also in line with the 'Communication' factor in the PACE model in that experience, inter- and intra-personal thought, beliefs and convictions will influence the escape path or the choice of the individual. For example, the lack of experience with alcohol, tobacco, or leisure drugs in conjunction with long exercise history and positive beliefs about exercise (media, social, health values) all interact with unique personal factors during the effort of coping. An already 'therapeutic' exerciser in the model, is more likely to choose exercise for coping. Then, also in agreement with the PACE model, the greater the expectation linked to exercise, the more unlikely that the exerciser will turn to other forms of addictions. Perceived as a *positive addiction* it is much easier to hide behind exercise whilst maintaining one's reputation in the social environment, in contrast to other forms of addictions bearing a strong negative social stigma.

Figure 4.8. An interactional model for the better understanding of the exercise paradox.



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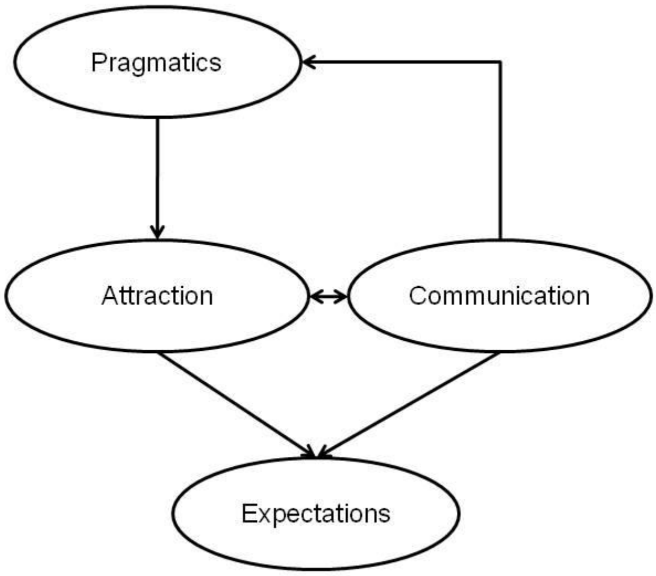
The PACE model was proposed for behavioural addictions in general (Sussman et al., 2011b). While the current model is in harmony with the PACE model, it is specific to exercise and highlights how orientation, experience and personal-situational interactions could all play mediating roles in the manifestation of exercise addiction. Past research long ago has revealed that addiction risk is higher in those who exercise for escaping the stress or changing their emotions, or physical appearance to improve self-esteem as compared to those who exercise for mastery reasons (Thornton & Scott, 1995). Indeed, Baker et al. (2004) proposed a model for drug addiction in which addictive behaviour is sustained through negative reinforcement in an effort to avoid negative affect. Szabo (2010) also argued that exercise addiction is motivated by negative reinforcement. However, initial therapeutic orientation, like losing weight and/or gaining muscles, may - following fulfilment of the goal - turn into mastery orientation and be maintained within the spectrum of healthy exercise pattern. Then, as the bidirectional arrow (refer to Figure 4.8) indicates between the therapeutic-orientation and major life-stress (black), it is possible that through therapeutic exercising - without addiction - one could master the situation and re-establish a healthy pattern of exercise whilst coping with adversity in a healthy way.

Figure 4.9. Pragmatics, Attraction, Communication, Expectation (PACE) model for behavioural addictions.



A broken arrow (Figure 4.8) from mastery orientation to exercise addiction accounts for the unlikely and possibly rare occurrences when an athlete would jeopardize her/his health to stretch the personal limits. It must be stressed that the key reason beyond overtraining - which eventually will be unsuccessful due to strain, injury and staleness - could be traced to mental or psychological origins: 1) the athlete is unable to accept and to realize rationally a personal limit; 2) the athletes strive to beat the own or past (other's) record at any cost or else the athletic career was meaningless, 3) pressure from a past failure, or an unpleasant experience, generates a psychological need to *prove* oneself at whatever cost. While these motivations could fuel exaggerated exercise behaviours, the route and path leading to the manifestations of the behaviour is different from that of exercise addiction. In fact, the broken arrow may reflect instances of exaggerated training whilst chasing of dream (or illusion) that an athlete cannot give up. As such, it may be more closely defined as obsessive-compulsive behaviour rather than addiction. It should be noted that addiction involves compulsion and dependence (Berczik et al., 2012) and the latter may be absent in mastery situations, and, therefore, marked with a broken arrow. Realizing that the existing models for exercise addiction are incomplete, Egorov and I present a new more comprehensive interactional model (Figure 4.8), complementing the extant theories. We offer this model for the sake of clearer conceptualization of exercise addiction. Nevertheless, this dual interactional model has a subjective or idiosyncratic component, that interacts with objective situational elements, for which the nomothetic perspective and scholastic research may not account for. Therefore, the message of the work is that researchers should clearly distinguish between the *risk for exercise addiction* that may or may not end up in morbidity and the actual clinically *diagnosed* cases of exercise addiction. The scope of the model presented in here is to draw a line between *risk* and *morbidity*. The exercise addiction literature, apart from a few case studies, deals with estimates of risk that may never turn into actual morbidity.

4.7 Idiographic Approach to the Assessment of Exercise Addiction: Case Studies

4.7.1 Anna (when exercise means life itself)

This first case study in exercise addiction was reported by Veale (1995). I summarize the case with brevity and focus on the key issues. Anna (her fictive name) was a 27-year-old university educated woman. She was single and unemployed. Anna did not seek help for exercise related behaviour, but she responded to a call by Veale for talking to people who consider themselves addicted to exercise. Anna trained for marathon races and had an excellent personal best time of 2 hours 40 minutes. Her weekly exercise regimen included 15 miles of cycling each day and running twice a day except two days a week, when she ran only once. Anna also engaged in weight training twice a week. While her total amount of running was not seen as excessive by Veale (1995), she had no other interests in life. Running or exercise meant life itself. Anna saw her running as a compulsion (quote: "I've got to do it"). Clearly, her exercise behaviour was motivated by negative reinforcement. She would experience withdrawal symptoms that included depressed mood, insomnia, restlessness, and uncertainty at the times when she was obliged to reduce her training due to an injury. Anna even ended up in a casualty department as a result of her severe withdrawal symptoms, but she did not

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receive psychiatric help. The very severe withdrawal symptoms point to an addictive pattern in her exercise behaviour. Anna's life was running; she described her life-goals as (quote): "to run till I die". She wanted to represent her country in the Olympic games. This attitude, reflecting that everything revolves around the exercise in her life, shows evidence of salience. Another typical symptom of addiction was that Anna continued to exercise in spite of injury or health difficulties. Indeed, she was running while having severe back pain and other health problems. According to Veale, once she ran a marathon with a high fever from German measles. She did such things more than once. On another occasion, when she had a fever, she had to stop after 16 miles. Conflict is also evident in her case. Anna lost her partner because of her excessive exercise and there were frequent arguments and conflicts with her family about the volume of her exercise that has damaged her health. She was unemployed, because she did not want work to conflict with her training routine. Anna showed no manifestation of psychiatric or eating disorders However, she was concerned about her weight and appearance because she considered herself as being too fat for a runner. She was a vegetarian and, skipped lunch sometimes, but she could not be diagnosed with an eating disorder. Her laboratory (blood) tests were normal and her menstrual cycles were also normal. There was a family history of depression from her mother's side and she herself had a past history of a depressive episode at the age of 18. Veale (1995) suggests that her exercise could be considered as a means of preventing a recurrence of her depression (a form of coping), even at the expense of her physical well-being. Clearly, Anna displayed all components of addiction (Griffiths, 2005). Her case fits well the interactional model model that I have proposed with Egorov (Figure 4.8 above). Her running exhibits both, mastery and therapeutic orientation, and if Veale is right in his presumed diagnosis, the black box in the model embeds Anna's depression, or fear of depression. Nevertheless, it may also hide the means of coping with losses (i.e., partner) and/or compensation for neglecting all other possibly rewarding aspects of life (Anna's life was running itself). The negative consequences, stemming from her exercise, that may be considered as the fine line between high commitment and addiction to exercise (Szabo, 2010), were clearly evident in Anna's case.

4.7.2 Joanna (typical symptoms of addiction)

In the second published case study on exercise addiction, Griffiths (1997) described the story of Joanna (not the person's real name) who was a 25 year old woman exhibiting problematic exercise behaviour. Joanna had a good education and reported a stable background. She paid attention to her eating habits, which was deemed adequate and healthy. Joanna saw herself as being in an excellent physical condition. She had practiced a martial art known as Jiu-jitsu, that was her main hobby. She started the sport in her late teenage years and she thought about herself to be a very good amateur of the sport. Joanna did not use anabolic steroids or other forms of performance enhancement agents. Jiu-jitsu was the most important activity in Joanna's daily life, reflecting the *salience* component of the addictive behaviours. Several times a day, while doing other things, Joanna was thinking about her next training session or competition. She claimed that she spent about six hours a day (or more) in training, but the total included other forms of exercises than Jiu-jitsu, like weight training, jogging, or general exercise. A year before the interview, she walked out of a final exam to catch a train and travel to a Jiu-jitsu competition in another town. She got behind with her studies due to her high volumes of exercise that left little time for education. Joanna enjoyed exercising both in the morning

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and evening. When she missed a morning session, she had a longer or an extra long evening session to compensate for it. Moreover, she started to go swimming during her lunch break. The increasing amounts of exercise illustrate how Joanna's behaviour was affected by *tolerance*, another common component of exercise addiction and other addictions as well. Indeed, she started Jiu-jitsu at an evening class once a week in her teens and built up progressively over several years. At the time of the interview, she exercised every day and the duration of each session was getting longer and longer. When she could not practise Jiu-jitsu, she had to do other forms of exercises. Joanna said that she became highly agitated and irritable when she was unable to exercise, pointing to the presence of *withdrawal symptoms*. At the time when her arm was bandaged up because of injury, she went for a three-hour jog instead. She also exhibited physical symptoms, like headaches and nausea if she had to go for more than one day without exercise or if she had to miss a planned exercise session. These symptoms are clearly pointing to strong feelings of deprivation when exercise is prevented for any reason, mimicking or being identical to withdrawal symptoms in chemical addictions. Joanna also experienced positive *mood changes* and euphoria in a number of ways. She was in a very good mood if she had a good Jiu-jitsu session or a successful competition, as well as when she won. She also felt satisfied and euphoric after a hard and long training session. Joanna was productive in other life-areas, like academic work, for example, only if she has fulfilled her need to exercise. She claimed that she often trained until very late at night, and upon fulfilling her exercise, she was able to study throughout the rest of the night. Joanna's relationship with a long term partner has ended as a result of her excessive exercise behaviour. She admitted that she never spent enough time with him, leading to *conflict*, but she was not sad because of the breakup. Joanna felt that she had become "a bit of a loner" (p. 165) having fewer and fewer friends as a result of her excessive exercise. She also felt that her studies have suffered because of the little time and major difficulty in concentration. She also acknowledged that she was spending too much time with her exercise and knew that she had other important life-obligations that she has neglected. Joanna affirmed that she could not resist the urge to exercise and her exercise sessions must last a minimum of a few hours. She claimed that she was not able to concentrate during her lectures at the university, or to study at home, unless she has satisfied her need to exercise, that reflects the *loss of control* over the behaviour (i.e., exercise). The *relapse* aspect of the addiction was also present in Joanna's case. She could do only a few days without exercise before her day became unbearable. If she missed a competition, that was just as bad. She tried to stop and/or cut down on her exercise, but she was unsuccessful. Joanna became very anxious if she was unable to exercise and got better (*relief*) only after the next exercise session. She was fully aware of the fact that exercise has taken a toll in her life, but felt powerless to control it. Joanna experienced many negative consequences stemming from her maladaptive exercise behaviour. She spent lots of money, beyond her means, to keep up with her exercise habits. She also travelled a lot and spent much time between two towns. Therefore, she had several dual memberships in various exercise settings. Joanna was in financial debt because of her low income as a student, as well as because of the high expenses associated with exercise and travelling to, or participating in, Jiu-jitsu competitions. She said that she had to resort to socially unacceptable means of getting money for herself (the act was not disclosed). Joanna suffered a sport-related re-injury at the time of the interview. She was worried about her arm that was not given enough time to heal properly because of the urge to train. Her doctor has advised her to give up the sport before suffering permanent damage to her arm. However, Joanna felt that giving up was not an option and that she would not do that in spite of the risk of an irreversible loss. Griffiths (1997) published the interview with Joanna, because he saw clearly the components of exercise addiction in her case. All typical symptoms were present, but the route or the cause of addiction was not identified. Therefore, the triggering cause(s) of the maladaptive exercise behaviour in the black box of the interactional model (Egorov & Szabo, 2013) could not be determined in Joanna's case.

4.7.3 Jackie (salience, tolerance, loss of control)

Jackie was a primary school teacher in Bristol, UK. She started exercising regularly in her mid twenties. Her devotion to exercise has increased progressively. She has not only needed more of it, but also several forms of it. She ended up exercising three hours every day in three different racquetball sports, aerobics classes, and circuit training. This was still not enough for Jackie. She started going for a walk during her lunchtime instead of being with her colleagues, then after work she went for a 2 hour run and on the same day in the evening she went for 3 hours in the gym. Now her total daily exercise time added up to 6 hours. At this pace she had to quit her work, while still increasing her daily exercise to 8 hours! Below is a quote from Jackie's testimonial published in the London Daily Standard about 15 years ago:

> *"I moved to a new town and decided to join a health club as a way of meeting people. Soon, exercise began to become a focal part of my life and I became more determined to keep fit and improve my physique. Gradually the three hours a day I was doing increased to six hours and I started to become totally obsessive about exercise. I wouldn't miss a day at the gym. I just lost sight of my body really - I just had to do my workout, come what may, and get my fix."* (Source: Evening Standard, 01/08/2000).

This testimonial published in a daily newspaper is another very vivid example of exercise addiction. Unfortunately, like in the case of Joanna, the reason beyond Jackie's addiction remains a mystery. The negatively reinforced aspect of the behaviour is evident from Jackie's words: " *I just had to do my workout,...*". She had to do or else she would have had experienced a bunch of negative symptoms. The tolerance, reflected by the increase in the amount of exercise, is also evident. The salience facet of addiction is reflected by the words: " *Soon, exercise began to become a focal part of my life...".* Did she and Joanna escape from something? Or, did exercise provide some sort of order or safety for these two young women? One assumption could be made: Both Joanna and Jackie needed to experience the psychological effects of their exercise, and they needed more and more, even at the expense of other life obligations. Was exercise a conditioned behaviour for them, used to escape from something unpleasant? Or simply a vehicle to avoid unwanted chores and/or tasks that caused major stress in their daily life? Knowing, and not speculating, the reason behind their behaviour would be very useful in the better understanding of the manifested maladaptive exercise behaviour.

4.7.4 Mr. M. Y. (co-morbidities, psychopathology, and other addictions)

The story of this lonely man has been brought into the attention of the scholastic community only very recently by Kotbagi, Muller, Romo, and Kern (2014). Mr. M. Y. is a 50 year old cyclist. He showed up at the Center for Support and Prevention of Athletes (CSPA) at Saint Andrew Hospital in Bordeaux, France, to seek help for his maladaptive exercise habits. He has experienced conflict in personal affective partnerships, that resulted in the breakup of his relationships. The conflict was due to his unavailability - because of too much time spent with exercise - for nurturing a relationship. He started cycling at the age 15 and continued without interruption. At the time of the interview he trained 10 hours a week and participated in one or two races each month, during the weekend. There was no history of athletic training in his family, but his father supported and encouraged him in his training and competition. Between 1980 and 1987, M. Y. participated successfully in nearly 100 races each year. He had a short experience with a performance enhancer in 1982, but gave up the habit upon advice from his cycling mates and coaches. His personal life was also fulfilled in this period that M. Y. remembers nostalgically. Due to his only average physical condition he could not become a first class professional cyclist. However, he still competes at regional level where he gets good results. In fact, he trains hard to become national champion in his age category. In his personal life, M.Y. works at night to get more time for training. He lives alone since his divorce. He met a woman on the Internet, but the relationship failed and he had a depressive relapse.

His exercise behaviour is very stereotypical. He follows the same training programme that he started when he was 15, he follows and cycles on the same path, the same number of hours and the same distance. His training log-book dates back to 1979. He follows the same warm up rituals in preparing for competitions. All his life seems to be centred around cycling. He plans his holidays in accord with the cycling races. M. Y. matches his cycling outfit to the colour of his bicycle on which he spends large amounts of money. He derives pleasure from visual self-observation. While cycling, he enjoys passing by a reflective window or mirror and seeing his own reflection in it. He expresses tolerance in his cycling pattern, because over the years he needs more and more training to feel good about himself. When he is unable to train for any reason, he experiences severe tension and anxiety that affect his work and the subsequent races. At this time, he also experiences fear of ageing and sadness. M.Y. has a poor social life, because his life-priorities revolve around cycling.

Symptoms of other behavioural addiction were present between 1980 and 1986. Part of these symptoms were suggestive of compulsive shopping. However, M.Y., at this time, also manifested behaviour that was clearly pointing to sexual addiction. For example, he had several sexual acts with different partners each day and he experienced severe urges to masturbate, that are no longer present at this time. While eating disorders were not apparent in M.Y.'s case, he showed past concern for his body, especially with respect to his shape and muscularity. Currently he weighs only 65 kg, while his height is 1.80 m.

M.Y. also had a history of psychiatric disorders. Apart from experiencing generalized anxiety disorder and being treated for depression, he also attempted suicide in his early years. His score on an exercise addiction questionnaire was high. (However, without information about his training habits and personal-social life-environment, the questionnaire datum would not be enough for a diagnosis.) Indeed, Kotbagi et al. (2014) have approached the problem in the right direction. First, they have established a case history that has revealed most of the symptoms of exercise addiction in conjunction with co-morbidities. The stereotypical behaviour, the following of the same routines as at age of 15, shows the inherent need for stability and control. M.Y. had, in general, a poor social life and a series of unsuccessful romantic relationships following his divorce. The discomfort, lack of control, and hindrance of repressed needs in this context may have been self-vindicated, at least temporarily, by training. Cleary, a number of major negative events, like not making the professional team, divorce, loss of control over sexuality, all may have driven M.Y.'s exercise addiction and be either triggering or fuelling "items" in the black box (subjective anguish requiring coping) of the interactional model proposed by Egorov and myself. Perhaps, the only stability in his life, over a period of 35 years, was his cycling. Exercise addiction in case of Mr. M.Y. was an escape from the unknown, uncertain, or unreachable into the predictable, stable, and accessible. However, even cycling had to be performed in a stereotypical way to yield the anticipated feelings of safety, stability and reassurance. Cycling was a *controllable mate* to M.Y. According to the authors, his psychological condition has improved after a four-phase cognitive-behavioural therapy at CSPA.

4.7.5 Tara (blame it on stress; further evidence for the interactional model)

Tara disclosed her case on the Internet. From a scholastic perspective, one may use doubt and treat this type of information with care. However, unless Tara is an expert in exercise addiction with the intention to mislead people, her story looks very real and fits the recent interactional model of exercise addiction (Figure 4.8; Egorov & Szabo, 2013). The quoted full personal story is presented in Appendix P with highlights on typical symptoms of addiction. Tara used exercise as a switch-off from the busy life she lived. Her exercise motivation was health related, mostly focusing on the psychological benefits, that was initially positively reinforced. Exercise became more important than her physical health, as she admits it, and she turned to exercise for coping with her emotional challenges. The (negative) reinforcement was the psychological relief experienced following each bout of exercise. The behaviour fits the therapeutic orientation if the interactional model, in which the initial positive reinforcement started to be replaced by negative reinforcement over time. In other words, Tara *had to do* her exercise to cope with her emotional hardship. Then, suddenly not one, but several life-stresses took a toll on Tara's life. Quote: "*when it rains, it pours*". These series of life-events (the black box in Egorov and Szabo's model), including the conflict in her relationship, changing jobs, not being able to complete a task given by the current employer, and a turbulent family life, all stroked at once. Instead of talking to her friends, Tara escaped into exercise for coping with adversity. I will not continue the story, since it is presented in detail in Appendix P, but I will highlight that the outcome of her addiction was the permanent damage to her health at a very young adult age. She returned to healthy exercise patterns (Egorov and Szabo's model lowest two boxes, Figure 4.8), after realizing, with medical intervention, that she already suffered irreversible damage to her health. Tara's story was published on the Internet after Egorov and Szabo (2013) published their model, but it illustrates clearly, that there is a "black box" in the life of the exerciser that may contain not one, but a large number of personal pain and anguish, which in turn trigger health-damaging morbid patterns of exercise. This voluntarily disclosed personal case clearly illustrates the fitting explanation of the model for exercise addiction. It also shows that exercise addiction is set on fire by very subjective life events that cause stress and pressure for the person. In Tara's case it was the personal and family life, as well as work life, that pulled the trigger. In other cases, may be the loss of a job, loss of a partner, feelings of helplessness, etc. In most cases, however, I suspect that passive stress (in which the person has *no control* over the event) triggers the maladaptive behaviour more often than active stress, but the latter cannot be excluded either. Currently, I am collecting case studies, similar to Tara, Anna, Joanna, and Jackie with an international team. We try to identify the variety of the triggering causes of the pathological exercise behaviour. I strongly believe, that nomothetic questionnaire-data may only identify people *at risk*, many of who will never develop exercise addiction. Our model with Egorov, stressing the importance of the idiographic factors in the aetiology of the disorder, may be most suitable explanation of this exercise-linked morbidity. However, due to its idiographic central- or core-point, only the antecedents and outcomes of the model may be researched empirically.

4.7.6 Ludmilla (when too much exercise appears to be the solution)

Ludmilla was consulted for an over-devotion to her exercise and physical activity, *without any current manifestation of psychological dysfunction*, as part of an ongoing collaborative project with A. Y. Egorov (Egorov & Felsendorrf, personal communication on 19.10.2014). I summarize and evaluate this case in this section, because it has a unique and paradoxical link with exercise addiction. Ludmilla was often sick during her childhood. She started gymnastics in school, but dropped out. She also engaged in athletics, volleyball, skating, and long distance running. All her exercises were done at the amateur level, with little success. However, she remembers the picture that hung on the board of honour in her school with the slogan: "the best athletes". By the age of 15 she had severe sport injuries. She quit sports after enrolling in college, but sometimes she played basketball. She got injured again. All her sporting injuries may be linked to psychological problems. At age 7, her father died in a car crash. Her mother concealed the news from her for 40 days, but she knew it already the next day, from the kids at school. This caused her severe psychological trauma. She hated the world and felt ugly. At that time she wanted to die. Luda (Ludmilla's nickname) hated her mother because not telling her the truth. Even today, she has a complicated relationship with her mother because of this. The anguish resulted in her having tachycardia. The tachycardia attacks became more frequent, she could not do physical education. She left school at 19 and got married. Soon she started to have "paranoia attacks". She felt that everyone laughed at her, and being jealous of her husband, she was afraid that he would divorce her. She also had severe migraine attacks and menstrual pain lasting for several days. At age of 25, she had another major injury needing surgery, but she has refused the operation. A few years later, at age 29, she had an intense fear of death, because her father died at that age. At this time she radically changed her lifestyle. Luda went back to school, started seeing a psychologist, and paid attention to her well-being. Eventually she graduated with honours. Soon after that, she went to a country club known as "Good Life". She stayed there for several weeks, practiced vegetarianism, abstained from alcohol, and had massages. In the club, she met a woman who advised her to start up fitness. She was very thin and had insufficient muscle and fat that may have been the reason for not getting pregnant. There are still conflicts with her husband concerning their childless partnership. Her life changed on September 30, 2011 when she joined a fitness club. Since then, Luda is running regularly and never misses a fitness class. All her thoughts and talks are about fitness. She also walks 3 times a week, and attends yoga classes on the weekend. Exercise changed her life. Her menstruation ceased to be painful, the migraine attacks have passed, and the tachycardia dissipated slowly. She has experienced improved movement coordination and posture. Luda became physically stronger, appears more muscular, and she is in a good mood. If there was no opportunity to train at the club, she would perform physical exercises at home, or run, because it has become a lifestyle. When her friends go to a birthday party, Luda goes to exercise. Her new friends are from leisure and fitness clubs. She even helps out the fitness instructors by solving personal issues, leading workshops, and planning and organizing exercise sessions (Egorov & Felsendorff, personal communication on

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19.10.2014). In spite of her life revolving around exercise, she scored very low on an exercise addiction questionnaire. Is then Ludmilla affected by exercise addiction? It seems that she had more losses and traumas before than after her exercise life. At this time it seems like Ludmilla has solved most, if not all, her problems with exercise in an efficient and healthy manner. Her exercise addiction score is low. She follows a large volume and possibly exaggerated, but apparently healthy exercise pattern, in that she does not (currently) experience negative effects in her life because of her exercise. Whether this pattern will change or not, remains to be seen.

I have illustrated her case because, ironically the salience, tolerance, mood modification, deprivation-feelings, and possibly conflict (with her husband and/or old friends who are going drinking) are present in Luda's case, but she has not lost control over her exercise. In fact, exercise became a *solution* with positive gains for Ludmilla. Other people may try to run away from stress by escaping into exercise, and experience the opposite effects. The fact that exercise is the solution to a problem for one person while causes anguish instead of solution for another illustrates the paradox of exercise behaviour that is little understood. In the next, and the last case covered, I will present a story in which even a lifelong pattern of excessive exercise presented no problem at all.

4.7.7 Péter (exaggerated amounts of exercise do not imply addiction)

A great misconception is the exercise psychology literature is that high volume of exercise is associated with exercise addiction. Like the mere occurrence of withdrawal symptoms, exercise volume has nothing to do with exercise addiction. To illustrate this point, I need to present Péter's case. "My family is the most important" claims Péter Kropkó (Kropkó & Bene, 2006, p. 149, [translation]) a happily married man, father of two children. Péter is a triathlete who completed 51 times (!) the Ironman Triathlon (3.8-km swimming, 42-km running, and 180-km cycling). Until 2006, Péter was 16 times the "triathlete of the year" in Hungary, and he was undefeated for 15 years in the country. He swam 70,000-km, ran 140,000-km, and cycled 650,000-km throughout his 37 year sporting career (Kropkó & Bene, 2006). Is he sane? Of course he is! I am privileged to know Péter in person, and all his friends and the Hungarian sporting community can confirm that he is a well balanced person, a great father, and an exemplary husband who puts his family first and above everything else. Last time I met Peter in a swimming pool, he was organizing a training camp for young triathletes in the company of his supportive wife and children. I do not wish to make this story any longer in a scientific discourse, but I need to make a point. A person who spent almost all his life exercising and competed in the world's most challenging endurance races, is still able to have a well-balanced and psychologically sound personal and social life, without signs of pathological exercise behaviour, even though the volume of his exercise may seem to be 'pathological' to the average person. In his Hungarian book, describing his athletic life, entitled "*I did it because I believed it*", is no evidence of any maladaptive exercise behaviour, but rather a well-controlled exercise and training regimen that could be an inspiration to all.

It is important to realize that exercise is a behaviour that has healthy and unhealthy aspects, which depend on the person's approach to, and control over exercise. Even the word "moderation" is inadequate for one who expects to conquer the world (like Péter). Even the very large amounts of training do not necessarily imply morbidity, but reliance, obligation, and lack of control, resulting from the idea that exercise will *solve all the problems*, may be at the routes of morbid exercise.

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4.8 Nomothetic Approach to the Assessment of Exercise Addiction: Questionnaires

4.8.1 Strengths and limitations of the questionnaire-based assessment

All the exercise addiction questionnaires could only be used for surface screening or risk assessment, but not for diagnosis. Therefore, the questionnaire method of assessment estimates the *possibility of addiction* in the respondent, *if* the life circumstances drive the person in that direction. Even individuals scoring very high on these questionnaires may not be addicted to exercise. Nevertheless, a score that is close to the maximum may suggest that there is a possibility, or high risk of addiction. Still, the proper and unambiguous diagnosis of exercise addiction could only be made after a deep interview conducted by a qualified mental health professional. Serving well for screening purposes, exercise addiction questionnaires, guide the individual, or those who are concerned, in the right direction. In schools, sport and leisure facilities, they are useful for screening, but many addicted exercisers perform their activity in an informal setting, by simply going out for a run on their own. In fact, it is likely that many, if not most exercise addicts are loners in some sense because no structured physical activity classes or exercising friends could keep up with the spontaneous and the busy schedule of exercise in which they engage on a daily basis. Further, an "addict" needs to fulfil the urge when that arises, whether during the day or night, and scheduled activities do not permit that. An urge is spontaneous, and this is why athletes training massive volumes and extended hours are unlikely to be addicted to exercise. Assuming that only about half to three percent of the exercising population may be affected by exercise addiction (Mónok et al., 2012; Szabo, 2000; Terry, Szabo, & Griffiths, 2004) and that the majority of exercise addicts are “lone wolfs”, the use of the questionnaires may have further limited value in assessment.

Although the assessment of exercise addiction is based on some of the general symptoms of addiction listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM V -American Psychiatric Association. (2013), the latter does not list exercise addiction as a separate category of (behavioural) addiction. There may be several reasons for the omission of exercise addiction from the DSM V. First, the incidence of exercise addiction is very rare. In fact, to the very best of my knowledge, there are only three case studies published in the scholastic literature (Griffiths, 1997; Kotbagi et al., 2014; Veale, 1995). As such, exercise addiction appears to be a phantom morbidity that generates keen interest in the scholastic circles. Some authors question even the existence of exercise addiction in absence of eating disorders (this issue will be discussed later in the context of the concepts of primary and secondary exercise addiction; Bamber, Cockerill, & Carroll, 2000a). Therefore, it is possible that there is insufficient medical or scientific evidence on which the DSM-5 could draw solid conclusions. Second, in contrast to the passive and *let go / let down* attitude common in addictive behaviours, exercise addiction requires substantial physical and mental effort, determination, and self-discipline. These characteristics are paradoxical to the *quick fix* aspects of other addictions. A third reason, that may also be true in other addictions as well, is that exercise addiction, identified on the basis of certain symptoms, may only be a *symptom in itself* of an underlying psychological or mental dysfunction in which exercise abuse is a means of escape from the problem rather than the route of the problem. This presumption is most evident in eating

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disorders that often include massive amounts of painful exercise to lose or maintain body weight. Accordingly, if exercise addiction is more than a symptom of another psychiatric disorder, like the escape from noxious life events (a method of coping), the motives behind this escape or avoidance behaviour need to be examined more closely. However, motives are personal and subjective, and, therefore, it remains dubious whether this examination could successfully take place in nomothetic research or whether it is restricted to idiographic case analyses.

Although key symptoms are critical in the assessment of a health condition, as seen in the previous sections, exercise addiction cannot be positively assessed simply on the basis of the presence or absence of withdrawal symptoms. A combination of symptoms co-occurring is a more precise index of maladaptive exercise. Currently, there are several exercise addiction questionnaires that are based on the most common symptoms of addictions. In general, the frequency and intensity of the symptoms reported by the respondents are computed to yield an exercise addiction score. However, these scores only measure the *degree of* or *the susceptibility to* exercise addiction, rather than positively diagnose the condition. In the following sections, the psychometrically validated tools used in the assessment of the *risk of* exercise addiction will be presented and evaluated.

4.8.2 The Obligatory Running / Exercise Questionnaire (OEQ)

This questionnaire was among the pioneering instruments aimed at the assessment of exercise addiction. It was modified from the original Obligatory Running Questionnaire (ORQ – Blumenthal et al., 1984). Later the OEQ has been modified to a version that is a more general measure of running and exercise activity (Thompson & Pasman, 1991). The new version of the questionnaire (Appendix K) consists of 20 items pertaining to running or exercise habits, which are rated on a 4-point frequency scale: 1-never, 2-sometimes, 3-usually, 4-always. Two of the items are inversely rated during scoring. The psychometric properties of the tool have been well established (Coen & Ogles, 1993). The internal reliability of the OEQ was reported to be α =. 96 and its concurrent validity was r = .96 (Thompson & Pasman, 1991).

Ackard et al. (2002) found that the OEQ (1991 version) has three subscales. These are exercise fixation (items associated with missing exercise and exercise to compensate for perceived overeating), exercise frequency (addressing the frequency and type of exercise) and exercise commitment (indicating a sense of routine which cannot be missed). Ackard et al. (2002) believe that these subscales highlight the multifaceted nature of excessive exercise.

4.8.3 The Exercise Dependence Questionnaire (EDQ)

The EDQ (Ogden, Veale, & Summers, 1997) was developed with a sample of 449 participants who exercised for more than 4 hours a week. The EDQ consists of 29 items and it has 8 subscales: 1) interference with social/family/work life, 2) positive reward, 3) withdrawal symptoms, 4) exercise for weight control, 5) insight into the problem, 6) exercise for social reasons, 7) exercise for health reasons, and 8) stereotyped behaviour. The EDQ was found to have moderate to good internal reliability, ranging from α =. 52 to α =. 84. Its concurrent validity with other instruments has not been reported. Further, certain items assess attitudes and social practices rather than addiction. Consequently, the EDQ has been used only on relatively few occasions in

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researching exercise addiction, but it has been adopted more frequently in studies connecting excessive exercise with various forms of eating disorders. In spite of the availability of more specific and psychometrically more robust questionnaires developed later, the scale is still used by a number of scholars. For example, not very long ago the EDQ has been translated and validated in French (Kern & Baudin, 2011).

4.8.4 Exercise Dependence Scale (EDS)

Hausenblas and Symons Downs (2002b) have developed the Exercise Dependence Scale (EDS). Exercise dependence is described as a craving for exercise that results in uncontrollable excessive physical activity and manifests in physiological symptoms, psychological symptoms, or both (Hausenblas & Symons Downs, 2002b). The EDS was based on the earlier Diagnostic and Statistical Manual of Mental Disorders criteria for substance dependence (DSM IV - American Psychiatric Association, 1994). The scale is able to differentiate between at-risk, non-dependent-symptomatic, and non-dependent-asymptomatic individuals. It can also specify whether people may have a physiological dependence (evidence of withdrawal) or no physiological dependence (no evidence of withdrawal). The 21-items of the EDS are rated on a 6-point Likert frequency scale ranging from 1 (*never*) to 6 (*always*). Evaluation is made in reference to the DSM-IV criteria (APA, 1994), screening for the presence of three or more of the following symptoms, most of them described in the previous section: 1) *tolerance,* 2) *withdrawal,* 3) *intention effects* (exercise is often taken in larger amounts or over longer period than was intended), 4) *loss of control,* 5) *time* (a great deal of time is spent in activities conducive to the obtainment of exercise), 6) *conflict*, and 7) *continuance* (exercise is continued despite knowledge of persistent or recurrent physical or psychological problems that are likely to have been caused or exacerbated by exercise).

A total score and subscale scores can be calculated for the EDS. The higher the score, the higher is the risk for addiction (the authors use the term dependence). The EDS is rated with the aid of a scoring manual that comprises flowchart-format decision rules. The rules specify the items or the combinations of the items that help in classifying the individual as being at risk, non-addicted-symptomatic or non-addicted asymptomatic on each criterion. Individuals who score in the addiction range, defined as 4 - 5 (out of 6) on the Likert scale on at least three of the seven criteria, are classified as ‘at risk’ for exercise addiction. Those who fulfil at least three criteria in the non-addicted symptomatic range, scoring around 3 on the Likert scale, or a combination of at least three criteria in the ‘at risk’ and non-addicted symptomatic range, but did not meet the criteria for exercise addiction, are classified as non-addicted symptomatic. Finally, individuals who fit at least three of the criteria in the non-addicted asymptomatic range (1 - 2 on the on the Likert scale) are classified as non-addicted asymptomatic. It has been shown that the scale possesses good internal reliability (α =. 78 to α =. 92) and test–retest reliability (r = 0.92). Not long after the release of the original scale, improvements in the scale were reported, in a revised version, by the developers (Symons Downs, Hausenblas, & Nigg, 2004). The scale has excellent psychometric properties and it was translated in several languages, including a recent translation in Spanish (Sicilia & González-Cutre, 2011). In spite of its popularity, and reported validity and reliability, the scale is relatively difficult to score and interpret by non-clinicians or professionals lacking the expertise in psychological testing and evaluation.

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4.8.5 Less widely used tools in the assessment of exercise addiction

Prior to the development of reliable psychometrically validated tools for gauging exercise addiction, this condition was investigated with interviews (Sachs & Pargman, 1979) and the *Commitment to Running Scale* (CRS – Carmack & Martens, 1979). However, using the CRS (Appendix C) has been criticized (Szabo et al., 1997; 2010), because addiction and commitment to exercise are two different constructs. While addiction is a dysfunction, commitment to exercise implies involvement in the activity for mastery, enjoyment, and fun (as already discussed earlier).

The *Negative Addiction Scale* (NAS – Hailey & Bailey, 1982) has been used primarily with runners. Its items measure the psychological rather than physiological aspects of compulsive running. Because of its mediocre psychometric characteristics, inference about scores that define a person as addicted to running is hard to be made.

The *Exercise Beliefs Questionnaire* (EBQ – Loumidis & Wells, 1998) assesses personal assumptions about exercise behaviour on the bases of four factors: 1) *social desirability*, 2) *physical appearance*, 3) *mental and emotional functioning*, and 4) *vulnerability to disease and aging*. The scale's internal reliability is relatively good, ranging between $\alpha = .67$ and $\alpha = .89$ and concurrent validity between $r = .67$ and $r = .77$.

Another instrument, the *Bodybuilding Dependency Scale* (BDS – Smith, Hale, & Collins, 1998), was developed specially to assess excessive exercise in bodybuilders. The questionnaire contains three subscales: 1) *social dependence* (individual's need to be in the weightlifting environment), 2) *training dependence* (individual's compulsion to lift weights) and 3) *mastery dependence* (individual's need to exert control over his/her training schedule). Because of its sports specificity the BDS has restricted range of employability in sport and exercise psychology.

4.9 Development of the Exercise Addiction Inventory[18]

The listed screening tools are not theory driven and the one having the best psychometric properties (EDS) is relatively complex. As mentioned earlier, it is relatively long to administer, score and interpret the ratings. Consequently, it is impractical for use in sports medicine clinics, physiotherapy settings, and occupational therapy practices. Why these settings? Where would an exercise addict most likely show up first? In a psychologist's practice? No, because the person often believes that exercise is good, so she or he has no problem whatsoever. Nevertheless, injuries and re-injuries gravitate the person towards occupational and orthopaedic settings. The purpose of the here presented study was to develop and examine the psychometric properties of a short and practical Exercise Addiction Inventory, which was also a theoretically-based screening tool of exercise addiction. The brief questionnaire can distinguish between individuals who are at-risk, have some symptoms or predisposition, or have no symptoms of exercise addiction. Exercise addiction symptoms were operationalised using Griffiths' (1996; 2005) six components of addiction The psychometric properties of the measure were examined through statistical tests and cross-validation against two other measurement tools: the Obligatory Exercise Scale (Thompson

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*[18] Based on: Griffiths, M. D., **Szabo, A.,** & Terry, A. (2005). The exercise addiction inventory: a quick and easy screening tool for health practitioners. British Journal of Sports Medicine, 39, e30. doi:10.1136/bjsm.2004.017020*

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& Pasman, 1991) and the twenty-one item Exercise Dependence Scale (Hausenblas & Symons Downs, 2002b) which are conceptually similar, but are relatively impractical (taking a long time to administer and needing expertise in scoring), and difficult to use for screening in orthopaedic clinics, physiotherapy and occupational settings, where exercise addicts may show up first.

4.9.1 Method

4.9.1.1 Participants

In this study, an opportunistic sample of 200 hundred participants was used comprising of 111 males (55.5%), and 89 females (44.5%). The first half of the sample consisted of about 50% sport science students (n = 102) who was involved in team sports (although some also practiced individual or combined sporting activities). The other half of the sample was psychology students (n=98) who reported regular participation in aerobic, gym or both forms of exercises. Since the purpose of the study was the development of a general exercise (rather than specific sport or exercise) tool, this mixed-exerciser sample served well the purpose of the study. The age range was 18 to 40 years (mean age = 21.24, SD = 3.77). The mean age of the males was 20.82 years (SD = 3.19) and for females the mean age was 21.75 years (SD = 4.36).

4.9.1.2 Design and analysis

The present study involved the creation of the short-form Exercise Addiction Inventory. The new brief inventory was administered to a sample of participants (all of whom were exercisers), along with the Obligatory Exercise Questionnaire and the Exercise Dependence Scale, to establish its psychometric properties, by calculating its internal consistency, concurrent validity and construct validity.

4.9.1.3 Materials

The questionnaire was divided into four sections. The first section asked for demographic information (i.e., gender, age, and exercise frequency). The next three sections were made up of three tools intended to measure exercise addiction. The first was the Obligatory Exercise Questionnaire (Thompson & Pasman, 1991), the second was the Exercise Dependence Scale-21 (Hausenblas & Symons Down, 2002b), and the third was the Exercise Addiction Inventory (EAI: Appendix R). The Exercise Addiction Inventory consists of only six statements that are based on a modified version of the components of behavioural addiction (Griffiths, 1996). These statements were self-constructed and were designed to be indicative of addictive behaviour components. Each statement had a five point Likert response option. The statements were coded so that high scores reflected the attributes of addictive exercise behaviour: 1=”Strongly disagree”, 2=”Disagree”, 3=”Neither agree nor Disagree”, 4=”Agree”, 5=”Strongly Agree”. The six statements that make up the inventory are: “Exercise is the most important thing in my life”- This statement reflects the *salience* component of addictions. “Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do” - This statement gauges the conflict component of

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addictions. “I use exercise as a way of changing my mood” - This statement mirrors the mood modification or euphoria (reward phase) component of addictive behaviours. “Over time I have increased the amount of exercise I do in a day” - This statement measures the tolerance involved in the addictive behaviour. “If I have to miss an exercise session I feel moody and irritable” - This statement refers to the presence of withdrawal symptoms in exercise addiction. “If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before” - This statement gauges the relapse aspect of the addictive behaviour.

The EAI cutoff score for individuals considered at-risk of exercise addiction was set to 24. This cutoff represents those individuals who score among the top 15% of the total scale score. In fact a score of 24 reflects an average "agree" answer given that the maximum score is 30 (6 x 5, see Appendix R) that would reflect the highest possible "strongly agree" average. High scores (≥ 24) were considered to be the most problematic for the individual. A score of 13 to 23 was chosen to be indicative of a symptomatic individual (predisposition) and a score of 0 to 12 was deemed to indicate an asymptomatic individual (no predisposition). A principal component analysis showed that the six questions represented a single component explaining 55.9% of the variance. All the factor loadings were high and very significant (see Table 4.4)

Table 4.4. Factor loadings of individual EAI items.

(1) Exercise is the most important thing in my life	0.754
(2) Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do	0.610
(3) I use exercise as a way of changing my mood	0.800
(4) Over time I have increased the amount of exercise I do in a day	0.742
(5) If I have to miss an exercise session I feel moody and irritable	0.801
(6) If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before	0.762

4.9.1.4 Procedure

Approximately half the questionnaires were administered in a health and fitness club. Participants completed the questionnaires individually to reduce the confounding external influence, with no time constraints on completion. The remaining questionnaires were completed by university sports science students at Nottingham Trent University. The questionnaire contained an introductory statement informing the individual that they would remain anonymous and that they could withdraw from the study at any point. These participants marked their responses to the statements in close proximity to each other, but the questionnaires were completed individually.

4.9.2 Results

4.9.2.1 Participant characteristics

The means for the participants' exercise frequency can be seen in Table 4.5 below. Exercise was defined as the weekly number of purposeful (planned) physical activity lasting at least 30 minutes and it was based on self-report data.

Table 4.5. Means and Standard Deviations of Participant Characteristics.

Characteristic	All Participants (N = 200)	Men (N = 111)	Women (N = 89)
Mean exercise /week	M = 3.77	M = 3.95	M = 3.54
Standard deviation	SD = 2.66	SD = 2.29	SD = 3.05

4.9.2.2 Test scores

The mean scale score for participants on each measure was calculated. The mean item score on the Obligatory Exercise Questionnaire was 2.2 (SD = .44), lying between "sometimes" and "usually" on the four-point Likert scale. The mean item score on the Exercise Addiction Inventory was 2.7 (SD = .49), lying between "disagree" and "neither agree or disagree" on the five point Likert scale. The mean item scale on the Exercise Dependency Scale was 4.19 (SD = .48), lying closer to "never" on the six point Likert scale. The mean item score is higher on the Exercise Dependence Scale because the scale is reversed compared to the previous two tools.

Six of the participants (3%) were found to score above 24 on the Exercise Addiction Inventory. This would mean that these participants responded with "agree" or "strongly agree" answers to most of the items, and for the purpose of the present study these were classified as *at-risk* for exercise addiction. Five of these (2.5%) were also classified as exercise dependent according to the Exercise Dependence Scale criteria. No cutoff score was provided for the Obligatory Exercise Questionnaire.

4.9.2.3 Internal reliability

A principal component factor analyses extracted a single component (see Method section). To evaluate the internal reliability of the questionnaires, Cronbach's Alpha levels were computed. This is because the items were answered along a Likert response scale. The internal consistencies of the Exercise Addiction Inventory, the Obligatory Exercise Questionnaire, and the Exercise Dependence Scale were 0.84, 0.9, and 0.95 respectively. In spite of the fact that the EAI score was lower than the other two, it should be appreciated that the EAI contains significantly fewer items (6) on the basis of which the internal reliability was calculated. Nevertheless, an alpha value (α) of 0.84 can be considered as very good for a scale's internal reliability value.

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4.9.2.4 Concurrent validity

Correlational analysis was used to assess the concurrent validity of the Exercise Addiction Inventory using the Obligatory Exercise Questionnaire and the Exercise Dependence Scale. The results of both correlations were high (see below), confirming the concurrent validity of the EAI.

4.9.2.4.1 The Exercise Addiction Inventory and the Obligatory Exercise Questionnaire. The analysis revealed a strong positive correlation for the relationship between the Exercise Addiction Inventory and the Obligatory Exercise Questionnaire. The correlation coefficient was $r = 0.80$ ($p < 0.001$).

4.9.2.4.2 The Exercise Addiction Inventory and the Exercise Dependence Scale. The analysis revealed a strong negative correlation for the relationship between the Exercise Addiction Inventory and the Exercise Dependence Scale the correlation coefficient was $r = -0.81$ ($p < 0.001$). This correlation was negative because the scoring on the Exercise Dependence Scale is reversed compared to the other two tools.

4.9.2.5 Content validity

This was established by having two experts (a professor of addictive behaviours and a sport and exercise psychology expert) review the inventory for appropriateness, readability, and comprehension. The questions were checked to correspond to Brown and Griffiths' components of behavioural addiction.

4.9.2.6 Construct validity

This was assessed using a cross-sectional one-way analysis of variance for unequal sample sizes. This was calculated to determine if the scale could successfully distinguish between higher and lower frequencies of exercise. Analysis revealed that subjects who exercised five times or more per week ($n = 51$) scored significantly higher on the Exercise Addiction Inventory than those who exercised two times or less per week ($n = 66$) ($F(1,115) = 77.11$, $p < 0.001$). The Obligatory Exercise Questionnaire ($F(1,115) = 147.17$, $p < 0.001$) and the Exercise Dependence Scale ($F(1,115) = 112.77$, $p < 0.001$) were also able to distinguish between higher and lower frequencies of exercise. A second analysis of variance revealed no significant differences between gender scores for the Exercise Addiction Inventory (F(1,1980 = 1.02, p = 0.32). In addition, there were high correlations between the frequency of weekly exercise reported and the scores on the three scales (Hasenblas: $r = -.59$, $p < .001$; Pasman: $r = .71$, $p < .001$; and EAI: $r = .54$, $p < .001$).

4.9.3 Discussion

The aim of the presented study was to produce a theory-based and short format exercise addiction questionnaire. The Exercise Addiction Inventory (EAI - Appendix R) is a self-report

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measure that consists of six items and is quick and simple to administer. It reflects attitudes and beliefs about exercise behaviour, based on the perceived importance of exercise, the subjective experience reported as a consequence of exercise, and the frequency of exercise needed to achieve the desired benefits. It also reflects the motivation to continue exercising due to the fear of experiencing withdrawal symptoms, the perceived conflicts between the sufferer and family or friends arising from the exercising, and the ease of relapse and reinstatement back to the problem exercise behaviour pattern. Furthermore, findings from the presented study provided initial support for the psychometric properties of the EAI. Specifically, the internal consistency was very good, showing that the inventory had strong internal reliability. The inventory also showed excellent concurrent validity when compared with the Obligatory Exercise Questionnaire (Thompson & Pasman, 1991) and the Exercise Dependence Scale (Hausenblas & Symons Downs, 2002b), two psychometrically sound tools.

These excellent psychometric properties indicated that the six components of behavioural addiction (Griffiths, 1996) can be successfully applied to the measurement and identification of risk for exercise addiction. The EAI can distinguish between exercise addiction and exercise commitment. Most of the participants in the presented study were considered casual exercisers or committed exercisers yet the study still identified 3.0% (n = 6) of the sample as being *at risk* for exercise addiction. The Exercise Dependence Scale (Hausenblas & Symons Downs, 2002b) identified 2.5% of the sample as being at risk. These are low figures, supporting the argument and later evidence that exercise addiction is rare (Mónok et al., 2012; Szabo, 2010; Veale, 1995) and suggesting that other studies presenting higher prevalence rates (Slay, Hayaki, Napolitano, & Brownell, 1998) may be assessing other components of the behaviour, like commitment rather than exercise addiction, as discussed by Szabo (2010). The EAI can also distinguish between different frequencies of exercise (i.e., those exercising five times or more a week and those exercising twice or less).

The concurrent validity of the EAI was clearly established using the Obligatory Exercise Questionnaire (OEQ) and the Exercise Dependence Scale (EDS). This indicated that the EAI is indeed measuring problem exercise. Developers of the OEQ claim that the questionnaire is a measure of obligatory exercise, although Thompson and Pasman (1991) did not adequately define these individuals. Obligatory exercisers have been described as having a high need for perfection and the desire to control their bodies (Yates, Shisslak, Crago, & Allender, 1994). The EDS was developed to measure exercise dependence, which is described as a craving for exercise that results in uncontrollable excessive physical activity and manifests in physiological symptoms, psychological symptoms, or both (Hausenblas & Symons Downs, 2002b). The EAI is used to identify symptoms, or rather components, of exercise addiction. The here presented study found strong similarities in the results of the three instruments. It would appear that the three instruments are all identifying the same concept, but using different definitions of problem exercise. If the EAI is similar to other instruments, it has an advantage over them in its ease of administration, and in specificity in that it is based on components of behavioural addiction rather than components of substance dependence which may be an inadequate comparison.

Researchers need to be cognizant of the fact that problematic exercisers are not a homogenous population because the pathological processes leading to the development of the condition *differ between individuals*, as also suggested by the interactional model forwarded for

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exercise addiction (Egorov & Szabo, 2013). Previous research has distinguished between primary exercise dependence (actual exercise addiction) and dependence that is secondary to an eating disorder (Veale, 1995; Adams & Kirkby, 2003). The EAI is a tool for identifying those at-risk for the primary exercise disorder only. The here presented study - and the current dissertation - are not intended to address the issues related exaggerated exercise that is associated with eating disorders, since that would cover a different area in the field of psychology.

Hausenblas and Symons Downs (2002b) identified a number of limitations of previous inventories in the field of exercise addiction. The EAI has a specific cutoff point for the identification of those who are *at risk* for addiction, and can distinguish between those who may be predisposed or symptomatic and those who are asymptomatic of exercise addiction. Items were operationalised using components of behavioural addiction, derived from a conceptual base and considered to be a theory- rather than data-driven. Also, neither exercise frequencies nor exercise histories were used as diagnostic markers for addiction. Thus, the presented study produced an inventory that largely overcame the limitations proposed by Hausenblas and Symons Downs (2002b).

While the results from the presented study revealed preliminary psychometric support for the Exercise Addiction Inventory and good evidence for its utility in exercise addiction assessment, it is important to recognise the limitations of the study and to consider future research. Firstly, the sample was an opportunity sample that makes it difficult to know how far the results are true of the whole population. Secondly, the presented study asked for exercise frequency information in the form of the number of exercise sessions engaged in per week. It would have been more useful to seek information on how long these sessions were so that those who were exercising six times a week, for example, were not in fact, exercising less than those who were working out twice a week but for a longer duration. Even better, both the duration and frequency of exercise could have yielded a measure of the total exercise volume, especially if some index of exercise intensity could also be obtained. Thirdly, the type of exercise was not determined. Further research could examine whether addiction scores on the EAI differ for different physical activities (e.g., swimming, running, and gym use). Finally, using a self-report assessment measure raises questions about the truthfulness of responses that must be taken into consideration. Answers may not have been fully accurate because the study was an investigation into a socially undesirable activity. It is also likely that, for reasons of social desirability, the extent of participants' self-reported involvement in exercise might have been exaggerated in an effort to appear fitter (Williams & Krane, 1992) or more committed to their chosen activity.

Despite these shortcomings, the EAI has the following three advantages. The first is that the EAI is a tool based on behavioural addiction theory rather than being based on researcher perceived criteria or substance dependence criteria as is the EDS. The second advantage is that it is a short form inventory that is quickly, easily, and anonymously administered, finding the same results as the more long-winded tools discussed previously. Occupational therapists and sports medicine clinics are often the first to encounter the exercise addict sufferer due to an injury or re-injury (Wichmann & Martin, 1992). Furthermore, these health professionals are not trained experts in psychometric assessment. However, the EAI with its convenient cut off point value, ease of administration and rating, could be valuable in deciding – by these medical specialists – whether the patient needs to be referred for consultation with a mental healt professional to prevent further damage. The third is that, in the long run, the EAI may be used more frequently because of the aforementioned advantages. Taken together, the main purpose of the presented work was to develop and examine the psychometric properties of the EAI. The study has produced a valid and reliable inventory capable of identifying individuals that are asymptomatic, symptomatic, and at-risk from exercise addiction. The EAI is a powerful evaluation tool that is efficient and advantageous, making an important contribution for practical use in applied settings as well as to the exercise addiction literature. As it will be demonstrated later, the EAI became a popular tool in this area of research.

4.10 Are Sport Students at Risk of Exercise Addiction?; Testing the EAI[19]

The aim of the here presented work was to test the sensitivity of the EAI by comparing the rate or prevalence of self-reported symptoms of exercise addiction in sports sciences students, who are in daily contact with sports and exercise, to those in the general leisurely-exercising people. It was speculated that social, physical, and mental (i.e., academic) involvement with sports and exercise, for the majority of the time in the sport science students, may translate into a greater predisposition or risk of exercise addiction in comparison to the general exercising population.

4.10.1 Method

A large sample of 455 male and female participants completed the EAI. The first group was recruited from two year cohorts of sport science university students at Nottingham Trent University (n = 261), representing the 'Sport Science Student' group (age range 19-23 yrs). The second group was recruited from several community fitness centres (n = 194) representing the 'General Exercising Population' group (age range 17-74 yrs). Sport science students completed the EAI in the classroom, whereas participants from the fitness centres completed the EAI on an individual basis immediately upon arrival to the centre where they exercised. As a consequence, all questionnaires were completed before exercise to avoid possible bias due to affective changes post-exercise.

4.10.2 Results

Following spreadsheet processing and computerised rating of the EAI, the data were analysed with a one way analysis of variance (ANOVA). The test yielded a statistically significant difference between the two groups ($F(1, 454) = 18.02$, $p < .001$). Sport science students scored higher (mean = 18.6, SD = 3.8) than exercisers from the general population (mean = 17.1, SD = 3.8). The effect size (Cohen’s d) was found to be only moderate ($d = .40$).

Since the six questions of the EAI represent six components of addiction, each of the individual components was compared (using Bonferroni corrected t-tests) between the two groups. The mean scores for the first three questions (salience, conflict, and mood change) were

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[19] *Based on:* ***Szabo, A.,*** *& Griffiths, M. D. (2007). Exercise addiction in British sport science students. International Journal of Mental Health and Addiction, 5(1), 25-28. doi: 10.1007/s11469-006-9050-8*

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significantly different between the two groups (see Table 4.6). There were no significant differences between the groups on the remaining three questions.

We have proposed earlier (Griffiths, Szabo, & Terry, 2005; Terry et al., 2004) that individuals scoring above 24 on the EAI may be classified as "at risk" of exercise addiction. In this study, cross-tabulations were used to determine the incidence of scores above 24 in the two groups. Results showed that 6.9% (18 out of 261) sport science students were at risk of exercise addiction compared to only 3.6% (7 out of 194) of the general exercising population, but this difference did not reach the usual conservative level (.05) of statistical significance (χ^2 (1) = 2.32, p < .09).

Table 4.6. Means and standard deviations (SD) for the six questions of the EAI, and therefore the six components of addiction, for two groups (Sport Science Students (SSS) and General Exercising Population (GEP)) along with the t-values of the mean differences, probability levels (p), and effect sizes (d), when statistically significant group-differences were found.

Questions on the EAI / Components of Addiction	Mean / SD SSS (n = 261)	Mean / SD GEP (n = 194)	*t*	*p*	*d*
1) Exercise is the most important thing in my life. (SALIENCE)	2.85 (0.90)	2.59 (1.03)	2.84	.005	.27
2) Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do. (CONFLICT)	2.34 (1.24)	1.87 (1.06)	4.37	.001	.41
3) I use exercise as a way of changing my mood (e.g., to get a buzz, to escape, etc.). (MOOD MODIFICATION)	3.85 (0.84)	3.24 (1.06)	6.68	.001	.64
4) Over time I have increased the amount of exercise I do in a day. (TOLERANCE)	3.48 (1.07)	3.48 (1.07)	0.00	NS	-
5) If I have to miss an exercise session I feel moody and irritable. (WITHDRAWAL SYMPTOMS)	2.77 (1.08)	2.68 (1.14)	0.90	NS	-
6) If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before. (RELAPSE)	3.32 (0.95)	3.24 (1.01)	0.87	NS	-

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4.10.3 Discussion and conclusion

The here presented study shows that sport science students have a higher score of exercise addiction than the general exercising population. The overall higher scores on the EAI were due to the higher scores reported by the students on the first three questions of the EAI, representing salience, conflict, and mood modification. Accordingly, exercise and sport represents a greater daily preoccupation (which was expected) for sport science students than to the general exerciser, albeit the effect size for salience was relatively low. Also, sport science students tended to report more conflict related to their exercise than the comparison group. Finally, the strongest finding in terms of effect size (refer to Table 4.6) was seen in relation to question three, suggesting that sport science students use exercise more for mood modification than the general exercising population.

The finding the prevalence of risk of exercise addiction was almost twice as high (6.9% versus 3.6%) in sport science students than in the general exercising population confirmed the sensitivity of the EAI. This figure is substantially higher than the three percent (3%) reported by Terry et al. (2004). Consequently, it is possible that the cohort examined in this investigation had greater affinity for exercise than the students examined by Terry et al. In the latter study only half of the sample consisted of sport science students (n = 102) in contrast to a substantially larger sample examined in the current study (n = 261). Further, the results obtained here may not be surprising in light of other reports suggesting a relatively high incidence of exercise addiction among students in health and physical education (Garman, Hayduk, Crider, & Hodel, 2004).

The true prevalence of exercise addiction is unknown because only a few clinical cases surface in the scientific literature. Some scholars conjecture that exercise addiction is rare (Szabo, 2010). Indeed, it was speculated that about 3% of the exercising population are affected. However, in a population-wide study, Mónok et al. (2012) showed that the figure may be even lower (0.3-05%). The results of this work showed a high risk for exercise addiction in students studying sport sciences. These individuals have also reported more symptoms of exercise addiction, especially on salience, conflict, and mood modification, in contrast to the general exercisers. The reason beyond the differences may be linked to greater daily personal, social, theoretical, as well as practical involvement with sports and exercise. The findings also raise the possibility that sports science students may be more susceptible to exercise addiction than other exercisers. However, it may also mean that the EAI also traps some other aspects of exercise behaviour than the risk of addiction.

4.11 Are Athletes or Sport Students at Greater Risk of Exercise Addiction?: A Replication[20]

Systematic investigation of risk for exercise addiction in athletes, whether in team or individual sports, was sparsely reported. However, a recent study found no difference between fitness exercisers and soccer athletes (Lichtenstein, Christiansen, Bilenberg, & Støving, 2012). Since fitness exercises are often performed in a group, better understanding of exercise addiction in individual (and self-scheduled) and team/group sports is needed. Actual cases of exercise

[20] *Based on:* ***Szabo, A.,*** *De la Vega, R., Ruiz-Barquín, R., & Rivera, O. (2013). Exercise addiction in Spanish athletes: Investigation of the roles of gender, social context and level of involvement. Journal of Behavioral Addictions, 2(4), 249-252. doi: 10.1556/JBA.2.2013.4.9*

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addiction may be greater in the former due to the freedom of exercise scheduling. Indeed, I have discussed earlier that addiction cannot be scheduled. The addiction process involves a response to a strong inner urge for gratification that surfaces often at random (but possibly conditioned) times. Therefore, in athletics where the training is scheduled for a certain hour, the athlete would have to delay the urge until the start of the training, which necessarily implies the exertion of control over the urge. However, if there is control over an urge, we can no longer imply about addiction.

Furthermore, some inquiries have disclosed gender differences in exercise addiction using other questionnaires (Hausenblas & Symons Downs, 2002c; Pierce, Rohaly, & Fritchley, 1997; Tata, Fox, & Cooper, 2001) while others did not (Furst & Germone, 1993; Modolo et al., 2011). These findings are also controversial because the differences were often opposite (Hausenblas & Symons Downs, 2002c; Pierce et al., 1997). Thus, further studying of sex differences is warranted.

In the here presented study I have addressed several issues. First, I wanted to test whether the findings from the 2007 study, with the sport science students, can be replicated with a Spanish sample of sport science students. Instead of a general exercise sample, the comparison group was an exercising student population to ensure that differences (if any) in exercise addiction-proneness are not due to lifestyle and age differences, that could have been the case in the study of Szabo and Griffiths (2007). In addition to these issues, in the here presented study, my colleagues and I have also examined a group of high level athletes comprised of elite ultra-marathon runners. This group was included to see whether actual involvement in athletics or the mere involvement combined with environmental and social factors linked to a sporting life is the more predisposing factor to higher exercise addiction scores. Further, considering the controversial reports in the literature, the possible gender differences in exercise addiction were also investigated. Finally, the risk of exercise addiction in a social context, in terms of individual or group exercises, was also explored.

4.11.1 Method

4.11.1.1 Participants

Non-sport oriented (n = 90) and sport science (n = 57) university athletes, involved in team and individual sports, were invited to participate in the study. Elite ultra-marathoners (n = 95) were also solicited to participate in the inquiry. A total of 242 athletes (174 men and 78 women) were recruited (Mean age = 27.54 yrs; SD = 10.65). They trained an average of 6.71 hrs (SD = 3.53) per week. Participants were given informed consent about the protocol and the study was conducted in full agreement with the ethical principles for research with human subjects of the Helsinki Declaration (World Medical Association, 2008) and the guidelines for ethical considerations in psychology research with human participants (British Psychological Society, 2010).

4.11.1.2 Materials

The Spanish version of the 6-item Exercise Addiction Inventory (EAI; Griffiths et al., 2005; Terry et al., 2004) was used along with a demographic questionnaire. The EAI comes with good psychometric properties as discussed earlier in this dissertation. The properties of the here used Spanish scale are reported in the Results section.

4.11.1.3 Procedure

Participants completed the questionnaire in a natural setting (university or training venues) in the presence of an experimenter. Data collection lasted two months. Data were entered into Excel files, then imported into the SPSS software for statistical analyses.

4.11.2 Results

The Spanish version of the EAI was subjected to factor analysis. Each of the six items was statistically significantly correlated ($p < .001$) with another item, supporting factorability. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .801. The Bartlett's test of sphericity was significant ($\chi 2$ (15) = 253.08, $p < .001$). Diagonals of anti-image correlation matrix were all over .77 supporting the inclusion of each item in the factor analysis. Principal component analysis was used and only components with eigenvalues of ≥ 1.0 were retained. In this way one factor emerged that accounted for 41.99% of the total variance. A minimum loading of 0.40 was observed for each item. The internal reliability of the Spanish scale was .71 (Cronbach's alpha). Construct validity was determined by comparing median-split groups of high- (above 6 hrs/week) and low-exercise volumes (below 6 hrs/week) groups. The two groups differed statistically significantly in EAI scores ($F(1, 201) = 23.14$, $p <.001$).

Group differences in EAI scores were tested with a group (3) by gender (2) analysis of variance (ANOVA). The test yielded two main effects; one for gender (Means: men =19.40, SD = 3.50, and women 18.23, SD = 3.73; $F(1, 236) = 5.08$, $p = .03$, effect size (Cohen's d) = .32), and one for group ($F(2, 236) = 6.81$, $p = .001$). For the latter, Tukey's HSD post hoc tests showed that elite runners (EAI: M = 20.08; SD = 3.70) differed from university athletes (M = 18.41, SD = 3.46, and M = 18.23, SD = 3.34, respectively, $p = .005$, the effect sizes (d) were .47 and .52, respectively). The two groups of university athletes did not differ from each other and the group by gender interaction was statistically not significant.

Differences in EAI between athletes in individual and team sports included data from university students only who did not differ from each other on the previous test. The ANOVA showed that athletes in team sports scored higher on EAI than individual athletes (M = 19.12, SD = 3.34, and M = 17.55, SD = 3.15; $F (1, 1145) = 8.26$, $p = .005$, d = .47) .

To test the link between amount of exercise and EAI scores, a median split was used to generate high- (>6 hrs/week) and low-exercise-volume (<6 hrs/week) groups. Excluding those right on the median, the ANOVA revealed a group by volume interaction ($F (2, 197) = 4.45$, $p = .013$). The interaction showed that lesser training is linked to lower EAI scores in university athletes, but not in elite runners (Figure 4.10). The correlation between weekly hours of training and EAI scores was $r = .24$ $p <.001$, $r^2 =.058$. The shared variance, therefore, was less than 6.0% percent.

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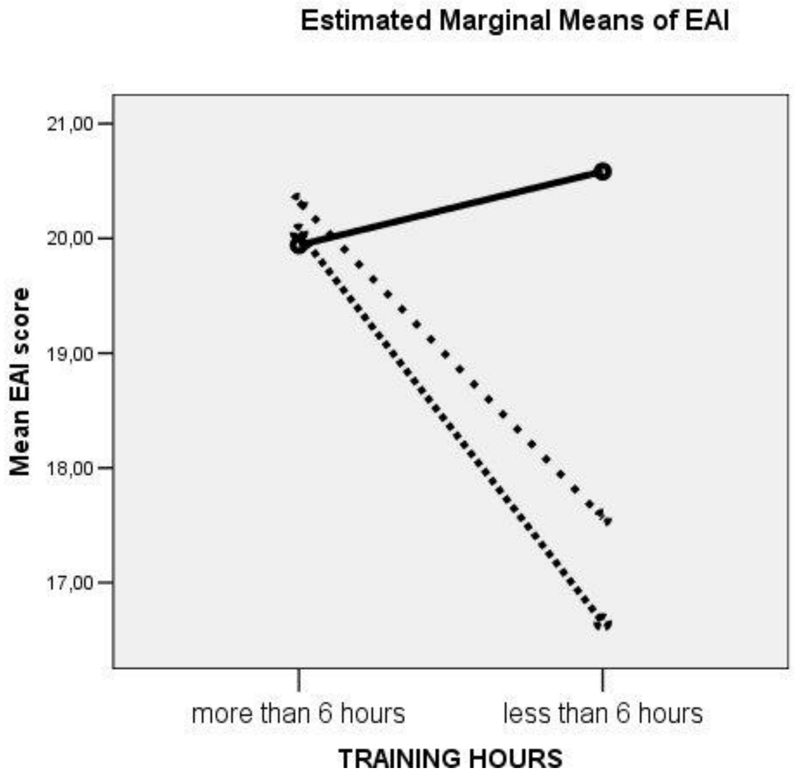
Figure 4.10. EAI scores of those who train more and less than 6 hours per week. Dotted lines represent university athletes and continuous lines represents the elite runners.



Finally the prevalence of "at risk" for exercise addiction was calculated on the bases of the EAI cutoff score of 24 (Griffiths et al., 2005; Terry et al., 2004). In the current research, 7% of the sport science athletes, 10% of non-sport science university athletes (8.8% of all university athletes), and 17% of the elite runners have scored 24 or above the EAI. From the whole sample 29 (or 12%) athletes scored 24 or more on EAI. The ratio of men was higher than that of women (21 vs. 8), which was statistically significant ($\chi 2$ (4) = 10.79, p = .029).

4.11.3 Discussion

These results showed that the Spanish EAI has good psychometric properties. All six items emerged as a one-factor solution. The internal consistency of the scale was lower than that of the original (Terry et al., 2004), but it was higher than in a Danish study (α=.66; Lichtenstein et al., 2012) and it was comparable to a large population-wide Hungarian study (α=.71 vs. α=.72; Mónok et al., 2012). The construct validity of the scale was good, as based on the method of Terry et al. (2004). The concurrent validity and test-retest reliability of the Spanish EAI was not determined.

The presented study showed that proneness to exercise addiction varies among athletes. Therefore, it seems relatively impossible to establish a universal prevalence value unless specific populations are examined. High variability noted in past studies, examining exercise addiction, was seen as a methodological shortcoming (Szabo, 2010). However, the current findings may suggest that specific samples may possess some unique characteristics that contribute to the variability in the established preponderance of exercise addiction. It is important to stress that risk of exercise addiction is not a diagnosis yet, and devotion to athletics may inflate the subjective ratings of the EAI items through infiltration of concepts linked to commitment. In reality few professional athletes were diagnosed with exercise addiction (if any).

This study failed to replicate the work of Szabo and Griffiths (2007). Here no differences were disclosed between sport- and non-sport oriented university athletes. The preponderance of risk of exercise addiction in these groups were similar to that reported by Szabo and Griffiths (2007), but higher than the figure disclosed for habitual exercisers. It is possible that university athletics bear some features that raise the ratings of the EAI items. However, it is also possible that cultural and/or local habits or sport practices contribute to the observed differences. Finally, lifestyle and age differences that were not addressed in the study by Szabo and Griffiths (2007), could have also contributed to the different findings. These issues need thorough and systematic investigations in the future.

In agreement with past results (Anderson, Basson, & Geils, 1997; Smith, Wright, & Winrow, 2010), the findings are in discord with Allegre, Therme, & Griffiths's (2007) results of 3.2% risk of exercise addiction in ultra-marathoners. In the two studies the participants were comparable in number and training habits, but different tools of assessments were used. Indeed Allegre et al. classified 61.1% of their sample as non-dependent symptomatic. In general, the reported risk for exercise addiction among various groups of runners fluctuates to a large extent, which shows that other factors than the exercise - or even level of involvement - may be responsible. This issue calls for research attention in future work. One cannot assume, because of the higher exercise addiction scores, that ultra-marathoners are a bunch of exercise addicts who compete in long races as a result of progressively developed tolerance in their addiction.

Another important contribution of the presented work was that it provided clear results for unlinking exercise volume from EAI scores. Indeed, as visible in Figure 4.10, while university athletes training more than six hours per week reported higher EAI scores in contrast to those who trained less than six hours, this was not the case with the elite runners. The latter group showed consistently high EAI scores regardless of training volume. However, only a few (n = 12) ultra-marathoners trained less than 6 hrs per week. In spite of this fact, the statistically significant but low correlation showing only 5.6% common variance between training volume and EAI scores justifies the weak link between the latter variables. Here and in my earlier work (Szabo, 2010), I have argued that exercise volume alone is not an index of one's proneness to exercise addiction.

A finding obtained from an exploratory perspective is that team athletes score higher than individual athletes on the EAI. Since addiction, as a psychological morbidity, cannot be lived out in an organized manner (training), it is possible that athletes in team sports interpret some items of the EAI in a confounding way. Indeed, the current results call for a systematic re-investigation of the validity of the EAI - and possibly other paper and pencil tools - in team sports.

In the presented study, women scored lower than men on the EAI. These results agreed with those observed in some previous inquiries (Hausenblas & Symons Downs, 2002b,c?; Tata et al., 2001) but were in discord with others (Pierce et al., 1997; Modolo et al., 2011). It was suggested that women score higher on exercise addiction scales when there is an accompanying eating disorder (Szabo et al. 2010; Tata et al., 2001). A clearer understanding of the gender differences in risk for exercise addiction should take into consideration the presence or absence of eating disorders.

4.11.4 Conclusion

The present study, apart from preliminary evidence for acceptable psychometric properties of the Spanish EAI, had the following contribution: 1) High variability in proneness to exercise addiction may be expected on the basis of exercise and sport practices; 2) Athletes in team sports score higher on exercise addiction risk assessment than athletes in individual sports, which could be an artifact; 3) Gender differences in EAI rating occur, but since women scored lower than men, in the current work this finding may not be linked to some correlates of exercise addiction, like eating disorders, and 4) The volume of weekly exercise is not related to EAI scores in elite runners, demonstrating that exercise addiction is not a function of exercise or training intensity.

4.11.5 Psychometric re-evaluation of the EAI

The two studies presented earlier, illustrate that the EAI is able to differentiate between various levels of risk for exercise addiction. Indeed, today the EAI is among the most widely used instruments in the assessment of the risk for exercise addiction. A very recent study by Griffiths et al. (2015) has further explored the psychometric properties of the EAI by combining the datasets of past surveys conducted in five different nations (Denmark, Hungary, Spain, UK, and US) comprising a total sample size of 6,031 participants. The findings showed that components of exercise addiction can be studied reliably with the EAI across several cultures, because of the metric invariance (stability) of the scale. From another analysis, it emerged that the EAI may be interpreted differently (item-meaning) in various nations and some gender differences in the interpretation of the scale have also surfaced. This recent re-analysis of the scale, with a very large dataset, confirms the appropriateness of the EAI for gauging *the risk* for exercise addiction as long as caution is exerted in the between group comparison relate to gender and cultural factors. Apart from the EAI, the Exercise Dependence Scale (EDS) remains a reliable and a frequently adopted instrument for the gauging of the risk for exercise addiction. It should be reemphasized that the EAI can be used by almost anyone, even those who are not qualified in the field of psychology. It can be administered within seconds (it takes less than one minute to rate the six items on the EAI) and by simply adding the item-ratings it can be scored with ease within a couple of seconds. Given this advantage of the EAI, it can be used in busy general practitioners' consultation or orthopaedic health units by medical professionals who meet patients with frequent injuries, especially re-occurring injuries. The latter is a typical symptom in exercise addiction, because affected people cannot wait until full recovery after an injury, and they return to exercise while augmenting the problem or re-injuring themselves. In other words, they are very likely to exercise in spite of the contraindicated medical advice. Overall, the EAI is a reliable and valid research tool that can also be used by non-psychologists in applied health settings for screening the possible cases of exercise addiction. Then, those scoring high on the EAI may be referred to mental health professionals for dealing with the hardship that fuels their addiction. The EDS is also a reliable and valid research tool for gauging the risk of exercise addiction, but it is relatively useless in applied health settings.

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4.12 Research on Exercise Addiction

4.12.1 Primary and secondary exercise addiction

There is an unfortunate and conceptually incorrect distinction between two similar and compulsive exaggerated patterns of exercise behaviour in the literature. The terms primary and secondary exercise addictions (the actual word was dependence) were used by De Coverley Veale (1987) to differentiate between compulsive behaviour without (primary) and with (secondary) accompanied eating disorders, such as anorexia nervosa, bulimia, binge eating, and so on. For a long time now, I have rejected the concept of secondary exercise addiction, because the two behaviours are not comparable. Let me look at the role of exercise in eating disorders. Without going in-depth analyses of the latter, clearly diet and exercise are means of loosing weight in the various eating disorders. Therefore, exercise has a definitive role, which is weight-loss. Indeed, the goal or the "reward", if we use the behaviourists' point of view, in eating disorders is a number on the scale reflecting the maintenance or loss of body weight. In exercise addiction the scale may be important, but the reward is the psychological and/or emotional feeling experienced after exercise, or as a result of the fulfilment of exercise. In exercise addiction one "runs away" from *stress* and/or other *psychological hardship* and exercise represents the *solutio*n. In eating disorders, exercise is only one of *the means* or the vehicles (in addition to diet) in the behaviour used to achieve a goal or a reward, that is *weight loss*. Therefore, the distinguishing feature between the two concepts is that in primary exercise addiction, the exercise is the objective, whereas in secondary exercise addiction, weight loss is the objective, while exaggerated exercise is one of the primary means in the achievement of the objective. I strongly oppose the use of the term "secondary exercise addiction", because in eating disorders there is no addiction. Perhaps one can measure a compulsion to exercise or otherwise diet alone is not sufficient to lose weight. Such compulsion is clearly motivated by the need to lose weight to feel comfortable. So exercise acts as a complimentary or auxiliary behaviour in eating disorders. In Part III of this dissertation, I will only cover addictive exercise behaviour characterized by dependence on exercise in an obsessive and compulsive manner and without control over the behaviour.

4.12.2 Research interest in exercise addiction

Using the PubMed and Google Scholar over a three year period (January 2011 to January 2014) 128 publications were found in the area of exercise addiction. The results were obtained by using five search terms: exercise addiction, exercise dependence, compulsive exercise, obsessive exercise, and obligatory exercise. The figure, shows that there are slightly more than 40 publications in the area every year. The 128 publications appeared in a total of 89 different journals, showing that exercise addiction is studied from a multidisciplinary perspective. It should be noted that in this short content-analysis no distinction was made between primary and secondary or eating disorders-related exercise addiction, so research on exercise addiction *per se*, may be much less. The scholastic work emerges primarily from three wealthy anglophone nations (Figure 4.11), in which exercise may represent higher order needs in contrast to the less developed nations (Maslow, 2013).

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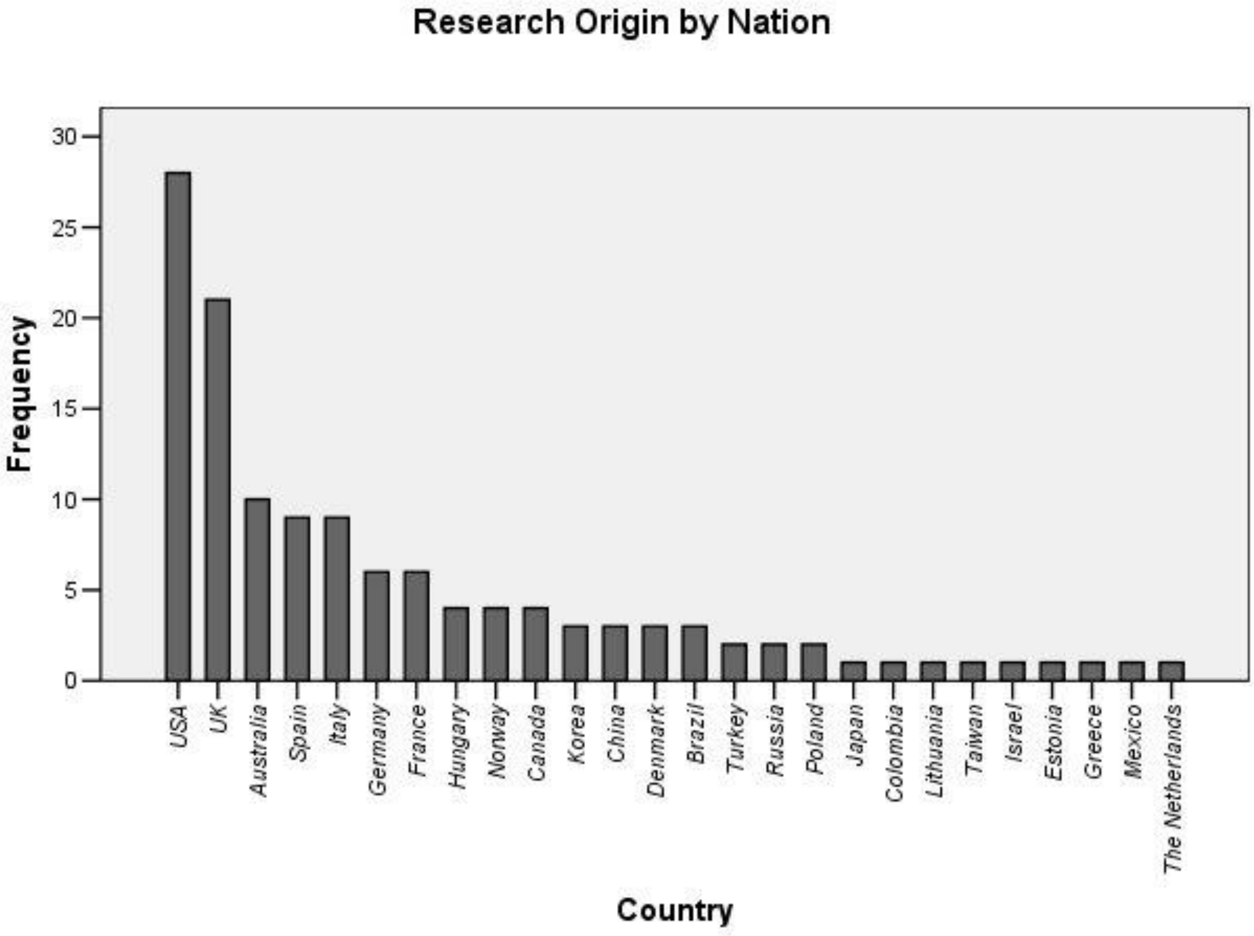
Figure 4.11. Origin of research on exercise addiction over three years, between 2011-2014.



4.12.3 Research perspectives on exercise addiction

Research into exercise addiction can be classified into two major categories: 1) Survey research, which measures the prevalence and /or predisposition to exercise addiction in various contexts, and 2) methodological studies, developing, validating, or verifying assessment tools or questionnaires (Table 4.7). Research effort has increased significantly after the two popular and psychometrically reliable instruments have been developed, namely the EDS and the EAI. In fact, as illustrated in Table 4.7, most (over 80%) of the studies have used the EDS or EAI, with or without complementary tools, in their investigations. The term "exercise dependence" appears to be the most popular connotation of the pathogenic exercise behaviour, in spite of the fact that long ago Goodman (1990) has pointed out that dependence is only one aspect of the addiction, which also includes compulsion. The majority of research in the area is carried out in the field with a variety (mixed) exercisers (refer to Table 4.7). However, the most striking information emerging from the past 20 years of research on exercise addiction is the wide range of prevalence reported for the disorder (see Table 4.7), ranging from 0.3% (Mónok et al., 2012) up to 42% (Lejoyeux, Avrel, Richoux, Embouazza & Nivoli, 2008). None of the thousands of exercisers tested in the over 50 studies were actually diagnosed with exercise addiction!

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Table 4.7. Summary table of research on exercise addiction over the past 20 years. Abbreviations explained: ? = not clear or not known; CS = Case Study; EA = Exercise Addiction; ED = Exercise Dependence; EAI = Exercise Addiction Inventory; EDS = Exercise Dependence Scale; EE = Excessive Exercise; MT = Method or Test development; n = number of observations; OE = Obligatory Exercise; Other = Other QTRs than the EDS or EAI; QTR = Questionnaire; yrs = years

Year	Author(s)	Type of Study	Term	n	Age (yrs)	Type of Sport	QTR	Inter-view	Data Source	Prevalence (%)
1995	Thornton & Scott	Survey	EA	40	?	Runners	Other	No	Field	22,5
1998	Slay et al.	Survey	OE	324	?	Runners	Other	No	?	26
1997	Griffiths	CS	EA	1	25	Jiu-jitsu	Other	Yes	Clinical	Symptoms
2000	Bamber et al.	Survey	ED	194	28,8	Mixed	Other	No	Field	13,9 -22,2
2002b	Hausenblas & Symons Downs Study 1	MT	ED	266	21,7	Mixed	EDS & Other	Yes	Field	3,4
2002b	Hausenblas & Symons Downs Study 2	MT	ED	553	22	Mixed	EDS & Other	No	Field	13,4
2002b	Hausenblas & Symons Downs Study 3	MT	ED	862	21,2	Mixed	EDS & Other	No	?	3,1
2002b	Hausenblas & Symons Downs Study 4	MT	ED	366	20,6	Mixed	EDS & Other	No	?	9,6
2002b	Hausenblas & Symons Downs Study 5	MT	ED	46, 373	22,9 20,3	Mixed	EDS & Other	No	?	9,8
2002c	Hausenblas & Symons Downs	Survey	ED	408	20,2	?	EDS & Other	No	Field	?
2002	Hausenblas & Fallon	Survey	ED	474	20,3	?	EDS & Other	No	Field	?
2002	Ackard et al.	Survey	EE	586	20,6	Mixed	Other	No	?	?
2002	Blaydon & Lindner	Survey	ED	203	29,8	Triathlon	Other	No	?	21,6 -30,4
2003	Hagan & Hausenblas	Survey	ED	79	21,8	Mixed	EDS & Other	No	Field	?
2004	Terry et al.	MT	EA, ED, OE	200	21,2	Mixed	EAI, EDS, & Other	No	Field	2,5 -3
2004	Hausenblas & Giacobbi Jr.	Survey	ED	390	21,8	?	EDS & Other	No	Field	?
2004a	Symons Downs et al.	MT	ED	408	20,2	?	EDS & Other	No	Field	3,6
2004b	Symons Downs et al.	MT	ED	885	20,2	?	EDS & Other	No	Field	5

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Year	Author(s)	Type of Study	Term	n	Age (yrs)	Type of Sport	QTR	Inter-view	Data Source	Prevalence (%)
2005	Griffiths et al.	Survey	EA	279	21,2	Mixed	EAI, EDS & Other	No	Field	3
2006	Edmunds et al.	Survey	ED	339	32,1	Mixed	EDS & Other	No	Field	3,4
2007	Youngman	Survey	EA	1273	37,9	Triathlon	EAI & Other	No	Internet	19,9
2007	Szabo & Griffiths	Survey	EA	455	?	Mixed	EAI	No	Field	3.6 - 6.9
2007	Allegre et al.	Survey	ED	95	43,5	Runners	EDS & Other	No	?	3,2
2008	Lejoyeux et al.	Survey	ED	300	28,6	Mixed	Other	Yes	Field	42
2008	Cook & Hausenblas	Survey	ED	330	19,9	Mixed	EDS & Other	No	Internet	?
2008	Hausenblas et al.	Survey	ED	40	20,5	Mixed	EDS & Other	No	Field	?
2009	Chittester & Hausenblas	Survey	ED	113	20,3	Weights	EDS & Other	No	Labora-tory*	?
2009	Lindwall & Palmeira	MT	ED	162	22,6	Mixed	EDS & Other	No	Field	9,2
2009	Lindwall & Palmeira	MT	ED	269	26,1	Mixed	EDS & Other	No	Field	5,2
2010	Bratland-Sanda et al.	Survey	ED, EE	38	30,9	Mixed	EDS & Other	Yes	Field	29
2010	Kern	Survey	ED	484	25,7	Mixed	EDS & Other	No	Field	?
2010	Smith et al.	Survey	ED	184	28,1	Runners	EAI, EDS & Other	No	Field	>30 if competes, <10 leisure
2011	Villella et al.	Survey	EA	2853	16,7	Mixed	EAI & Other	No	Field	8,7
2011	Pugh & Hadjistavropoulos	Survey	ED	144	20,7	Mixed	EDS & Other	No	Internet	?
2011	Sicilia & González-Cutra	Survey	ED	527	29,6	Mixed	EDS & Other	No	Field	?
2011	Cook et al.	Survey	ED	539	19,8	Mixed	EDS & Other	No	Field	?
2011	Bratland-Sanda et al.	Survey	ED	112	30,7	Mixed	EDS & Other	Yes	Field	?
2011	Modolo et al.	Survey	ED	300	21,2	Mixed	Other	No	?	33
2011	Cook & Hausenblas	Survey	ED	387	20,1	Mixed	EDS & Other	No	Field	?
2011	Grandi et al.	Survey	ED	79	30	Mixed	Other	No	Field	29,9

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Year	Author(s)	Type of Study	Term	n	Age (yrs)	Type of Sport	QTR	Inter-view	Data Source	Prevalence (%)
2012	Lejoyeux et al.	Survey	ED	500	29	Mixed	EDS & Other	Yes	Field	29,6
2012	Costa et al.	MT	ED	519	37,1	Mixed	EDS & Other	No	Field	6,6
2012	Mónok et al.	Survey & MT	EA, ED	474	33,2	Mixed	EAI, EDS & Other	Yes	Field	EAI = 0,5- EDS = 0,3
2012	Lichtenstein et al.	Survey & MT	EA, EE	590	28,4	Fitness & Football	EAI & Other	No	?	5,8
2012	McNamara & McCabe	Survey & MT	ED	234	22,5	Mixed	Other	No	Internet	34,8
2013	Cook et al.	Survey	ED	513	19,9	Mixed	EDS & Other	No	Field	?
2013	Szabo et al.	Survey	EA	242	27,5	Mixed, Runners	EAI & Other	No	Field	7-17
2013	Cook, Karr, et al.	Survey	ED	2660	38,8	Runners	EDS & Other	No	Internet	1,4
2013	Menczel et al.	Survey	ED	1732	31,7	Fitness	EDS & Other	?	Field	?
2014	Cook et al.	Survey	ED	387	20,1	Mixed	EDS & Other	No	Field	?
2015	Costa et al.	Survey	ED	262	20,9	Mixed	EDS & Other	No	Field	18.3
2014	Kotbagi et al.	CS	EA ED	1	50	Cyclist	EDS & Other	Yes	Clinical	Symptoms
2014	Müller et al.	MT	ED	134	22,2	Mixed	EDS & Other	Yes	Field	10,4

4.12.4 Diagnosis of exercise addiction

Less than 10 studies (<20%) have used an interview in addition to questionnaire assessment. The latter, however, cannot be used for diagnosis. They may reflect the level of risk for exercise addiction, but this level itself may be relatively meaningless. First, the cultural and gender-related interpretation of the exercise addiction gauging tools may vary (Griffiths et al., 2015). This variation means that a given value or cutoff point may impart different messages in different samples. Second, even a higher value or score on these questionnaires may not point to the future onset of exercise addiction. As discussed in the context of the theories forwarded for exercise addiction, especially the interactional model (Egorov & Szabo, 2013) the morbidity is revolutionary (suddenly erupting due to a major stress), rather than progressive. Then what is the diagnostic value of paper and pencil tools in the diagnosis of exercise addiction? Complemented with interviews, mental health professional can assess whether the behaviour (exercise) has ill effects on the person's life, physical, environmental or professional. In lack of negative effects, one cannot speak of morbidity. This is the key dilemma why DSM V is not listing exercise (and other behaviours) in its new category of behavioural addictions.

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While the problematic exercise behaviour can be diagnosed on the bases of the typical symptoms of addiction, an "official diagnosis" for exercise addiction cannot be performed because the disorder is not listed in the DSM V. Therefore, the problematic exercise behaviours manifested in the case studies covered earlier in this dissertation reflect psychological hardships in which exercise is used as a defence or coping mechanism. Indeed, a pathological reliance on exercise reflects some sort of escape behaviour. The individuals, manifesting abnormal exercise patterns in the case studies presented in section 4.7, perhaps all tried to escape from a subjective psychological distress that they could not otherwise control. Most addictions mirror some sort of escape behaviour. The man who divorces his wife and turns into an alcoholic may try to deal with his learned helplessness in the new situation. Alcohol provides temporary relief, but the pain reoccurs and more alcohol is needed. In contrast to alcohol or various leisure drugs, which carry a social stigma, exercise is a praised social behaviour behind which it is easy to hide for the trained individual. Once the exerciser realizes that the workout provides a sort of relief from stress and positive psychological feelings, the behaviour may be repeated more and more to cope with various difficulties. This is the stage where the risk (but only the risk) for exercise addiction may arise. Indeed, the use of exercise for coping reflects the second phase in Freimuth et al.'s, (2011) "Four-Phase Model" and the therapeutic exercise form in the interactional model (Egorov & Szabo, 2013). At this stage the exerciser enters in the therapeutic zone of exercise and the motivation for exercise is fuelled by negative reinforcement to cope with adversity. Like alcohol, exercise provides a pleasant relaxation and positive affect, accompanied by decreased anxiety and positive engagement, as discussed in Part I of this dissertation. The instant effects of exercise are rewarding. While they provide relief from hardship, these acute effects do not last for long. Upon dissipation of the effects, the pain returns and the need to exercise resurfaces. Accordingly, the acute psychological effects, rather than the chronic ones, provide an instant gratification. In the model that we proposed with Egorov (2013), we point out that the risk of exercise abuse surfaces from therapeutic exercise, which fully agrees with Freimuth et al. (2011).

Pathological exercise erupts suddenly from therapeutic exercise for different reasons. It is not progressive, it is revolutionary. However, there is a common denominator behind all subjective cases of exercise addiction and that is a major life stress or an adversity that the individual cannot control (Egorov & Szabo, 2013). Escaping into exercise may provide a false sense of control over the hardship that ignites the addictive behavioural pattern while the exerciser loses control over the exercise behaviour. Then exercise addiction may be perceived as a symptom of a passive (uncontrollable) and even traumatic stress disorder (Szabo, 2010). Then maladaptive exaggerated exercise behaviour can be conceived as a symptom of another disorder. In case of primary exercise addiction, in which exercise is a perceived solution, the disorder can be related to a number of psychological hardships in which exercise is used as a means of coping. Until, no negative effects are experienced by the individual, this coping is healthy and beneficial. When the behaviour becomes compulsive and the individual depends on (dependence characterized by very severe withdrawal symptoms) the behaviour carries the risk to cause damage. If damage to health and/or personal/social life of the affected person occurs the diagnosis of its cause (rather than exercise addiction) needs to be done. Therefore, it is likely that exercise addiction is often accompanied by other comorbidity in which the pathogenic exercise behaviour may only be a symptom. In line with this thought, research that gauge risk for exercise addiction may in fact measure the vulnerability to using exercise as a means of coping with adversity. This vulnerability is higher in therapeutic exercisers.

4.12.5 Correlates and co-morbidities of exercise addiction

4.12.5.1 Eating disorders

I have mentioned earlier that exercise addiction was classified as primary and secondary. The latter is the manifestation of excessive exercise in eating disorders as an additional means (to dieting and purging) of weight loss. Excessive involvement in exercise is a common characteristic of eating disorders such as Anorexia Nervosa and Bulimia Nervosa (De Coverley Veale, 1987). Excessive exercise occurs in different "doses" in people affected by eating disorders. It was estimated that one third of anorectic patients may also exhibit abnormally high doses of exercise (Crisp, Hsu, Harding, & Hartshorn, 1980). Relatively early, Yates et al. (1983) observed a striking resemblance between the psychology of anorectic patients and the very committed runners. They labelled this group of runners as obligatory runners. In the course of their research these authors interviewed sixty marathoners and examined the traits of a subgroup of male athletes who corresponded to the "obligatory" category. They reported that the male obligatory runners resembled anorexic women in some personality traits, such as feelings of anger, high self-expectation, tolerance of pain, and depression. Yates et al. (1983) related these observations in a unique and hazardous way of establishment of self-identity. This work has marked the foundation of research into the relationship between exercise and eating disorders.

Since Yates et al. (1983) published their article, a large number of studies have examined the relationship between exercise and eating disorders. A close examination of these studies reveals some controversial findings to the original report. For example, three studies comparing anorectic patients with high level, or obligatory, exercisers (Blumenthal et al., 1984; Davis et al., 1995; Knight, Schocken, Powers, Feld, & Smith, 1987) failed to demonstrate an analogy between anorexia and excessive exercising. While Zmijewski and Howard (2003) disclosed an association between exercise addiction and eating disorders in a student population, a large proportion of the same exhibited symptoms of exercise addiction without any sign of eating disorder. Differences in methodology between these inquiries are, however, significant. They all looked for an analogy between excessive exercise and anorexia, but from a different perspective. Blumenthal et al. (1984) and Knight et al. (1987) examined a mixed gender samples' scores on a popular personality test (the Minnesota Multiphasic Personality Inventory - MMPI). Davis et al. (1995) tested an all female sample using specific questionnaires aimed at assessing compulsiveness, commitment to exercise, and eating disorders. Yates et al. (1983) looked at some demographic and personality parallels between obligatory runners and anorectic patients. Finally Zmijewski and Howard (2003) examined a group of healthy students. Further, the classification of the exercise behaviour may have differed in these studies. Therefore, these studies are not easily comparable.

The controversy among the above studies may be solved at least in part by considering the results of a study by Wolf and Akamatsu (1994) who studied female athletes who showed tendencies for eating disorders. These women, however, did not manifest the personality characteristics associated with eating disorders. Therefore, in agreement with Blumenthal et al.'s (1984) and Knight et al.'s (1987) explanation, differences between people addicted to exercise and anorectic patients may outweigh the similarities reported by Yates et al. (1983). In another theoretical article, Yates et al. (1994) also admit that the comparison of excessive exercisers with eating disordered patients is incorrect because the two populations may be significantly different.

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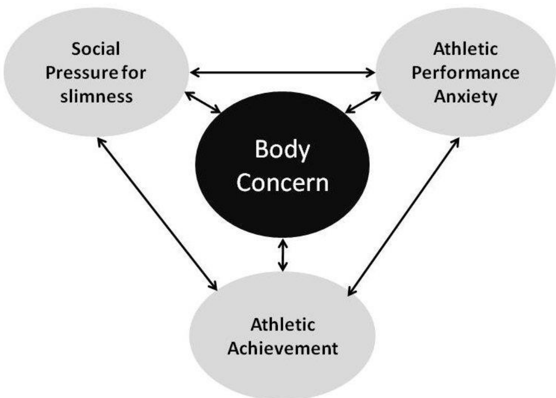
A number of authors (Davis, 1990a; 1990b; Davis et al., 1993) conducted a series of studies in which they examined exercising and non-exercising individuals and their tendency for eating disorders. In none of these studies was exercise behaviour clearly related to eating disorders. Opposing these conclusions are the results reported by French, Perry, Leon, and Fulkerson (1994), Pasman and Thompson (1988), Richert and Hummers (1986), Szymanski and Chrisler (1990), and Wolf and Akamatsu (1994). Because similar measurements were used in general, the discrepancy between the two sets of studies may be most closely related to the definition of exercise. In the latter set of studies either excessive exercisers or athletes were tested in contrast to those tested in the first set. However, the definition of "excessive exercise" needs to be standardised in research. Four factors, including mode, frequency, intensity, and duration, must be reported. Otherwise, it is unclear what is meant by "excessive exercise" or what is the definition of an "athlete". Reporting only one or two exercise parameter(s) is not enough, especially in studies dealing with eating disorders because the latter appears to occur only in a very limited segment of the physically active population.

Several studies suggest that high levels of exercise or athleticism is associated with symptoms of eating disorders. The determinants of this relationship are not well known. Williamson et al. (1995) proposed a psychosocial model for the development of eating disorder symptoms in female athletes (Figure 4.12; re-drawn from Szabo, 2000). The authors revealed that overconcern with body size, that is mediated in part by social influence for thinness, anxiety about athletic performance, and negative appraisal of athletic achievement, is a primary and a strong determinant of the aetiology of eating disorder symptoms. This model should be given serious consideration in the future and tested in several segments of the athletic and exercising population.

Although women appear to be at higher risk for developing eating disorders (Yates et al., 1994), male athletes may be at risk too. For example, Thiel, Gottfried, and Hesse (1993) reported a high frequency of eating disorder symptoms and even sub-clinical incidences of eating disorders in low weight male wrestlers and rowers. This report attracts attention to the fact that in some sports (i.e., gymnastics, boxing, wrestling), in which weight maintenance is critical, athletes may be at high risk for developing eating disorders. Athletes in these sports may turn to often "unhealthy", weight control methods (Enns, Drewnowski, & Grinker, 1987). This high-risk population, however, has received little attention in the literature. In the future more research should be aimed at this segment of the athletic population.

Figure 4.12. A psychosocial model for the development of eating disorder symptoms in female athletes proposed by Williamson et al. (1995); Figure re-drawn on the basis of Szabo's (2000) work.



4.12.5.2 Narcissism

The manifestation of exercise addiction symptoms was linked to narcissistic personality traits (Flynn, 1987; Jibaja-Rusth, 1989). However, opposite evidence (at least in women) was also disclosed (Davis & Fox, 1993). Recently, Bruno et al. (2014) studied a sample of 150 male and female gym attendees who exhibited higher or lower exercise addiction scores as based on the EAI. While, the mean EAI score did not reach the "at risk" category (i.e., mean EAI < 24), gym attendees who scored higher on the EAI also exhibited higher scores of narcissism and lower self-esteem than their mates who scored at the lower end of the EAI. Similar findings were reported by Miller and Mesagno (2014). These authors studied 90 male and female gym, fitness centre, and sport contest attendees and found that exercise addiction was positively associated with narcissism and perfectionism. A hierarchical regression analysis revealed that narcissism and self-oriented perfectionism combined predicted the risk for exercise addiction. Increased scores of narcissism were reported in substance and alcohol addiction as well (Carter, Johnson, Exline, Post, & Pagano, 2012; Stinson et al., 2008). Furthermore, a group of scholars suggested that narcissistic personality may predict predisposition to drug addiction (Cohen, Chen, Crawford, Brook, & Gordon, 2007). Earlier, Spano (2001) also revealed a weak correlation between frequency of physical activity and narcissism, but that was not categorized in terms of exercise addiction. It appears that traits of narcissism combined with low self-esteem and high perfectionism, may play a moderating role in one's predisposition to using exercise as a means of coping with life's adversities.

4.12.5.3 Perfectionism

Researchers examining the relationship between personality and exercise dependence have found a positive association between exercise dependence symptoms and perfectionism (Coen & Ogles, 1993; Cook, 1997; Hagan & Hausenblas, 2003; Hall, Hill, Appleton, & Kozub, 2009; Hall, Kerr, Kozub, & Finnie, 2007; Hausenblas & Symons Downs, 2002b; Miller & Mesagno, 2014). Coen and Ogles (1993) studied a sample of 142 marathon runners grouped into a high-risk (obligatory) and a low-risk (non-obligatory) exercise addiction groups. Their multivariate perfectionism scores were compared with appropriate statistical analysis, which showed that perfectionism was higher in the high-risk group in contrast to the low-risk group. However, multidimensional perfectionism only accounted for 11.6% of the variance in exercise addiction. In spite of the relatively low common variance, this study provided a primer evidence for the link between exercise addiction and perfectionism. Later, Cook (1997) also disclosed a positive link between exercise addiction scores and perfectionism, in addition to compulsiveness and body dissatisfaction. Cook also disclosed a negative relationship between self-esteem and scores of exercise addiction. In another study of 262 exercisers classified as at-risk, symptomatic and asymptomatic for exercise addiction, the at-risk group scored 15% higher on perfectionism than the asymptomatic subjects (Hausenblas & Symons Downs, 2002b). Later Symons Downs et al. (2004) have replicated these earlier findings with a multidimensional perfectionism tool, on which the group at-risk for exercise addiction has achieved higher scores than the asymptomatic and the symptomatic group. The latter group reported higher perfectionism scores than the asymptomatic group on four out of the six perfectionism indices. Similar findings have emerged in a study of 246 British middle-distance runners (Hall et al., 2007) in which high ability and perfectionism together explained 29% of the variance in the exercise addiction scores of women, and high task and ego orientation along with perfectionism explained 27% of the variance in exercise addiction in men. Later, a part of the same research team (Hall et al., 2009) has replicated the study with 307 British middle-distance runners and found that self-oriented perfectionism and socially prescribed perfectionism were associated with increased scores of exercise addiction. Recently, Miller and Mesagno (2014) also reported that exercise addiction scores are positively associated with self-oriented perfectionism and socially prescribed perfectionism. The positive association between these aspects of perfectionism and the predisposition to exercise addiction may reflect the inner motivational striving to solve problems according to personal and social expectation, while also avoiding failure and shame. This orientation, may also explain, at least in part, why habitual exercisers with a certain personality and behavioural predisposition may choose the therapeutic route of exercise (Egorov & Szabo, 2013) and rely on a physically challenging and effortful coping mechanism instead of escape into a passive and instantly gratifying - but marked by a social stigma - form of ill-coping behaviour, like drug or alcohol abuse.

4.12.5.4 Self-esteem

People at risk for exercise addiction appear to demonstrate lower levels of self-esteem than controls or asymptomatic individuals (Ackard et al., 2002; Chittester & Hausenblas, 2009; Cook, 1997; Grandi et al, 2011; Hall et al., 2009). A study conducted with 155 female aerobic instructors has disclosed a negative correlation between the risk for exercise addiction and self-esteem (Cook, 1997). However, the author used the Commitment to Exercise Scale to assess the risk for exercise addiction and, therefore, the actual tendency for addiction or a morbid exercise pattern cannot be established in this work. In another survey of 586 college women, Ackard et al. (2002) found that compared to well adjusted exercisers, women at risk for exercise addiction reported significantly lower self-esteem. Further a similar study of 113 men, revealed a statistically significant negative correlation between the risk for exercise addiction and self-esteem. However, the shared variance (r^2) was only 4% between the two variables (Chittester & Hausenblas, 2009). A study of 307 British middle-distance runners revealed that labile self-esteem (fluctuating or unstable self-esteem) mediated the relationship between unconditional self-acceptance and the risk for exercise addiction (Hall et al., 2009). A positive correlation between the latter and labile self-esteem indicated that two shared 15.2% of the variance. In a study of 107 volunteers, Grandi et al. (2011) also found lower self-esteem in exercisers at risk for exercise addiction in comparison to an asymptomatic control group. Opposite to these findings, Bamber et al. (2000a/b?) reported that individuals exhibiting eating disorder symptoms, with or without risk for exercise addiction, had significantly lower levels of self-esteem than a group of control subjects and individual at risk for exercise addiction without symptoms of eating disorders. It appears that self-esteem may play a role in the aetiology of exercise addiction, but it may be connected with other personality traits like perfectionism (Hall et al., 2009; Miller & Mesagno, 2014) or other inherent psychological dysfunction like labile self-esteem (Hall et al., 2009). Given that exercise is a socially accepted and esteemed behaviour, its adoption for coping with life-adversities may preserve one's self-esteem in contrast to destructive forms of coping like drug or alcohol abuse. The individual using exercise for coping with stress may be convinced that exercise is the right and healthy path in dealing with the hardship. This form of coping behaviour would not damage the potentially already fragile self-esteem of the individual.

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4.12.5.5 Neuroticism and extroversion

Neuroticism and extroversion are two relatively widely studied personality traits that were also linked the risk for exercise addiction. In fact, a study with 246 male and female runners found that among several psychological variable only neuroticism could predict the risk for exercise addiction (Jibaja-Rusth, 1989). Later a group of researchers (Yates, Shisslak, Allender, & Crago, 1992) reported that compulsive runners showed higher neuroticism than asymptomatic runners. Similarly, Adams and Kirkby (1996) found that among a sample of 306 aerobics participants, instructors, and competitors the risk for exercise addiction was predicted by an elevated score of neuroticism. Bamber et al. (2000) found higher scores of neuroticism in people at risk for exercise addiction who also evinced eating disorders in contrast to the subjects who did not exhibit eating disorders. In another investigation conducted with 390 university students, the results revealed that extroversion, neuroticism, as well as agreeableness, predicted the risk scores for exercise addiction (Hausenblas & Giacobbi, 2004). These findings were later replicated by Costa and Oliva (2012) who tested 423 volunteers who exercised for at least one full year before the study. Their results suggested that extraversion, neuroticism, and agreeableness is linked to the aetiology of exercise addiction. Further, in a study of 806 student and sport association exercisers, Kern (2010) disclosed a significant inverse relationship between the risk for exercise addiction and emotional stability. In other words, participants with higher scores of exercise addiction exhibited greater neuroticism A more recent inquiry, conducted with 218 psychology students in Norway, also confirmed that neuroticism may be strongly related to the risk for exercise addiction (Andreassen et al., 2013). In the context of extroversion, Mathers and Walker (1999) examined 12 exercising students who were at risk for exercise addiction in contrast to 12 asymptomatic and another 12 non-exercising students recruited from the same student population. The "at risk" group did not differ from the asymptomatic group in extraversion, although the two exercise groups were more extroverted than the non-exercise group. The results were interpreted as evidence against the claim that extroversion is a component of the addictive exercise behaviour. Similar negative findings were disclosed by Davis (1990) in an investigation of 96 exercising women. The author failed to disclose a connection between the risk for exercise addiction and neuroticism and extroversion. Later, Bamber et al. (2000) showed that subjects affected by the risk of exercise addiction, and also having symptoms of eating disorders, showed the lowest level of extroversion. Recently, a group of Danish researchers (Lichtenstein, Christiansen, Elklit, Bilenberg, & Støving, 2014a) failed to reveal a difference in neuroticism between a group of exercisers at risk for exercise addiction and an asymptomatic exercise control group. However, the two groups differed statistically significantly in their extroversion scores, but the effect size was only small to moderate. It appears that findings in the context of a link between the risk for exercise addiction and personality traits are rather inconsistent. Neuroticism was also linked to other behavioural addictions, including internet addiction (Lei, Yang, & Liu, 2006; Tamanaeifar, Arfeei, & Gandomi, 2014), pathological gambling (Bagby et al., 2007), compulsive shopping for clothes (Johnson & Attmann, 2009), addiction to sex (Pinto, Carvalho, & Nobre, 2013), and online pornography (Egan & Parmar, 2013). Consequently, some personality traits may act as predisposing factors for a wide range of behaviours, including addictive behaviours, which may depend strongly on an interaction with the social and physical environment. For example, the motivation of the individual is determined by past experience and learning. Non-exercisers who have no affinity for exercise will be unlikely to escape in sports and exercise at times of coping with adversity. However, the exerciser having some personality predisposition, interacting with personal and social motives and/or values, could use exercise to escape from stress in the same way as the social drinker who initially enjoyed alcohol in moderation, but upon experiencing a life-trauma starts to drink for pain relief.

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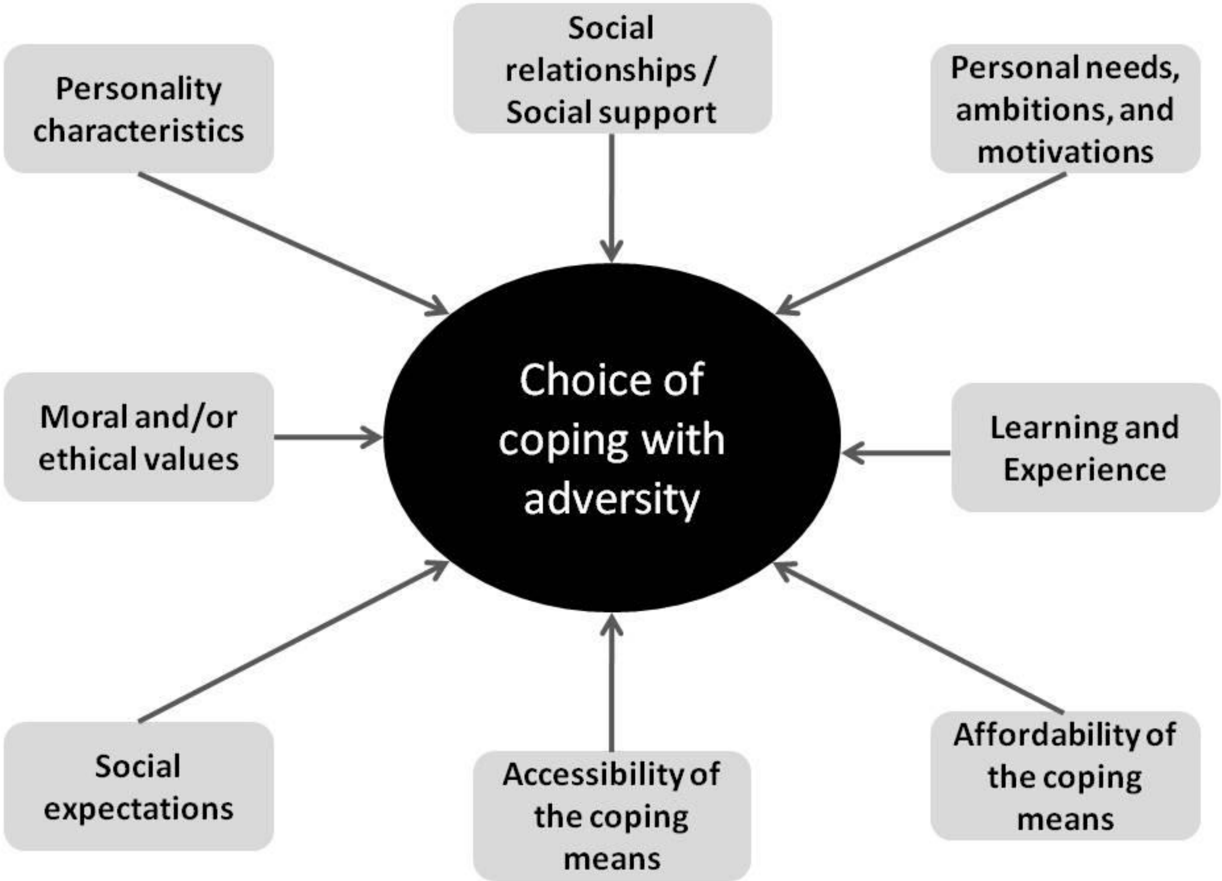
It can be posited that some typical personality traits may increase the risk of escape into excessive exercise. Exercise is not only a part of the everyday life of the habitually physically active individual, but also a conditioned routine behaviour. This conditioned aspect of exercise behaviour is illustrated by the fact that all exercisers experience feelings of deprivation when the exercise routine must be stopped for a reason or another (Szabo, 2010). Conditioned behaviours are reinforced, either positively or negatively. A grey area between the latter two may depict the transition from the healthy and positively reinforced behaviour, that is carried out in moderation, and the morbid pattern of exaggerated exercise behaviour, fuelled by negative reinforcement. Not all exercisers, or even the therapeutic exercisers, as illustrated in the interactional model (Egorov & Szabo, 2013) will choose exercise as a means of escape from stress and hardship. Personality and learned factors, in combination with environmental factors, will all contribute to the cognitive decision (Figure 4.13). This complex set of interactions is most likely the moderating factor in the transition from mastery to therapeutic exercise (Egorov & Szabo, 2013; Freimuth et al., 2011) as well as in the appraisal of the means of coping when a major or uncontrollable life event strikes. It should be noted that all determinants (the grey boxes in Figure 4.13) also interact with each other and each of them bears a different weight at any given time in every person's case. This is why the pathological reliance on exercise behaviour can (and should) only be studied from an idiographic perspective as suggested by the interactional model (Egorov & Szabo, 2013).

Figure 4.13. Personal, social, and environmental factors interacting in the cognitive arbitration used by an individual in making the choice of coping means with stress or psychological hardship.



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4.12.6 Research shortcomings in exercise addiction

Research in exercise addiction is very unfocused. Starting with the scholastic terminology and the labelling of this maladaptive exercise behaviour, scientists may encounter several different words describing the condition (Table 4.7). This is very unproductive in conducting literature searches and in the interpretation of the findings. Cook and Hausenblas (2008) warned that the use of the same scientific term to different situations or the *adoption of different terms to the same situation* will lead to ambiguity, misleading and irreproducible results and errors in interpretation. Many scholars (Berczik et al., 2012, 2014; Szabo, 2010) have clearly emphasized that the term addiction is the most appropriate, not only because exercise addiction comprises all symptoms and components of addiction, but also because the term includes dependence as well as compulsion that are used independently, but incorrectly, to describe the condition.

Second, the research effort is very sporadic in this field. Examination of Table 4.8 that attempts to present a snapshot of the research conducted in the past two decades in the area, which show that the study efforts appear to be random and opportunistic. There is not one central theme under scrutiny. Researchers looked at the connection between symptoms and severity of exercise addiction, primarily based on questionnaire data (Table 4.7), and a wide variety of other factors like motives for exercise, gender, imagery, weight concerns and eating disorders, level of sport or competition, connection to other addictive behaviours, and so on. A closer consultation of Table 4.8 should reflect the diversity of research effort in this area. However, this apparent inconsistency is also due to the mostly opportunistically selected research participants. Most studies approached exercisers at university, fitness or athletic facilities. This method of subject recruitment is not theory driven. If previous studies have identified that people with high scores of perfectionism, narcissism and neuroticism, for example, are more prone to demonstrating this maladaptive behaviour, then these are the individuals who should be recruited and studied. Any scientific knowledge derived from studying these people will ultimately benefit them. In my view, studying exercise addiction is trendy without a solid infrastructure for knowledge. Even the existence of exercise addiction as a disorder may be questionable (Bamber et al., 2000).

The thin ice on which this research area lies is also illustrated by the very wide range in the reported prevalence of the disorder (refer to Table 4.7). Mónok et al. (2012) found that the incidence of high risk exercise addiction is between 0.3% and 0.5% in the general population depending which questionnaire is adopted of the two psychometrically validated tools, the EDS and the EAI. This figure is clearly less than 1.0% percent. When the authors looked at a subset of regular exercisers within the studied sample, the rates were 1.9% with the EDS and 3.2% with the EAI. The near 3.0% figure is consistent with a number of reports from the literature (Allegre et al., 2007; Edmunds et al., 2006; Griffiths et al., 2005; Szabo & Griffiths, 2007; Szabo, 2000, 2010). However, there are several reports (refer to Table 4.7) of prevalence that exceeds 5 to 10 times this figure. For example, Lejoyeux et al. (2008) reported that 42% of their sample could be classified as at high risk for exercise addiction (quote: "*All clients of the fitness room 18 years and older were invited to participate in the study. Three hundred subjects were included; 125 (42%) presented diagnostic criteria of exercise dependence*." p. 353). Clearly, the wide range of prevalence reported for the morbidity raises a question concerning the reason for the diverse findings. I believe that there is not one, but several reasons. First, every assessment tool yields different results, even though the EDS and the EAI, generate relatively closely comparable results. Second, the samples studied may not only be different (i.e., students, runners, body builders, etc.), but also, as a consequence of the diversity, they may attribute different meanings or interpretations to the statements on the questionnaires (Griffiths et al., 2015). A questionnaire item on the EAI is: "*Over time I have increased the amount of exercise I do in a day*". This item is intended to gauge the tolerance component of exercise addiction (Terry et al., 2004). However, an increase in one's physical condition, the taking up of a second or third - whether recreational or competitive sport - exercise, or by simply realizing and enjoying the feeling and benefits of exercise, all may result in a higher rating of this item on a *strongly disagree* to *strongly agree* Likert scale. In light of this contention, it is possible that elite athletes would score high on this (and possibly other) item on the scale, but that would reflect their *progression* or *growth* in the sport rather than addiction. In section 4.7.7, I have presented the case of Péter, who likely went through such a progression in his athletic career without exhibiting any sort of maladjustment in exercise behaviour. Therefore, even using reliable tools, it does not guarantee that the interpretation of the items will be homogenous among the samples studied in various research. Recent evidence shows, that there are differences in the subjective interpretation of the items on the EAI, for example, between men and women and across several different cultures as well (Griffiths et al., 2015).

Considering a definition of exercise addiction, which describes the maladaptive behaviour comprising the components of addiction that lead to physical, psychological or social harm in the affected person's life, questionnaires cannot establish the *harm* through a total score. Indeed, high volume of exercise does not need to be maladaptive. World champions and Olympic athletes spend a large portion of their day with training, without having psychological problems related to their volume of exercise. A morbid pattern of exercise behaviour involves *harm* to the self. A score on questionnaire cannot establish harm. Therefore, questionnaire data need to be complemented with interviews to elaborate and appreciate each individual case. However, as seen in Table 4.7 only a very small portion of the studies on exercise addiction have complemented their questionnaire-based measurements with interviews. Müller at al. (2014) examined the level of agreement between a questionnaire-based classification of *'at-risk for exercise addiction'* and an interview-based diagnosis of the disorder. The authors studied 134 participants using the EDS and a structured clinical interview. The congruence between the questionnaire-based categorizations of ‘at-risk for exercise addiction' and the diagnosis of the disorder was examined using k-coefficients (Cohen's kappa coefficient; see Carletta, 1996). The findings revealed that the agreement between questionnaire-based and interview-based assessment was only fair to moderate, with more false positive classifications emerging from the questionnaire (EDS). The authors conclude that if the structured clinical interview is accepted to be reliable method for the detection of the morbidity, then the questionnaire(s) - in this case the EDS, which is one the most reliable assessment tools for exercise addiction - overestimates the prevalence of the problematic exercise behaviour. The clear message of Müller et al.'s study is that without an interview, one cannot be certain of a problem in one's exercise behaviour. Between the 'at risk' classification and morbidity there is a grey area in obscurity because it is relatively unpredictable, at this time, who will venture onto the morbid path from among those who were classified - via questionnaires - as being *at risk* for exercise addiction. A clear borderline between 'at risk' and pathology is the evidence of *harm* suffered as a consequence of the (exercise) behaviour. This borderline can only be examined through a clinical interview. The mistake of not using interviews in diagnosis is a major shortcoming of the exercise addiction literature that hinders the advancement of the knowledge in the field.

Research diversity (Table 4.8) shows that scholars try to address many different issues surrounding the phenomenon of exercise addiction. Yet, such diversified effort is not productive. The identification and then the closer examination of the cases in which the morbidity can be established through a clear history of self-harm, arising as a consequence of the behaviour, may be the way forward in this area of research. Nearly 15 years ago, I have proposed what I called the “pyramid” approach for the advancement of knowledge about exercise addiction (Szabo, 2001; Figure 4.14). This is bottom-to-top approach requiring multidisciplinary collaboration at several professional levels. The approach requires planning and organization to generate focused effort in the work invested into the better understanding, prevention and treatment of exercise addiction. According to my model, scholars with academic or research training can do the surface screening

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(see “population” on Figure 4.14). Professionals with clinical and/or medical training could then follow up the individuals 'at-risk' with in-depth clinical interviews and then separate those who exercise in high volumes, but maintain control over their exercise, from those who have lost control over their exercise and exhibit maladaptive behavioural patterns (see “group” on Figure 4.14). The primary incentive for exercise, with special attention to “wants to do it” and “has to do it”, should be kept in perspective during the course of these interviews. Once separation at group level has taken place, professionals with clinical training should engage in the treatment of the positively identified individuals while - with the patient's consent - maintain a confidential record about the causes and consequences of their addiction (see “person” on Figure 7). Data from case studies, could then be compiled over time and analysed in an inductive manner by using qualitative methods. This approach can reveal the commonalities between various cases and allow the testing of several models, including the interactional model (Egorov & Szabo, 2013), for the sake of better understanding of the phenomenon of exercise addiction. Indeed, perhaps the greatest shortcoming in the exercise addiction literature is a confounding interpretation of the results from nomothetic research that do not emphasize that the findings only represent the likely or possible *risk* instead of a clinically established morbidity. The latter are unique to the person and, therefore, idiographic, as suggested by the interactional model developed by Egorov and myself (2013).

Figure 4.14. The interdisciplinary and collaboration-requiring “pyramid" approach for the better understanding and treatment of exercise addiction (Szabo, 2001).

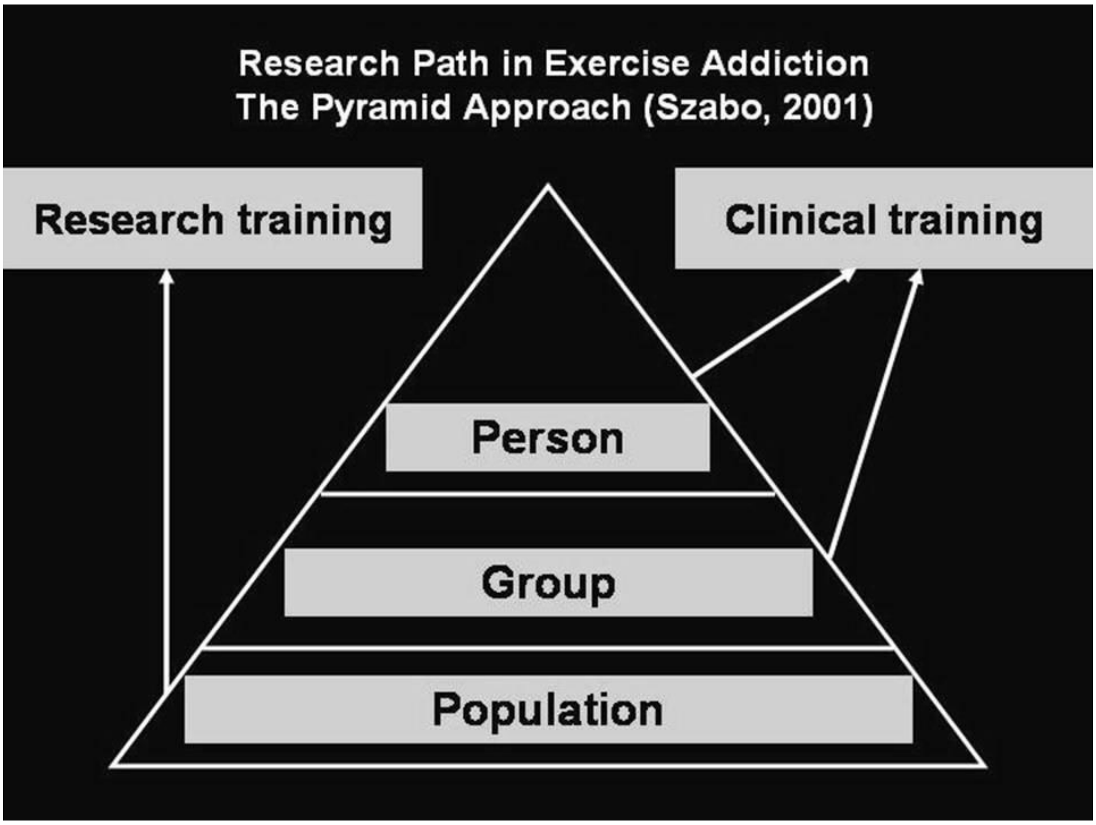

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Table 4.8. The variety of study objectives and main finding of research on exercise addiction over the past 20 years. The table omits case studies and also the methodological (i.e., questionnaire development) reports, but in contrast to Table 4.7, it also includes study findings that examined exercise addiction from a secondary perspective.

Year	Author(s)	Study aims	Key findings
1995	Thornton & Scott	To investigate the relationship between motives for running and addiction.	Primary motives for running were mastery, competition, and weight regulation. Lowest incentive was social recognition. Disclosed correlations between: mastery and addiction, addiction and social recognition, fitness and addiction, age and experience of running, frequency and distance, and mileage.
1998	Slay et al.	To compare the motives for running and examine eating concerns in male and female obligatory and nonobligatory runners.	Obligatory runners scored higher 'escape' and 'addiction' in contrast to the nonobligatory runners. Addicted runners were more prone to athletic injuries and stress fractures; women scored higher than men. Obligatory runners reported higher scores on positive motives factors and eating attitudes. The relationships between eating problems and obligatory running was independent of weekly mileage.
1997	Cook	To examine the relationship between exercise addiction and psychological characteristics.	Disclosed a positive relationship between risk for exercise addiction, perfectionism, compulsiveness and body dissatisfaction. It has also revealed a negative link between exercise addiction and self-esteem.
2000	Bamber et al.	To examine psychological morbidity, personality profiles, exercise beliefs, and eating disorders in women categorized with primary and secondary exercise addiction, and a non-exercises eating disordered group.	Women with primary exercise addiction were not different from controls. In sharp contrast, the secondary exercise addiction group showed higher levels of psychological morbidity, neuroticism, dispositional addictiveness, and impulsiveness, lower self-esteem, greater concern with body shape and body weight, and also with the consequence of not exercising in contrast to controls.
2002c	Hausenblas & Symons Downs	To examine sex differences and the predictive ability of exercise imagery for exercise addiction.	Both genders: Exercise behaviour and energy imagery predicted risk for exercise addiction. Men scored higher than women on exercise addiction. For women, aesthetic imagery was also linked to exercise addiction.

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Year	Author(s)	Study aims	Key findings
2002	Hausenblas & Fallon	To examine the relationship between body image, BMI, exercise behaviour and primary exercise addiction.	The body mass index (BMI) was the best predictor of body dissatisfaction and social physique anxiety in women. The same two variables were best predicted by exercise behaviour in men.
2002	Ackard et al.	To investigate the associations between excessive exercise, eating disorders, and psychological characteristics in college women.	A 'fixation' with exercise is closely linked to indices of psychosocial maladjustment and that is independent of the exercise frequency. An association was disclosed among exercise beliefs and activities, eating-disordered traits, and psychopathology in terms of depression, self-esteem, and mood sensitivity.
2002	Blaydon & Lindner	To investigate different types of dependencies in triathletes and to compare primary and secondary exercise addiction.	Revealed that a relatively large percentage of the studied triathletes exhibited high exercise addiction scores without showing symptoms of eating disorders that would represent a concern. Therefore, the authors concluded that exercise addiction (primary) exists independently of eating disorders.
2003	Hagan & Hausenblas	To examine the relationship between exercise addiction, exercise characteristics, and perfectionism.	A group identified as at high risk of exercise addiction, showed stronger symptoms of exercise addiction, more strenuous, moderate and mild exercise, and more perfectionism.
2004	Hausenblas & Giacobbi Jr.	To examine the relationship exercise addiction, and personality traits.	It was found that extraversion, neuroticism, and agreeableness predicted the scores of exercise addiction.
2006	Edmunds et al.	To examine exercise addiction in light of the Self-Determination Theory (SDT).	Individuals who were symptomatic for exercise addiction exhibited higher levels of competence need satisfaction and all forms of motivational regulation, compared to asymptomatic exercisers. Introjected regulation was found to be a positive predictor of exaggerated exercise behaviour in symptomatic individuals. Identified regulation was a predictor of exaggerated exercise for asymptomatic individuals. The results showed that the SDT is useful in the examination of exercise behaviour.

Year	Author(s)	Study aims	Key findings
2007	Hall et al.	To determine the link between runners' goal orientation, scores of perfectionism, perceived ability, and risk for exercise addiction.	Disclosed a positive association between achievement goal orientation, perfectionism, and exercise addiction in a sample of club runners.
2007	Youngman	To identify possible differences and risk of exercise addiction in sprint-, Olympic-, half-Ironman, and Ironman-distance triathletes.	No significant link was found between the risk for exercise addiction and sporting history (number of years), or the length of training sessions. The number of weekly training hours and training sessions were positively associated with triathletes' risk for exercise addiction. The results demonstrated that triathletes have a lower than presumed risk for exercise addiction, yet a higher risk than the average exercising population.
2007	Szabo & Griffiths	To compare the prevalence of exercise addiction between sport sciences students and general or the average exercising population.	The sport science students scored higher on EAI and on its salience, conflict, and mood change components than the general population.
2007	Allegre et al.	To examine the effects of individual factors and environmental context of physical activity on exercise addiction scores of ultra-marathoners (100 km race).	The results showed that participating exercising in the city in an unstructured Environment were the strongest predictors of exercise addiction in ultra-marathoners.
2008	Lejoyeux et al.	To study exercise addiction in a French fitness club users and its relationship to eating disorders, hypochondria, and other dependencies.	The results revealed that those at risk of exercise addiction were less likely to smoke, exhibited more frequent compulsive buying and bulimia, higher scores hypochondriasis, and spent more time in front of the computer.
2008	Cook & Hausenblas	To examine the possible moderating or mediating influence of the risk for exercise addiction in the relationship between exercise behaviour and eating disorders.	The results indicated that risk for exercise addiction was a mediator between exercise behaviour and eating disorders. The authors concluded that maladaptive exercise behaviour was the critical mediating component of the studied relationship.

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Year	Author(s)	Study aims	Key findings
2008	Hausenblas et al.	To examine the effects of exercise deprivation, in context of exercise addiction scores, using the experience sampling methodology.	Subjects with lower exercise addiction scores felt better on exercise deprivation days in contrast to usual no-exercise days, whereas subjects with higher exercise addiction scores felt about the same on deprivation and planned no-exercise days.
2009	Chittester & Hausenblas	To examine psychological and anthropometric correlates of drive for muscularity.	The results indicated that nutritional supplement use, exercise addiction scores, and low self-esteem were related to drive for muscularity.
2009	Hall et al.	To study the link between self-oriented and socially prescribed perfectionism and exercise addiction, and whether that is mediated by self-acceptance and self-esteem.	Self-oriented perfectionism was positively linked to exercise addiction. Unconditional self-acceptance mediated the relationship between socially prescribed perfectionism and exercise addiction. A labile self-esteem mediated the link between unconditional self-acceptance and exercise addiction.
2010	Kern	To examine the relationship between exercise addiction and personality and to determine whether there is a addictive personality type.	It was found that openness to experience and emotional stability or openness to experience and agreeableness jointly explain the greatest proportion of variance in exercise addiction. dependence. The description of an addictive personality was circumstantial and there was no relationship between exercise addiction and extraversion.
2010	Bratland-Sanda et al.	To describe changes in physical activity and exercise addiction during the treatment of eating disorders and to explore correlations among changes.	The results revealed a correlation between reduced eating disorder measures and the scores of (reduced) exercise addiction. Excessive exercisers had higher scores on every measure and the prevalence of self-injure was the highest among them.
2011	Villella et al.	To assess the prevalence of behavioural addictions in adolescents, by measuring the impact of gender and age, and by determining the correlation between different addictions.	Boys exhibited greater scores of exercise and gambling addiction then girls. The younger students showed greater compulsive buying tendencies. All addiction scores correlated with each other, suggesting a common underlying mechanism to behavioural addictions.

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Year	Author(s)	Study aims	Key findings
2011	Pugh & Hadjistavrop-oulos	To investigate the relationships between health anxiety, exercise desire, physical activity, and exercise addiction.	Health anxiety has affective, cognitive, behavioural, and perceptual dimensions. The perceptual dimension of health anxiety was related to greater exercise desire, exercise withdrawal, and exercise tolerance. General anxiety was negatively associated with the desire to exercise, exercise tolerance, and the time spent exercising.
2011	Cook et al.	To test a conceptual model, which predicts that habitual exercise without compulsion may have beneficial effects on preventing and treating exercise addiction.	The results provided a primer support for the conceptual model tested by showing that the psychological, but not the physical, benefits of exercise were associated with reduced risk for exercise addiction.
2011	Bratland-Sanda et al.	To examine link between exercise addiction score, amount of exercise and eating disorder symptoms in patients with longstanding eating disorders and a non-clinical control group.	A positive link was found between vigorous exercise, exercise addiction scores, and eating disorders symptoms in patients. In the control group, eating disorder symptoms were negatively associated with vigorous exercise and did not correlate with exercise addiction scores. Exercise used for negative affect regulation and the amount of vigorous exercise were predictor variables for exercise addiction in both groups.
2011	Modolo et al.	To examine if there are differences between male and female athletes' scores on measures of exercise addiction symptoms, quality of life, mood, and sleep.	The results revealed a higher commitment to training in males. Women with symptoms of exercise addiction showed lower score on the vigour subscale of the Profile of Mood States inventory in contrast to men. The depression symptoms were higher in subjects at risk for exercise addiction in contrast to their peers at no risk and these figures were even higher in women compared with the male group in the same situation.
2011	Cook & Hausenblas	To examine the relationship among eating disorder-specific quality of life, eating disorder symptoms and exercise behavior.	A significant correlation was found between exercise behavior and exercise addiction and eating disorder symptoms and well-being. Exercise behavior had a significant impact on exercise addiction, while the latter had a significant connection to eating disorder symptoms.

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Year	Author(s)	Study aims	Key findings
2011	Grandi et al.	To study personality and distress associated with exercise addiction.	Exercise addiction was associated with lower self-esteem, lower self-directness, more carefulness, passivity, insecurity, proneness to anxiety and depression in coping with stress (harm avoidance), higher persistence, dysmorphophobia, anxiety, and hostility.
2012	Lejoyeux, Guillot, Chalvin, Petit, & Lequen	To examine the prevalence of exercise addiction among sport shop customers, and its connections with nicotine and alcohol use disorders, eating disorders, hypochondria and compulsive buying.	Exercise addiction was linked to bulimia, increased incidence of hypochondria and higher levels of anxiety illness. The work also disclosed a link between exercise addiction and alcohol dependence. The authors concluded that alcohol use at intoxicating levels and alcohol-related disorders, bulimia and hypochondria all increase the risk for exercise addiction.
2012	Mónok et al.	To compare two assessment tools (the EDS and the EAI) and to examine the prevalence of exercise addiction in a population-wide survey.	Results revealed a high correlation between the two instruments. Both, the EDS and EAI, appeared to be a reliable assessment tools for the risk of exercise addiction. The risk for this morbidity was present in a small fraction of the population, ranging from 0.3% (EDS) to 0.5% (EAI).
2012	McNamara & McCabe	To determine the validity and usefulness of the "Biopsychosocial" model in explaining the onset and/or development, as well as the maintenance of exercise addiction in elite Australian athletes.	Risk for exercise addiction was present in 34% of elite athletes. These athletes had more idiographic and maladaptive exercise beliefs and also demonstrated higher body mass index in comparison to asymptomatic athletes. Further, these athletes also reported higher pressure from their coaches and teammates, as well as lower social support from them, compared to athletes who were asymptomatic. The authors interpret their findings as support for the Biopsychosocial model in the examination of the level of risk for exercise addiction.
2012	Pritchard & Beaver	To investigate the connection between reasons for exercise and risk for exercise addiction.	In women, exercise addiction was predicted by reasons for exercise to improve body tone, level of fitness, and to enhance mood. In men, exercise addiction was predicted by the reasons to exercise to improve body tone, To experience enjoyment, and to increase perceived attractiveness.

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Year	Author(s)	Study aims	Key findings
2013	Cook et al.	To examine the moderating effect of gender in the risk for exercise addiction in context of weight gain, weight loss, or weight maintenance goals.	The results revealed a moderating effect for gender on ideal-weight goals and a gender difference in exercise addiction symptoms. Men who were dissatisfied with their actual weight exhibited a higher risk for exercise addiction than women.
2013	Szabo et al.	To examine some of the moderators contributing to the variability in the risk factors for exercise addiction.	The results revealed that several factors - including gender, level of athletic training, and social context of the training - affect exercise addiction, and that the volume of exercise appears to be unrelated to the vulnerability to exercise addiction.
2013	Cook, Karr, et al.	To examine the risk of exercise addiction in a large community-based sample of runners and the differences between primary and secondary exercise addiction.	Disclosed very low incidence of exercise addiction in runners. The men exhibited more eating disorders than women. The difference between primary and secondary exercise addiction has emerged.
2013	Menczel et al.	To examine the frequency of exercise addiction and eating disorder symptoms and their relationship to each other in a fitness goers.	The prevalence of exercise addiction and eating disorders was much higher among fitness goers than in the average population, which could suggest a connection between the two morbidities.
2014	Cook et al.	To examine the link between pathological motives for exercise and eating disorders related health-related quality of life.	Exercise addiction and eating disorder severity impacted health-related quality of life. The shared (or common) variance was 16.1%. The findings reveal that the combined effects of eating disorder severity and exercise addiction significantly impact health-related quality of life.
2014	Müller et al.	To examine the congruence of the questionnaire derived categorization of ‘at-risk for exercise dependence’ and a clinical interview-based diagnosis.	Both assessment and categorization methods showed agreement. However, there was only a moderate concordance between the questionnaire data and the interview. The study concludes that the diagnosis of risk of exercise addiction based on questionnaires may often lead to false positive results.

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4.12.7 Exercise addiction in competitive athletes: Another paradox?

Exercise addiction is a maladaptive morbid or pathological form of behaviour, that by definition, manifests itself - like most other addictive behaviours - through damage or harm to the person. Researchers have started to examine exercise addiction in elite or competitive athletes (Table 4.7, and 4.8). In spite of the fact that a morbid pattern of exercise behaviour could represent the end of the sporting career for elite athletes, most studies that scrutinized this population have disclosed significantly higher prevalence of risk for exercise addiction than in the average leisure or recreational or student exercisers. Blaydon and Lindner (2002) in a study of 203 triathletes, competing at amateur and professional levels, have found that the incidence of exercise addiction ranged between 21.6% to 30,4%. Seventy of the subjects were professional athletes. A very high percentage (41.4%) of this group was found to be at risk for exercise addiction. Studying subjects competing at different triathlon distances, Youngman (2007) revealed that almost 20% of the 1285 triathletes studied were at risk for exercise addiction. According to the results of an inquiry by McNamara and McCabe (2012), about one third (34%) of the Australian elite athletes may be at risk for exercise addiction. In a more recent study conducted by myself and my Spanish colleagues (Szabo et al., 2013) a significant portion (17%) of a sub-sample of Spanish ultra-marathoners could be considered at risk for exercise addiction. Italian athletes have shown a similar rate, since 18.3% of 262 competitive athletes from nine different sports (basketball, futsal, football, handball, hockey, rugby, softball, volleyball, and water-polo) were found to be at risk of exercise addiction (Costa, Hausenblas, Oliva, Cuzzocrea, & Larcan, 2015). A lower incidence of 7.1% was found in non-professional second and third division Danish football (soccer) players (Lichtenstein, Larsen, Christiansen, Støving, & Bredahl, 2014b). However, even this "lower" figure is high considering the much lower percentages found in the general and recreational exercising population (Mónok et al., 2012; Szabo, 2000, 2010).

A major conceptual concern regarding these high figures is that if 7-42% of the elite or competing athletes are indeed at risk for exercise addiction, then scholars and health professionals are dealing with a rather psychopathological athletic population. This view is ironic in a sense, but it coerces scholars to think over the whole concept of exercise addiction, especially in relation to the methods of assessment that reveal an irrationally high prevalence among athletes. First, by definition in exercise addiction, there is a loss of control of exercise. Therefore, the gratification must occur when the urge compels the person to exercise. In sports, the training and competition sessions are scheduled. They do not match one's inner urges and compulsions. Hence, the exercise addicted athlete would need to exercise before and after training too, which would be impossible physically. There is no "scheduled" addiction. The high scores of athletes, must be due the unique interpretation of questionnaire's scale items by the athletes. For example, "*Exercise is the most important thing in my life.*" (item 1 of the EAI) can be interpreted as the main goal is to succeed in sporting career, thus a tick near the strongly agree (maximum high score) on the questionnaire is a reasonable answer. Then, athletes do experience conflicts in their lives because of their training. The frequent and demanding workouts may interfere with personal and social strivings. However, like work interfering with other life activities for other people, this type of conflict is not the intra- and interpersonal conflict that is experienced by people addicted to exercise. Nevertheless, a high or maximum high score may be given for statement 2 on the EAI: "*Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do*." at the time of assessment. Another item on the EAI is: "*If I have to miss an exercise session I feel moody and irritable*.". Of course that a professional athlete will get irritated when she or he has to miss an important training session, because that may cost her or him the participation at an upcoming competition. I do not intend to analyse each and every item on each and every questionnaire or tool assessing the risk for exercise addiction, because I hope that I can illustrate why high scores may be expected from professional or the elite athletes, for other reason(s) than from 'obsessed' exercisers, on these instruments. Yet, to make the point clear, I will use the EAI for illustration purposes, because it is the shortest assessment instrument aimed at measuring the risk for exercise addiction (Table 4.9).

Table 4.9. Illustration of the hypothetically different interpretations, of the statements on the EAI, by maladaptive exercisers and elite athletes. The key point of the table is to illustrate that different interpretations may yield equally high scores leading to erroneous conclusions.

EAI Items	**Interpretation by: Addicted to exercise**	**Interpretation by: Elite athlete**	**Ratings: 1=low 5 = high**
Exercise is the most important thing in my life.	I cannot manage my life without exercise.	I want to become the best, or to achieve my personal best.	1,2,3,4,5
Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do.	I neglect my family and /or my work because of my urges to exercise.	I cannot spend enough time with my friends and family because of the demanding training.	1,2,3,4,5
I use exercise as a way of changing my mood (e.g., to get a buzz, to escape, etc.).	This is my (only) way to cope with stress and other difficulties in life that I cannot control.	I do my best in training and competition because the good performance uplifts my mood and makes me feel good.	1,2,3,4,5
Over time I have increased the amount of exercise I do in a day.	I need more and more exercise to experience the same sort of stress-relief as before.	As I compete at higher and higher levels of competition, I need to train more and more.	1,2,3,4,5
If I have to miss an exercise session I feel moody and irritable.	Because I did not fulfil my urge to exercise I feel miserable.	If I miss a training session, that could cost me the next competition.	1,2,3,4,5
If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before.	I have tried to control my constant urges to exercise, but I cannot.	If I need to reduce my training for an injury, when I recover I'll train harder to make up for it.	1,2,3,4,5

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Therefore, elite athletes demonstrate high ratings on the questionnaires measuring exercise addiction, not because of morbidity, but because of a different interpretation that is linked to their high commitment to their sport. Their responses may involve aspirations and visions within their strong motivation to become the best they could be in their sport. Without follow-up interviews, the athletes' high scores on exercise addiction questionnaires may be a paradoxical mistake. Müller et al. (2014) showed that questionnaires overestimate the prevalence of exercise addiction. In case of elite athletes this observation is even more relevant.

4.13 What We Know and What We Don't About Exercise Addiction: A Factual Overview

Exercise addiction is a maladaptive behaviour in which most, if not all, component symptoms of addictions are present. It is not a recognized, or rather an 'official', psychiatric disorder in itself since, unlike pathological gambling, it is not listed in the behavioural addictions category of the DSM V. Exercise addiction is erroneously also referred to as exercise dependence, compulsive exercise, obligatory exercise, and/or excessive exercise. This form of pathogenic exercise behaviour includes obsession, compulsion and dependence as manifested by severe withdrawal symptoms and, therefore, the most appropriate terminology is exercise addiction. While its hypothetical presence may be detected with paper and pencil tools, a deep interview is necessary for establishing its symptom-based presence. Questionnaires assessing the risk for exercise addiction may often yield misleading interpretations, because even very high scores on them may not always mirror the presence of the pathogenic behaviour. For example, elite athletes tend to score higher than recreational exercisers, but their score may reflect different interpretation, higher commitment to the sport, and specific goal-based motivations, rather than maladaptation. By definition, exercise addiction affects an individual only if the person has, or very likely will, suffer a *major loss* in health (i.e., repeated injury or re-injury), in personal relationships (conflict with family or friends, divorce, loss of friendship) or in the professional life (e.g., failing a study-course, losing a job, being downgraded to a lower level job). In the absence of negative consequence, high volumes of exercise cannot be connected to exercise addiction. From among those scoring high on exercise addiction questionnaires, only those are likely vulnerable to pathogenic exercise behaviour who use exercise as a means of coping with a life adversity and anterior to that exhibit therapeutic exercise orientation fuelled by negatively reinforced motivation. Certain personality predispositions, such as narcissism, perfectionism, low-self esteem and neuroticism, appear to increase the vulnerability to exercise addiction. The manifestation of the pathogenic exercise behaviour is likely triggered by a sudden or slowly progressing, but reaching a breakpoint, negative life event or stress that may surface in many different forms in terms of personal and environmental interactions. Therefore, exercise addiction, as a form of morbid behaviour, cannot be studied effectively with the nomothetic approach. A clearer insight into the pathogenic condition could be gained through the inductive analyses of case studies identified through an idiographic method. Based on the limited, but unidirectionally pointing current evidence, it is unlikely that exercise addiction is a unique morbidity, but rather it appears to be a joint or co-morbidity of other psychological dysfunction. However, the excessive amount of exercise often traceable in eating disorders is not the same or related morbidity, because instead representing a *solution* (i.e., coping with stress, running away from psychological pain or discomfort), in eating disorders exercise is only a *means* used in achieving a different goal, which is weight loss or weight control.

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5.0 What Does this Dissertation Contribute to the Advancement of Knowledge in the Field of Exercise Psychology?

I have presented a transition from the positive to the negative psychological effects of acute and regular exercise in three parts. In the first part, I have highlighted that exercise has positive psychological effects that can be studied in terms of acute effects (immediate results) or chronic effects (accumulating results). I have emphasized that the motivating factors in the adoption and maintenance of exercise behaviour, or the immediate reward for which the behaviour is undertaken and continued, is the acute or the *immediate* post-exercise gratification. This gratification can be experienced in two different ways. Initially, the pleasant psychological feeling motivates the person to act and re-experience this feeling, at which stage the behaviour is maintained through positive reinforcement. However, psychological satisfaction resulting from exercise also includes feelings of success experienced through the learning and physical conditioning that yields a mastery feeling to the person. A desire to become better and more efficient in the exercise skill results in a mastery motivation that is also fuelled by positive reinforcement. However, an exerciser may focus on other psychological outcomes after an acute bout of exercise, such as the mental relief or feelings of calmness, tranquillity, and positive engagement after the exercise session. If the person, uses these feelings to gain a relief from the hassles and challenges of the daily life, the person's motivation initially is maintained via positive reinforcement, but at the point at which the individual adopts exercise for coping with more and more stress, exercise becomes motivated through negative reinforcement. At this stage, the exerciser *has to do* it, or else some negative consequences may occur. Therefore, motivation for exercise is a mediator of the exercise paradox. One person derives pleasure and *gains* tangible or intangible benefits from exercise, whereas the other person *avoids* something negative or unwanted occurrence (weight gain, stress, disease, etc.).

Through the series of the results emerging from my research, supported by results from the literature, I have shown that exercise intensity, or the workload during exercise, is not instrumental in generating positive psychological benefits. Indeed, several correlational analyses have shown that the positive changes in psychological variables are not associated with exercise intensity. These findings contradict the *"no pain, no gain"* slogan used in the exercise community, at least with respect to the psychological variables. I must stress, that the dose-response relationship that apparently does not play a role in the acute psychological benefits of exercise, it may play a significant role in the chronic, or long term, physiological effects of regular physical activity and training.

My research has shown that both recreational long and middle-range runners as well as elite short distance runners appraise their exercise days as positively more satisfactory than the no-exercise or rest day. While, the examination of the cumulative psychological effects of exercise and its impact throughout the day is an important information from both research and practical perspectives, my results should be viewed with caution for at least two reasons. First, the evening appraisal of the day with a focus on exercise and rest may prompt the exerciser to give answers more in terms of what is expected rather reflecting the actual feeling states. Second, single evening - prior to the bedtime - assessments are prone to memory distortion and may be also affected by the last event before the answering. Therefore, in spite of the fact that I have shown that the overall quality of the day, from a psychological viewpoint, is appraised as more positive in contrast to non-exercise days, these findings should be viewed as tentative and used to motivate experience sampling research in the field.

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In accord with several reports from the literature, my research has shown that regular exercise training lasting for 12 weeks also has measurable psychological effects. In addition to past research, this study has also demonstrated that a mixed strength and endurance exercise training programme, that also accounted for the physiological adaptation to exercise, decreases both the somatic and the cognitive anxiety of the individuals in the exercise group in contrast to people in a waiting-list control group. Moreover, the work is relatively unique in showing that behavioural anxiety (objectively observed) may also decrease in a stress-anticipation period as a result of regular training. Finally, the chronic exercise intervention program also confirmed past results from the literature and an initial theory that regular exercise training reduces the duration of heart rate recovery from stress. It appears then that physical exercise has both acute and chronic benefits on various psychological and physical measures. Among the former changes in affect, mood, and anxiety were the most widely studied and rigorous research yield robust results showing that these psychological factors are positively affected by both acute and chronic exercises.

However, it is the acute psychological effects of exercise that are missed when exercise is not possible for any reason in the regular exerciser's life. Once used to the feeling, the after exercise effect becomes a necessity or a need that if is not satisfied triggers feelings of deprivation. Through a series of pioneering studies on the Internet, I have shown that almost all adopted activities yield different levels of deprivation sensation, but a physically less-demanding activity, such as bowling, may yield less severe deprivation sensation than the physically more challenging exercises. These cross-sectional studies, have provided significant input to the understanding of exercise deprivation while also launching psychological research on the Internet. A follow-up intervention study with martial artists has confirmed the negative psychological effects of exercise deprivation in martial artists, even if those individuals were initially advised that the deprivation interval represents a rest period serving and benefitting their preparation for an upcoming competition. In this part of the dissertation, I discuss the transition from feelings of deprivation to withdrawal symptoms when the affected individual actually suffers because the urge to exercise is not fulfilled. In these situations, there is a loss of control over the exercise that may reflect maladaptation, a pathogenic phenomenon to which I have consecrated the third part of the dissertation.

My studies in the context of exercise addiction have shown that commitment to exercise should not be confounded with addiction to exercise, since the two are different concepts on a health-disease spectrum of the behaviour. I have contributed to the development and validation of the shortest risk-assessment tool for exercise addiction, useful in the screening of the morbid exercise pattern by non-psychologists or others than mental health professionals. I have shown that those who are attached to sports in any way, whether sport science students or ultra-marathoners, tend to score higher on the exercise addiction questionnaires, while that may not reflect pathology, but rather the different meaning of exercise to this population complemented by their motivation, vision, and goal-aspiration. Finally, with a Russian psychiatrist, we have developed an interactional model for the better understanding of exercise addiction that refutes the nomothetic examination of the pathogenic behaviour, because in spite of the similar symptoms, the route of the disorder may be highly unique in the person resulting from a set of personal and social-environmental interactions. A means of better understanding of the pathology would be the inductive examination and learning from case studies.

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5.1 A Point-by-Point Factual Summary of My Scholastic-Contribution to the Advancement of Knowledge in the Field of Exercise Psychology After Obtaining My PhD degree (May, 1993)

(In chronological order)

1. Authored the very first literature review on the topic of exercise deprivation (Szabo, 1995).
2. Presented a model for the role of the cognitive appraisal in therapeutic exercise (Szabo, 1995).
3. Showed that overt behavioural anxiety is decreased by exercise training (Calvo et al., 1996).
4. Revealed faster heart rate recovery from stress due to exercise training (Calvo et al., 1996).
5. Wrote the very first guidelines for research conducted on the Internet (Szabo & Frenkl, 1996).
6. Collected the first cross-sectional data in exercise psychology on the Internet (Szabo, 1997).
7. Showed that runners feel better on running days versus their rest days (Szabo et al., 1998a).
8. Showed that low-effort exercise yields the most psychological benefits (Szabo et al., 1998b).
9. Revealed that the mental benefits of tai chi/yoga last at least for 3-hours (Szabo et al., 1998b).
10. Showed the methodological/ research barriers in studying exercise deprivation (Szabo, 1998).
11. Revealed the negative psychological effects of training deprivation (Szabo & Parkin, 2001).
12. Proved that physical effort did not moderate psychological benefits of exercise (Szabo, 2003).
13. Took active part in the development of an exercise addiction inventory (Griffiths et al., 2005).
14. Showed that link to sports yields a high score of exercise addiction (Szabo & Griffiths, 2007).
15. Reevaluated the role of placebo effects in the psychological benefit of exercise (Szabo, 2013).
16. Showed that exercise patterns do not affect psychological results (Szabo & Ábrahám, 2013).
17. Demonstrated the psychological benefits of running in real life (Szabo & Ábrahám, 2013).
18. Showed that 3-min of light exercise yields improvement in well-being (Szabo et al., 2013a).
19. Showed that exercise addiction is a function of sports-level and gender (Szabo et al., 2013b).
20. Developed the interactional model for studying exercise addiction (Egorov & Szabo, 2013).

6.0 References

Abele, A., & Brehm, W. (1993). Mood effects of exercise versus sports games: Findings and implications for well-being and health. *International Review of Health Psychology, 2,* 53-80.

Ablin, J. N., Clauw, D. J., Lyden, A. K., Ambrose, K., Williams, D. A., Gracely, R. H., & Glass, J. M. (2013). Effects of sleep restriction and exercise deprivation on somatic symptoms and mood in healthy adults. *Clinical and Experimental Rheumatology, 31*(6 Suppl 79), 53-59.

Acevedo, E. O., Dzewaltowski, D. A., Gill, D. L., & Noble, J. M. (1992). Cognitive orientations of ultramarathoners. *The Sport Psychologist*, 6(3), 242-252.

Ackard, D. M., Brehm, B. J., & Steffen, J. J. (2002). Exercise and eating disorders in college-aged women: Profiling excessive exercisers. *Eating Disorders: The Journal of Treatment & Prevention, 10*(1), 31-47. doi: 10.1080/106402602753573540

Adams, J. (2009). Understanding exercise dependence. *Journal of Contemporary Psychotherapy, 39*(4), 231-240. doi: 10.1007/s10879-009-9117-5

Adams, J., & Kirkby, R. J. (Eds.). (1996). Proceedings of the International Conference on Exercise Science: *Exercise dependence in aerobics participants.* Gold Coast, Australia.

Adams, J., & Kirkby, R. J. (1997). Exercise dependence: A problem for sports physiotherapists. *Australian Journal of Physiotherapy, 43*(1), 53-58. doi: 10.1016/S0004-9514(14)60402-5

Adams, J., & Kirkby, R. J. (1998). Exercise dependence: a review of its manifestation, theory and measurement. *Research in Sports Medicine: An International Journal, 8*(3), 265-276. doi: 10.1080/15438629809512532

Adams, J., & Kirkby, R. J. (2002). Excessive exercise as an addiction: A review. *Addiction Research & Theory*, *10*(5), 415-438.

Adams, J., & Kirkby, R. J. (2003). *Exercise dependence: a multidimensional phenomenon*. Unpublished manuscript.

Adams, J. M., Miller, T. W., & Kraus, R. F. (2003). Exercise dependence: diagnostic and therapeutic issues for patients in psychotherapy. *Journal of Contemporary Psychotherapy, 33*(2), 93-107. doi: 10.1023/A:1022883104269

Aidman, E. V., & Woollard, S. (2003). The influence of self-reported exercise addiction on acute emotional and physiological responses to brief exercise deprivation. *Psychology of Sport and Exercise, 4*(3), 225-236. doi: 10.1016/S1469-0292(02)00003-1

Alavi, S. S., Ferdosi, M., Jannatifard, F., Eslami, M., Alaghemandan, H., & Setare, M. (2012). Behavioral addiction versus substance addiction: Correspondence of psychiatric and psychological views. *International Journal of Preventive Medicine, 3*(4), 290–294.

Albrecht, U., Kirschner, N. E., & Grüsser, S. M. (2007). Diagnostic instruments for behavioural addiction: An overview. *GMS Psycho-Social Medicine, 4*(11), Retrieved January 10, 2015 from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2736529/

dc_912_14

Alfermann, D., & Stoll, O. (1996). Befindlichkeitsveränderungen nach sportlicher Aktivität (Mood changes after physical exercise). *Sportwissenschaft, 26*(4), 406-422. (in German)

Allegre, B., Souville, M., Therme, P., & Griffiths, M. D. (2006). Definitions and measures of exercise dependence. *Addiction Research & Theory, 14*(6), 631-646. doi: 10.1080/16066350600903302

Allegre, B., Therme, P., & Griffiths, M. (2007). Individual factors and the context of physical activity in exercise dependence: A prospective study of 'ultra-marathoners'. *International Journal of Mental Health and Addiction, 5*(3), 233-243. doi: 10.1007/s11469-007-9081-9

Allen, M. S., & Laborde, S. (2014). The Role of Personality in Sport and Physical Activity. *Current Directions in Psychological Science, 23*(6), 460-465. doi: 10.1177/0963721414550705

Altchiler, L., & Motta, R. (1994). Effects of aerobic and nonaerobic exercise on anxiety, absenteeism, and job satisfaction. *Journal of Clinical Psychology, 50*(6), 829-840. doi: 10.1002/1097-4679(199411)50:6<829::AID-JCLP2270500603>3.0.CO;2-I

American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders. DSM-4. Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-5. Washington, D.C: American Psychiatric Association.

American Psychological Association. (1992). Ethical principles of psychologists and code of conduct. *American Psychologist, 47*, 1597-1612.

Anderson, S. J., Basson, C. J., & Geils, C. (1997). Personality style and mood states associated with a negative addiction to running. *Sports Medicine, 4*, 6–11.

Anderson, R. J., & Brice, S. (2011). The mood-enhancing benefits of exercise: Memory biases augment the effect. *Psychology of Sport and Exercise, 12*(2), 79-82. doi: 10.1016/j.psychsport.2010.08.003

Andreassen, C. S., Griffiths, M. D., Gjertsen, S. R., Krossbakken, E., Kvam, S., & Pallesen, S. (2013). The relationships between behavioral addictions and the five-factor model of personality. *Journal of Behavioral Addictions, 2*(2), 90–99. doi: 10.1556/JBA.2.2013.003

Andrews, F. M., & Withey, S. B. (1976). *Social indicators of well-being: Americans' perceptions of life quality.* New York: Plenum Press.

Annett, J., Steinberg, H., & Cripps, B. (Eds.). (1995). *Exercise addiction: Motivation for participation in sport and exercise.* Leichester: The British Psychological Society.

Anshel, M. H. (1991). A psycho-behavioral analysis of addicted versus non-addicted male and female exercisers. *Journal of Sport Behavior, 14*(2), 145-154.

Antunes, H. K. M., Terrão, F. L., & de Mello, M. T. (2011). Effects and symptoms of deprivation of physical exercise review. *Revista Brasileira de Ciências Médicas e da Saúde, 1*(1), 62-70.

Asmundson, G. J., Fetzner, M. G., DeBoer, L. B., Powers, M. B., Otto, M. W., & Smits, J. A. (2013). Let's get physical: a contemporary review of the anxiolytic effects of exercise for anxiety and its disorders. *Depression and Anxiety, 30*(4), 362-373.

doi: 10.1002/da.22043

Ábrahám, J., Velenczei, A., & Szabo, A. (2012). Perceived determinants of well-being and enjoyment level of leisure activities. *Leisure Sciences, 34*(3), 199-216. doi: 10.1080/01490400.2012.669677

Bacon, C. J., & Hookway, S. (2003). The effect of musical selections on submaximal exercise parameters and self-selected exercise intensity in aerobics participants. *Journal of Sports Sciences, 21*(4), 259-260.

Baekeland, F. (1970). Exercise deprivation: Sleep and psychological reactions. *Archives of General Psychiatry, 22*(4), 365-369. doi: 10.1001/archpsyc.1970.01740280077014

Bagby, R. M., Vachon, D. D., Bulmash, E. L., Toneatto, T., Quilty, L. C., & Costa, P. T. (2007). Pathological gambling and the five-factor model of personality. *Personality and Individual Differences, 43*(4), 873-880. doi: 10.1016/j.paid.2007.02.011

Bahrke, M. S., & Morgan, W. P. (1978). Anxiety reduction following exercise and meditation. *Cognitive Therapy and Research, 2*, 323-333. doi: 10.1007/BF01172650

Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological Review, 111*(1), 33-51. doi: 10.1037/0033-295X.111.1.33

Bamber, D. J., Cockerill, I. M., & Carroll, D. (2000a). The pathological status of exercise dependence. *British Journal of Sports Medicine, 34*(2), 125-132. doi: 10.1136/bjsm.34.2.125

Bamber, D. J., Cockerill, I. M., Rodgers, S., & Carroll, D. (2000b). “It's exercise or nothing”: a qualitative analysis of exercise dependence. *British Journal of Sports Medicine, 34*(6), 423-430. doi: 10.1136/bjsm.34.6.423

Bamber, D. J., Cockerill, I. M., Rodgers, S., & Carroll, D. (2003). Diagnostic criteria for exercise dependence in women. *British Journal of Sports Medicine, 37*(5), 393-400. doi: 10.1136/bjsm.37.5.393

Barrett, J. R. (1994). Exercise addiction. In M. B. Mellion (Ed.), *Sports Medicine Secrets* (pp. 141-144). Philadelphia: Hanley & Belfus.

Bartley, C. A., Hay, M., & Bloch, M. H. (2013). Meta-analysis: aerobic exercise for the treatment of anxiety disorders. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 45*, 34-39. doi: 10.1016/j.pnpbp.2013.04.016

Basson, C. J. (2001). Personality and Behaviour Associated with Excessive Dependence on Exercise: Some Reflections from Research. *South African Journal of Psychology, 31*(2), 53-60. doi: 10.1177/008124630103100207

Batson, C. D., Shaw, L. L., & Oleson, K. C. (1992). Differentiating affect, mood, and emotion: Toward functionally based conceptual distinctions. In M. S. Clark (Ed.), *Review of personality and social psychology* (pp. 294-326). Newbury Park, CA: Sage.

Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects*. New York, NY: Harper & Row.

Bell, J. M., & Bassey, E. J. (1996). Postexercise heart rates and pulse palpation as a means of determining exercising intensity in an aerobic dance class. *British Journal of Sports Medicine, 30*(1), 48-52. doi: 10.1136/bjsm.30.1.48

dc_912_14

Bellocco, R., Jia, C., Ye, W., & Lagerros Y. T. (2010). Effects of physical activity, body mass index, waist-to-hip ratio and waist circumference on total mortality risk in the Swedish National March Cohort. *European Journal of Epidemiology, 25*(11), 777-788. doi: 10.1007/s10654-010-9497-6

Benson, H. (1983). The relaxation response and norepinephrine: A new study illuminates mechanisms. *Integrative Psychiatry, 1*(1), 15-18.

Berczik, K., Griffiths, M. D., Szabo, A., Kurimay, T., Kökönyei, Gy., Urbán, R., & Demetrovics, Zs. (2014). Exercise addiction - the emergence of a new disorder. *Australasian Epidemiologist, 21*(2), 36-40.

Berczik, K., Szabo, A., Griffiths, M. D., Kurimay, T., Kun, B., Urbán, R., & Demetrovics, Zs. (2012). Exercise addiction: symptoms, diagnosis, epidemiology, and etiology. *Substance Use & Misuse, 47*(4), 403-417. doi: 10.3109/10826084.2011.639120

Berger, B. G., Grove, J. R., Prapavessis, H., & Butki, B. D. (1997). Relationship of swimming distance, expectancy, and performance to mood states of competitive athletes. *Perceptual and Motor Skills, 84*(3), 1199-1210. doi: 10.2466/pms.1997.84.3c.1199

Berger, B. G., & Motl, R. W. (2000). Exercise and mood: A selective review and synthesis of research employing the Profile of Mood States. *Journal of Applied Sport Psychology, 12,* 69-92. doi: 10.1080/10413200008404214

Berger, B. G., & Owen, D. R. (1987). Anxiety reduction with swimming: Relationships between exercise and state, trait, and somatic anxiety. *International Journal of Sport Psychology, 18*(4), 286-302.

Berger, B. G., & Owen, D. R. (1988). Stress reduction and mood enhancement in four exercise modes: Swimming, body conditioning, hatha yoga, and fencing. *Research Quarterly for Exercise and Sport, 59*, 148-159. doi: 10.1080/02701367.1988.10605493

Berger, B. G., & Owen, D. R. (1992). Mood alteration with yoga and swimming; aerobic exercise may not be necessary. *Perceptual and Motor Skills, 75*, 1331-1343. doi: 10.2466/pms.1992.75.3f.1331

Berger, B. G., Owen, D. R., Motl, R. W., & Parks, L. (1998). Relationship between expectancy of psychological benefits and mood alterations in joggers. *International Journal of Sport Psychology, 29*, 1-16.

Berk, L. S., Tan, S. A., Fry, W. F., Napier, B. J., Lee, J. W., Hubbard, R. W.,…Eby, W. C. (1989). Neuroendocrine and stress hormone changes during mirthful laughter. *The American Journal of the Medical Sciences, 298*(6), 390-396.

Berlin, A. A., Kop, W. J., & Deuster, P. A. (2006). Depressive mood symptoms and fatigue after exercise withdrawal: the potential role of decreased fitness. *Psychosomatic Medicine, 68*(2), 224-230. doi: 10.1097/01.psy.0000204628.73273.23

Bernstein, D. A., Borkovec, T. D., & Coles, M. G. H. (1986). Assessment of anxiety. In A. R. Ciminero, K. S. Calhoun & H. E. Adams (Eds.), *Handbook of behavioral assessment* (pp. 353-403). New York, NY:Wiley.

Biddle, S. J. H. (1995). Exercise and psychological health. *Research Quarterly for Exercise and Sport, 66,* 292-297. doi: 10.1080/02701367.1995.10607914

Biddle, S. J. H., Fox, K. R., & Boutcher, S. H. (Eds.). (2000). *Physical activity and psychological well-being*. London: Routledge.

dc_912_14

Biddle, S. J. H., & Mutrie, N. (1991). *Psychology of physical activity and exercise*. London: Springer-Verlag London Ltd.

Biddle, S. J. H., & Mutrie N. (2001). *Psychology of physical activity*. London: Routledge.

Blair, S. N., Kohl, H. W., & Barlow, C. E. (1993). Physical fitness and all-cause mortality: A prospective study of healthy men and women. *Journal of the American College of Nutrition, 12*, 368-371. doi: 10.1001/jama.1989.03430170057028

Blair, S. N., Kohl, H. W., Paffenbarger, R. S., Clark, D. G., Cooper, K. H., & Gibbons, L. W. (1989). Physical fitness and all-cause mortality: A prospective study of healthy men and women. *Journal of the American Medical Association, 262*, 2395-2401. doi: 10.1001/jama.1989.03430170057028

Blaydon, M. J., & Lindner, K. J. (2002). Eating disorders and exercise dependence in triathletes. *Eating Disorders, 10*(1), 49-60. doi: 10.1080/106402602753573559

Blázquez, D. (1990). *Evaluar en educación física.* Barcelona: Inde

Blumenthal, J. A., Emery, C. F., Madden, D. J., George, L. K., Coleman, R. E, Riddle, M. W.,…Williams, R. S. (1989). Cardiovascular and behavioral effects of aerobic exercise training in healthy older men and women. *Journal of Gerontology, 44*(5), M144-157. doi: 10.1093/geronj/44.5.M147

Blumenthal, J. A., Fredrikson, M., Kuhn, C. M., Ulmer, R. L., Walsh-Riddle, M., & Appelbaum, M. (1990). Aerobic exercise reduces levels of cardiovascular and sympathoadrenal responses to mental stress in subjects without prior evidence of myocardial ischemia. *American Journal of Cardiology, 65*(1), 93-98. doi: 10.1016/0002-9149(90)90032-V

Blumenthal, J. A., O'Toole, L. C., & Chang, J. L. (1984). Is running an analogue of anorexia nervosa? *Journal of the American Medical Association (JAMA), 252*(4), 520-523. doi: 10.1001/jama.1984.03350040050022

Blumenthal, J. A., Rose, S., & Chang, J. L. (1985). Anorexia nervosa and exercise: Implications from recent findings. *Sports Medicine, 2*(4), 237-247. doi: 10.2165/00007256-198502040-00001

Bonvallet, M., & Bloch, V. (1961). Bulbar control of cortical arousal. *Science, 133*(3459), 1133-1134. doi: 10.1126/science.133.3459.1133

Boone, T. (1990). Obsessive Exercise—Some Reflections. *Journal of Physical Education, Recreation & Dance, 61*(7), 45-49. doi: 10.1080/07303084.1990.10604579

Borg, G. (1983). Perceived exertion: A note on history and methods. *Medicine and Science in Sports and Exercise, 5*, 90-93.

Bouchard, C. E., Shephard, R. J., & Stephens, T. E. (Eds.). (1994). *Physical activity, fitness, and health: International proceedings and consensus statement*. Champaign, IL, England: Human Kinetics Publishers.

Boyce, C. J., Wood, A. M., & Powdthavee, N. (2013). Is personality fixed? Personality changes as much as "variable" economic factors and more strongly predicts changes to life satisfaction. *Social Indicators Research, 111*(1), 287-305. doi: 10.1007/s11205-012-0006-z

dc_912_14

Bozarth, M. A. (1994). Physical dependence produced by central morphine infusions: an anatomical mapping study. *Neuroscience & Biobehavioral Reviews, 18*(3), 373-383. doi: 10.1016/0149-7634(94)90050-7

Bratland-Sanda, S., Martinsen, E. W., Rosenvinge, J. H., Rø, Ø., Hoffart, A., & Sundgot-Borgen, J. (2011). Exercise dependence score in patients with longstanding eating disorders and controls: the importance of affect regulation and physical activity intensity. *European Eating Disorders Review, 19*(3), 249-255. doi: 10.1002/erv.971

Bratland-Sanda, S., Sundgot-Borgen, J., Rø, Ø., Rosenvinge, J. H., Hoffart, A., & Martinsen, E. W. (2010). Physical activity and exercise dependence during inpatient treatment of longstanding eating disorders: An exploratory study of excessive and non-excessive exercisers. *International Journal of Eating Disorders, 43*(3), 266-273. doi: 10.1002/eat.20769

Brehm, J. W., & Self, E. A. (1989). The intensity of motivation. *Annual Review of Psychology, 40*(1), 109-131. doi: 10.1146/annurev.ps.40.020189.000545

Brehm, B. J., & Steffen, J. J. (1998). Relation between obligatory exercise and eating disorders. *American Journal of Health Behavior, 22*(2), 108-119.

Brooke, S. T., & Long, B. C. (1987). Efficiency of coping with a real-life stressor: A multimodal comparison of aerobic fitness. *Psychophysiology, 24*(2), 173- 180. doi: 10.1111/j.1469-8986.1987.tb00275.x

Brown, R. I. F. (1993). Some contributions of the study of gambling to the study of other addictions. In W. R. Eadington & J. A. Cornelius (Eds.), *Gambling behavior and problem gambling* (pp. 241-272). Reno: University of Nevada Press.

Brown, W. J., Mishra, G., Lee, C., & Bauman, A. (2000). Leisure Time Physical Activity in Australian Women: Relationship with Well Being and Symptoms. *Research Quarterly for Exercise and Sport, 71*(3), 206-216. doi: 10.1080/02701367.2000.10608901

Bruce, R. A. (1972). Multi-stage treadmill tests of maximal and submaximal exercise. In *Exercise testing and training of apparently healthy individuals: A handbook for physicians* (pp. 32-34). New York, NY: American Heart Association.

Brunes, A., Augestad, L. B., & Gudmundsdottir, S. L. (2013). Personality, physical activity, and symptoms of anxiety and depression: the HUNT study. *Social Psychiatry and Psychiatric Epidemiology, 48*(5), 745-756. doi: 10.1007/s00127-012-0594-6

Brunner, B. C. (1969). Personality and motivating factors influencing adult participation in vigorous physical activity. *Research Quarterly. American Association for Health, Physical Education and Recreation, 40*(3), 464-469. doi: 10.1080/10671188.1969.10614863

Bruno, A., Quattrone, D., Scimeca, G., Cicciarelli, C., Romeo, V. M., Pandolfo, G.,… Muscatello, M. R. A. (2014). Unraveling Exercise Addiction: The Role of Narcissism and Self-Esteem. *Journal of Addiction, 2014*, Retrieved January 30, 2015 from: http://downloads.hindawi.com/journals/jad/2014/987841.pdf doi: 10.1155/2014/987841

Calogero, R. M., & Pedrotty, K. N. (2004). The practice and process of healthy exercise: An investigation of the treatment of exercise abuse in women with eating disorders. *Eating Disorders, 12*(4), 273-291. doi: 10.1080/10640260490521352

dc_912_14

Calvo, M. G., Alamo, L., & Ramos, P. (1990). Test anxiety, motor performance and learning: Attentional and somatic interference. *Personality and Individual Diferences, 11*(1), 29-38. doi: 10.1016/0191-8869(90)90165-N

Calvo, M. G., Ramos, P. M., & Estevez, A. (1992). Test anxiety and comprehension efficiency: The role of prior knolwedge and working memory deficits. *Anxiety, Stress, and Coping, 5*(2), 125-138. doi: 10.1080/10615809208250492

Calvo, M. G., Szabo, A., & Capafons, J. (1996). Anxiety and heart rate under psychological stress: The effects of exercise-training. *Anxiety, Stress & Coping, 9*(4), 321-337. doi: 10.1080/10615809608249409

Cameron, O. G., & Hudson, C. J. (1986). Influence of exercise on anxiety level in patients with anxiety disorders. *Psychososmatics, 27*(10), 720-723. doi: 10.1016/S0033-3182(86)72622-4

Carletta, J. (1996). Assessing agreement on classification tasks: The kappa statistic. *Computational Linguistics, 22*(2), 249–254.

Carmack, M. A., & Martens, R. (1979). Measuring commitment to running: A survey of runners' attitudes and mental states. *Journal of Sport Psychology, 1*(1), 25-42.

Carney, R. M., Templeton, B., Hong, B. A., Harter, H. R., Hagberg, J. M., Schechtman, K. B., & Goldberg, A. P. (1987). Exercise training reduces depression and increases the performance of pleasant activities in hemodialysis patients. *Nephron, 47*(3), 194-198. doi: 10.1159/000184490

Carter, R. R., Johnson, S. M., Exline, J. J., Post, S. G., & Pagano, M. E. (2012). Addiction and "Generation Me": Narcissistic and prosocial behaviors of adolescents with substance dependency disorder in comparison to normative adolescents. *Alcoholism Ttreatment Quarterly, 30*(2), 163-178. doi: 10.1080/07347324.2012.663286

Chan, C. S., & Grossman, H. Y. (1988). Psychological effects of running loss on consistent runners. *Perceptual and Motor Skills, 66*(3), 875-883. doi: 10.2466/pms.1988.66.3.875

Chang, M. Y., Chen, C. H., & Huang, K. F. (2008). Effects of music therapy on psychological health of women during pregnancy. *Journal of Clinical Nursing, 17*(19), 2580-2587. doi: 10.1111/j.1365-2702.2007.02064.x

Chapman, C. L., & De Castro, J. M. (1990). Running addiction: Measurement and associated psychological characteristics. *The Journal of Sports Medicine and Physical Fitness, 30*(3), 283-290.

Chen, H. I., Kuo, Y. M., Liao, C. H., Jen, C. J., Huang, A. M., Cherng, C. G.,…Yu, L. (2008). Long-term compulsive exercise reduces the rewarding efficacy of 3,4-methylenedioxymethamphetamine. *Behavioural Brain Research, 187*(1), 185-189. doi: 10.1016/j.bbr.2007.09.014

Chida, Y., & Steptoe, A. (2010). Greater cardiovascular responses to laboratory mental stress are associated with poor subsequent cardiovascular risk status a meta-analysis of prospective evidence. *Hypertension, 55*(4), 1026-1032. doi: 10.1161/HYPERTENSIONAHA.109.146621

Chittester, N. I., & Hausenblas, H. A. (2009). Correlates of drive for muscularity The role of anthropometric measures and psychological factors. *Journal of Health Psychology, 14*(7), 872-877. doi: 10.1177/1359105309340986

dc_912_14

Chodzko-Zajko, W. J., & Ismail, A. H. (1984). MMPI interscale relationships in middle aged male Ss before and after an 8-month fitness program. *Journal of Clinical Psychology, 40*(1), 163-169. doi: 10.1002/1097-4679(198401)40:1<163::AID-JCLP2270400131>3.0.CO;2-K

Clark, L. A., Watson, D., & Leeka, J. (1989). Diurnal variations in the positive affect. *Motivation and Emotion, 13,* 205-234. doi: 10.1007/BF00995536

Claytor, R. P. (1991). Stress reactivity: Hemodynamic adjustments in trained and untrained humans. *Medicine & Science in Sports & Exercise*, *23*(7), 873-881. doi: 10.1249/00005768-199107000-00017

Claytor, R. P., Cox, R. H., Howley, E. T., Lawler, K. A., & Lawler, J. E. (1988). Aerobic power and cardiovascular response to stress. *Journal of Applied Physiology, 65*(3), 1416-1423.

Cockerill, I. M., & Riddington, M. E. (1996). Exercise dependence and associated disorders: a review. *Counselling Psychology Quarterly, 9*(2), 119-129. doi: 10.1080/09515079608256358

Coen, S. P., & Ogles, B. M. (1993). Psychological characteristics of the obligatory runner: A critical examination of the anorexia analogue hypothesis. *Journal of Sport & Exercise Psychology, 15*, 338–354.

Cohen, J. (1969). *Statistical power analysis for the behavioral sciences*. New York, NY: Academic.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155. doi: 10.1037/0033-2909.112.1.155. Retrieved January 1, 2015 from: http://psycnet.apa.org/journals/bul/112/1/155/

Cohen, P., Chen, H., Crawford, T. N., Brook, J. S., & Gordon, K. (2007). Personality disorders in early adolescence and the development of later substance use disorders in the general population. *Drug and Alcohol Dependence, 88*(1), S71-S84. doi: 10.1016/j.drugalcdep.2006.12.012

Cole, C. L. (1998). Addiction, exercise, and cyborgs: Technologies and deviant bodies. In G. Rail (Ed.), *Sport and Postmodern Times* (pp. 261-275). Albany, NY: State University of New York Press.

Columbus, P. J., & Rice, D. L. (1991). Psychological research on the martial arts: An addendum. *British Journal of Medical Psychology*, *64*, 127-135. doi: 10.1111/j.2044-8341.1991.tb01650.x

Conboy, J. K. (1994). The effects of exercise withdrawal on mood states of runners. *Journal of Sport Behaviour, 17*(3), 188-203.

Conn, V. S. (2010). Anxiety outcomes after physical activity interventions: meta-analysis findings. *Nursing Research, 59*(3), 224-231. doi: 10.1097/NNR.0b013e3181dbb2f8

Cook, C. A. (1996). *The psychological correlates of exercise dependence in aerobics instructors* (Unpublished master’s thesis). University of Alberta, Alberta, Canada

Cook, C. A. (1997). *The psychological correlates of exercise dependence in aerobics instructors* (Unpublished master’s thesis). University of Alberta, Alberta, Canada.

dc_912_14

Cook, B. J., Engel, S., Crosby, R., Hausenblas, H. A., Wonderlich, S., & Mitchell, J. (2014). Pathological motivations for exercise and eating disorder specific health-related quality of life. *International Journal of Eating Disorders, 47*(3), 268-272. doi: 10.1002/eat.22198

Cook, B. J., & Hausenblas, H. A. (2008). The Role of Exercise Dependence for the Relationship between Exercise Behavior and Eating Pathology Mediator or Moderator?. *Journal of Health Psychology, 13*(4), 495-502. doi: 10.1177/1359105308088520

Cook, B. J., & Hausenblas, H. A. (2011). Eating disorder-specific health-related quality of life and exercise in college females. *Quality of Life Research, 20*(9), 1385-1390. doi: 10.1007/s11136-011-9879-6

Cook, B. J., Hausenblas, H. A., & Rossi, J. (2013). The moderating effect of gender on ideal-weight goals and exercise dependence symptoms. *Journal of Behavioral Addictions, 2*(1), 50–55. doi: 10.1556/JBA.1.2012.010

Cook, B. J., Hausenblas, H. A., Tuccitto, D., & Giacobbi, P. R. (2011). Eating disorders and exercise: A structural equation modelling analysis of a conceptual model. *European Eating Disorders Review, 19*(3), 216-225. doi: 10.1002/erv.1111

Cook, B. J., Karr, T. M., Zunker, C., Mitchell, J. E., Thompson, R., Sherman, R.,…Wonderlich, S. A. (2013). Primary and secondary exercise dependence in recreational road race runners. *Journal of Sport & Exercise Psychology, 35*(5), 464-469.

Corbin, C. B., Nielsen, A. B., Borsdorf, L. L., & Laurie, D. R. (1987). Commitment to physical activity. *International Journal of Sport Psychology, 18*(3), 215-222.

Costa, S., Cuzzocrea, F., Hausenblas, H. A., Larcan, R., & Oliva, P. (2012). Psychometric examination and factorial validity of the Exercise Dependence Scale-Revised in Italian exercisers. *Journal of Behavioral Addictions, 1*(4), 186-190. doi: 10.1556/JBA.1.2012.009

Costa, S., Hausenblas, H. A., Oliva, P., Cuzzocrea, F., & Larcan, R. (2015). Perceived parental psychological control and exercise dependence symptoms in competitive athletes. *International Journal of Mental Health and Addiction*, *13*(1), 59-72. doi: 10.1007/s11469-014-9512-3

Costa, S., & Oliva, P. (2012). Examining relationship between personality characteristics and exercise dependence. *Review of Psychology*, *19*(1), 5-11.

Cousineau, D., Ferguson, R. J., de Champlain, J., Gauthier, P., Cote, P., & Bourassa M. (1977). Catecholamines in coronary sinus during exercise in man before and after training. *Journal of Applied Physiology*, *43*(5), 801-806.

Cox, R. H., & Orford, J. (2004). A qualitative study of the meaning of exercise for people who could be labelled as' addicted'to exercise-can'addiction'be applied to high frequency exercising?. *Addiction Research & Theory, 12*(2), 167-188. doi: 10.1080/1606635310001634537

Cox, R. H., Thomas, T. R., & Davis, J. E. (2000). Delayed anxiolytic effect associated with an acute bout of aerobic exercise. *Journal of Exercise Physiology Online, 3*(4), 59-66. doi: 10.1111/j.1467-9280.2007.01867.x

dc_912_14

Craft, L. L. (2005). Exercise and clinical depression: examining two psychological mechanisms. *Psychology of Sport and Exercise, 6*(2), 151-171.

Crews, D. J., & Landers, D. M. (1987). A meta-analytic review of aerobic fitness and reactivity to psychosocial stressors. *Medicine & Science in Sports & Exercise, 19*(5), 114-120. doi: 10.1249/00005768-198710001-00004

Cripps, B. (1995) Exercise Addiction and Chronic Fatigue Syndrome: A Case Study of a Mountain Biker. In J. Annett, B. Cripps & H. Steinberg (Eds.), *Exercise Addiction: Motivation for Participation in Sport and Exercise* (pp. 22-33). Leicester: British Psychological Society.

Crisp, A. H., Hsu, L. K. G., Harding, B., & Hartshorn, J. (1980). Clinical features of anorexia nervosa: A study of a consecutive series of 102 female patients. *Journal of Psychosomatic Research, 24*(39), 179-191. doi: 10.1016/0022-3999(80)90040-9

Crossman, J., Jamieson, J., & Henderson, L. (1987). Responses of competitive athletes to lay-offs in training: Exercise addiction or psychological relief? *Journal of Sport Behavior, 10*(1), 28-38.

Crum, A. J., & Langer, E. J. (2007). Mind-Set Matters Exercise and the Placebo Effect. *Psychological Science, 18*(2), 165-171.

Cumella, E. J. (2005). The heavy weight of exercise addiction. *Behavioral Health Management*, *25*(5), 26-31.

Csikszentmihalyi, M., & Larson, R. (1987). Validity and reliability of the experience-sampling method. *The Journal of Nervous and Mental Disease, 175*(9), 526-536.

Csikszentmihalyi, M., & Larson, R. (2014). Validity and Reliability of the Experience-Sampling Method. *In Flow and the Foundations of Positive Psychology* (pp. 35-54). Amsterdam, NL: Springer.

Dagrou, E., & Szabo, A. (1998). Daily assessment of state anxiety and mood in African athletes: Psychological effects of training from a life-quality perspective. *Ife Psychologia, 6*(2), 1-12. doi: 10.4314/ifep.v6i2.23530

Dallal, C. M., Brinton, L. A., Matthews, C. E., Lissowska, J., Peplonska, B., Hartman, T. J., & Gierach, G. L. (2012). Accelerometer-based measures of active and sedentary behavior in relation to breast cancer risk. *Breast Cancer Research and Treatment, 134*(3), 1279-1290. doi: 10.1007/s10549-012-2129-y

Dalle Grave, R., Calugi, S., & Marchesini, G. (2008). Compulsive exercise to control shape or weight in eating disorders: prevalence, associated features, and treatment outcome. *Comprehensive Psychiatry, 49*(4), 346-352. doi: 10.1016/j.comppsych.2007.12.007

Dasilva, S. G., Guidetti, L., Buzzachera, C. F., Elsangedy, H. M., Krinski, K., De Campos, W., …Baldari, C. (2011). Psychophysiological responses to self-paced treadmill and overground exercise. *Medicine and Science in Sports and Exercise, 43*(6), 1114-1124. doi: 10.1249/MSS.0b013e318205874c

Davis, C. (1990a). Body image and weight preoccupation: A comparison between exercising and non-exercising women. *Appetite, 15*(1), 13-21. doi: 10.1016/0195-6663(90)90096-Q

Davis, C. (1990b). Weight and diet preoccupation and addictiveness: The role of exercise. *Personality and Individual Differences, 11*(8), 823-827.

dc_912_14

doi: 10.1016/0191-8869(90)90191-S
Davis, C. (2000). Exercise abuse. *International Journal of Sport Psychology, 31*(2), 278-289.
Davis, C., Brewer, H., & Ratusny, D. (1993). Behavioral frequency and psychological commitment: Necessary concepts in the study of excessive exercising. *Journal of Behavioral Medicine, 16*, 611–628. doi: 10.1007/BF00844722
Davis, C., & Fox, J. (1993). Excessive exercise and weight preoccupation in women. *Addictive Behaviors, 18*(2), 201-211. doi: 10.1016/0306-4603(93)90050-J
Davis, C., Katzman, D. K., & Kirsh, C. (1999). Compulsive physical activity in adolescents with anorexia nervosa: a psychobehavioral spiral of pathology. *The Journal of Nervous and Mental Disease, 187*(6), 336-342.
Davis, C., Kennedy, S. H., Ralevski, E., Dionne, M., Brewer, H., Neitzert, C., & Ratusny, D. (1995). Obsessive compulsiveness and physical activity in anorexia nervosa and high-level exercising. *Journal of Psychosomatic Research, 39*(8), 967-976. doi: 10.1016/0022-3999(95)00064-X
Dawson, K. A., & Peco, J. (2004). Exercise motivation, commitment, addiction and gender. *Medicine & Science in Sports & Exercise, 36*(5), 64-65.
Demetrovics, Zs., & Kurimay, T. (2007). Exercise addiction: a literature review. *Psychiatria Hungarica, 23*(2), 129-141.
DeBusk, R. F. (1990). Techniques of exercise testing. In J. W. Hurst & R. C. Schlant (Eds.), *The Heart* (pp. 1825-1834). New York, NY: McGraw Hill.
De Coverley Veale, D. M. W. (1987). Exercise Dependence. *British Journal of Addiction, 82*(7), 735-740. doi: 10.1111/j.1360-0443.1987.tb01539.x
De Geus, E. J. C., van Doornen, L. J. P., & Orlebeke, J. F. (1993). Regular exercise and aerobic fitness in relation to psychological make-up and physiological stress reactivity. *Psychosomatic Medicine, 55*(4), 347-363.
De Geus, E. J. C., van Doornen, L. J. P., de Visser, D. C., & Orlebeke, J. F. (1990). Existing and training induced differences in aerobic fitness: Their relationship to physiological response patterns during different types of stress. *Psychophysiology, 27*(4), 457-478. doi: 10.1111/j.1469-8986.1990.tb02343.x
De la Torre, J. (1995). Mens sana in corpore sano, or exercise abuse? Clinical considerations. *Bulletin of the Menninger Clinic. 59*(1), 15-31.
De Moor, M. H. M., Beem, A. L., Stubbe, J. H., Boomsma, D. I., & De Geus, E. J. C. (2006). Regular exercise, anxiety, depression and personality: a population-based study. *Preventive Medicine, 42*(4), 273-279. doi: 10.1016/j.ypmed.2005.12.002
De Vries, H. A. (1968) Immediate and long-term effects of exercise upon resting muscle action potential level. *Journal of Sports Medicine and Physical Fitness, 8*, 1-11.
De Vries, H. A. (1981). Tranquilizer effect of exercise: A critical review. *The Physician and Sportsmedicine, 9*(11), 47–53.
Dempsey, P. C., Owen, N., Biddle, S. J., & Dunstan, D. W. (2014). Managing sedentary behavior to reduce the risk of diabetes and cardiovascular disease. *Current Diabetes Reports, 14*(9), 1-11. doi: 10.1007/s11892-014-0522-0
Desharnais, R., Jobin, J., Cote, C., Levesque, L., & Godin, G. (1993). Aerobic exercise and the placebo effect: A controlled study. *Psychosomatic Medicine, 55*(2), 149-154.

dc_912_14

Diener, E., & Emmons, R. A. (1985). The independence of positive and negative affect. *Journal of Personality and Social Psychology, 47,* 1105-1117.

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, G. (1985). The satisfaction with life scale. *Journal of Personality Assessment, 49*(1), 71-75. doi: 10.1207/s15327752jpa4901_13

Di Nicola, M., Martinotti, G., Mazza, M., Tedeschi, D., Pozzi, G., & Janiri, L. (2010). Quetiapine as add-on treatment for bipolar I disorder with comorbid compulsive buying and physical exercise addiction. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 34*(4), 713-714.

Duncan, D. F. (1974). Drug abuse as a coping mechanism. *American Journal of Psychiatry, 131*(6), 724-724.

Dunn, A. L., & Dishman, R. K. (1991). Exercise and the neurobiology of depression. *Exercise and Sport Sciences Reviews, 19*(1), 41-98.

Eberle, S. G. (2004). Compulsive exercise: Too much of a good thing? *National Eating Disorders Association.* Retrieved March 11, 2015 from: http://www.uhs.berkeley.edu/edaw/CmpvExc.pdf

Edmunds, J., Ntoumanis, N., & Duda, J. L. (2006). Examining exercise dependence symptomatology from a self-determination perspective. *Journal of Health Psychology, 11*(6), 887-903. doi: 10.1177/1359105306069091

Edwards, P. (2007). Promoting physical activity and active living in urban environments. *Active Living, 16*(5), 27-30.

Egan, V., & Parmar, R. (2013). Dirty habits? Online pornography use, personality, obsessionality, and compulsivity. *Journal of Sex & Marital Therapy, 39*(5), 394-409. doi: 10.1080/0092623X.2012.710182

Egorov, A. Y., & Szabo, A. (2013). The exercise paradox: An interactional model for a clearer conceptualization of exercise addiction. *Journal of Behavioral Addictions, 2*(4), 199-208. doi: 10.1556/JBA.2.2013.4.2

Egorov, A. Y., & Felsendorff, O. (2014). Personal communication on 19.10.2014.

Ekkekakis, P. (2009). Let them roam free? Physiological and psychological evidence for the potential of self-selected exercise intensity in public health. *Sports Medicine, 39*(10), 857-888. doi: 10.2165/11315210-000000000-00000

Ekkekakis, P. (2013). *The measurement of affect, mood, and emotion: A guide for health-behavioral research*. New York, NY: Cambridge University Press.

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The pleasure and displeasure people feel when they exercise at different intensities. *Sports Medicine, 41*(8), 641-671. doi: 10.2165/11590680-000000000-00000

Ekkekakis, P., & Petruzzello, S. J. (1999). Acute aerobic exercise and affect: Current status, problems and prospects regarding dose-response. *Sports Medicine, 28,* 337-374.

Elbourne, K. E., & Chen, J. (2007). The continuum model of obligatory exercise: A preliminary investigation. *Journal of Psychosomatic Research, 62*(1), 73-80. doi: 10.1016/j.jpsychores.2004.12.003

El-Naggar, A. M. (1986). Physical training effect on relationship of physical, mental, and emotional fitness in adult men. *Journal of Human Ergology, 15,* 79-84. http://dx.doi.org/10.11183/jhe1972.15.79

Emmons, R. A., & King, L. A. (1988). Conflict among personal strivings: Immediate and long-term implications for psychological and physical well being. *Journal of Personality and Social Psychology, 54*(6), 1040-1048. doi: 10.1037/0022-3514.54.6.1040

Enns, M. P., Drewnowski, A., & Grinker, J. A. (1987). Body composition, body-size estimation and attitudes toward eating in male college athletes. *Psychosomatic Medicine, 49*(1), 56-64.

Ensari, I., Motl, R. W., & Pilutti, L. A. (2014). Exercise training improves depressive symptoms in people with multiple sclerosis: Results of a meta-analysis. *Journal of Psychosomatic Research, 76*(6), 465-471. doi: 10.1016/j.jpsychores.2014.03.014

Erdmann, L. D., Dolgener, F. A., & Hensley, L. D. (1998). A comparison of the postexercise heart rates by telemetry and self-pulse palpation in middle-school-age boys. *Measurement in Physical Education and Exercise Science, 2*(4), 199-204. doi: 10.1207/s15327841mpee0204_1

Evans, D. (2011). *The Internet of things: How the next evolution of the Internet is changing everything*. Cisco Internet Business Solutions Group (IBSG). Retrieved January 13, 2015 from: http://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

Eysenck, H. J., & Eysenck, S. B. G. (1963). *Manual for the Eysenck Personality Inventory*. San Diego, CA; Educational and Industrial Testing Service. Retrieved February 15, 2015 from: http://legacy.library.ucsf.edu/tid/hya78d00

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition and Emotion, 6*(6), 409-434. doi: 10.1080/02699939208409696

Fahrenberg, J. (1992). Psychophysiology of neuroticism and anxiety. In A. Gale & M. W. Eysenck (Eds.), *Handbook of individual differences: Biological perspectives* (pp. 179-226). Oxford, England: John Wiley & Sons.

Farrell, P. A., Gates, W. K., Maksud, M. G., & Morgan, W. P. (1982). Increase in plasma beta-endorphin/beta-lipotropin immunoreactivity after treadmill running in humans. *Journal of Applied Physiology: Respiratory, Environmental and Exercise Physiology, 52*(5), 1245-1249.

Farrell, P. A., Gustafson, A. B., Morgan, W. P. & Pert, C. B. (1987). Enkephalins, catecholamines, and psychological mood alterations: effects of prolonged exercise. *Medicine and Science in Sports and Exercise, 19*(4), 347-353. doi: 10.1249/00005768-198708000-00005

Fisher, H. (2006). The drive to love: The neural mechanism for mate selection. In R. J. Sternberg & K. Weis (Eds.), *The new psychology of love* (pp. 87-115). Yale University Press.

Fisher, L. A., & Wrisberg, C. A. (2004). Recognizing and dealing with exercise addiction. *Athletic Therapy Today 9*(1), 36-37.

Fleming, S., Bourgeois, A. E., LeUnes, A., & Meyers, M. C. (1992). *A psychometric comparison of the full scale Profile of Mood States with other abbreviated POMS scales in selected athletic populations*. Presented at the Annual Congress of the

dc_912_14

Association for the Advancement of Applied Sport Psychology, Colorado Springs, CO.

Flory, D. J., & Holmes, D. S. (1991). Effects of an acute bout of aerobic exercise on cardiovascular and subjective responses during subsequent cognitive work. *Journal of Psychosomatic Research, 35*(2), 225-230. doi: 10.1016/0022-3999(91)90076-Z

Flynn, B. R. (1987). *Negative addiction, psychopathology, and changes in mood states in runners* (Unpublished doctoral dissertation). Hofstra University, Hempstead, New York.

Fogaa Leite, G. S., De Mello, M. T., Souza, H. S., Barreto, A. T., Lee, K. S., Tufik, S., & Moreira Antunes, H. K. (2014). Committed exercisers and Exercise deprivation: The relation of biochemical markers and mood. Presented on May 30, 2014 as 'Free Communication' at the American College of Sports Medicine (ACSM) 61st Annual Meeting, Orlando, Fl., USA. *Medicine and Science in Sports & Exercise, 46*(5), 656-656. doi: 10.1249/01.mss.0000451238.24917.7e

Fontaine, K. R. (2000). Physical activity improves mental health. *Physician and Sportsmedicine, 28*(10), 83-84. doi: 10.3810/psm.2000.10.1256

Forcier, K., Stroud, L. R., Papandonatos, G. D., Hitsman, B., Reiches, M., Krishnamoorthy, J., & Niaura, R. (2006). Links between physical fitness and cardiovascular reactivity and recovery to psychological stressors: A meta-analysis. *Health Psychology*, *25*(6), 723–739. doi: 10.1037/0278-6133.25.6.723

Frazier, S. E., & Nagy, S. (1989). Mood stage changes of women as a function of regular aerobic exercise. *Perceptual and Motor Skills, 68*, 283-287.

Freimuth, M., Moniz, S., & Kim, S. R. (2011). Clarifying exercise addiction: Differential diagnosis, co-occurring disorders, and phases of addiction. *International Journal of Environmental Research and Public Health, 8*(10), 4069-4081. doi: 10.3390/ijerph8104069

French, S. A., Perry, C. L., Leon, G. R., & Fulkerson, J. A. (1994). Food preferences, eating patterns, and physical activity among adolescents: Correlates of eating disorders symptoms. *Journal of Adolescent Health, 15*(4), 286-294. doi: 10.1016/1054-139X(94)90601-7

Furst, D. M., & Germone, K. (1993). Negative addiction in male and female runners and exercisers. *Perceptual and Motor Skills, 77*, 192-194. doi: 10.2466/pms.1993.77.1.192

Gapin, J., Etnier, J. L., & Tucker, D. (2009). The relationship between frontal brain asymmetry and exercise addiction. *Journal of Psychophysiology, 23*(3), 135-142. doi: 10.1027/0269-8803.23.3.135

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M.,…Swain, D. P. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Medicine and Science in Sports and Exercise, 43*(7), 1334-1359. doi: 10.1249/MSS.0b013e318213fefb

dc_912_14

Garman, J. F., Hayduk, D. M., Crider, D. A., & Hodel, M. M. (2004). Occurrence of exercise dependence in a college-aged population. Journal of American College Health, 52(5), 221-228. doi: 10.3200/JACH.52.5.221-228

Gauvin, L. (1990). An experiential perspective on the motivational features of exercise and lifestyle. *Canadian Journal of Sport Sciences, 15*(1), 51-58.

Gauvin, L., & Rejeski, W. J. (1993). The Exercise-Induced Feeling inventory:development and initial validation. *Journal of Sport and Exercise Psychology, 15*(4), 403-423.

Gauvin, L., & Szabo, A. (1992). Application of the experience sampling method to the study of the effects of exercise withdrawal on well-being. *Journal of Sport Exercise Psychology, 14*(4), 361-374.

Glass, J. M., Lyden, A. K., Petzke, F., Stein, P., Whalen, G., Ambrose, K.,…Clauw, D. J. (2004). The effect of brief exercise cessation on pain, fatigue, and mood symptom development in healthy, fit individuals. *Journal of Psychosomatic Research, 57*(4), 391-398. doi: 10.1016/j.jpsychores.2004.04.002

Glasser, W. (1976). *Positive Addiction.* New York, NY: Harper & Row.

Glasser, W. (2012). Promoting client strength through positive addiction. *Canadian Journal of Counselling and Psychotherapy/Revue Canadienne de Counseling et de Psychothérapie, 11*(4), 173-175.

Gogulla, S., Lemke, N., & Hauer, K. (2012). Effects of physical activity and physical training on the psychological status of older persons with and without cognitive impairment. *Zeitschrift fur Gerontologie und Geriatrie, 45*(4), 279-289. doi: 10.1007/s00391-012-0347-x

Goldberg, A. S. (1988). *The sports mind: A workbook of mental skills for athletes*. Northampton, MA: Competitive Advantage.

Goldberg, D. (1978). *Manual of the General Health Questionnaire*. Windsor, UK: NFER.

Goldfarb, A. H., & Jamurtas, A. Z. (1997). β-Endorphin response to exercise. *Sports Medicine, 24*(1), 8-16. doi: 10.2165/00007256-199724010-00002

Goldfarb, A. H., Jamurtas, A. Z., Kamimori, G. H., Hegde, S., Otterstetter, R., & Brown, D. A. (1998). Gender effect on beta-endorphin response to exercise. *Medicine and Science in Sports and Exercise, 30*(12), 1672-1676. doi: 10.1097/00005768-199812000-00003

Gonzales, M. E. (1990). *Computer assisted survey information collection*. [Working paper, No.19]. Washington, DC: Statistical Policy Office. Retrieved January 3, 2015 from: http://ntl.bts.gov/lib/7000/7200/7218/wp19.html

Goodman, A. (1990). Addiction: definition and implications. *British Journal of Addiction, 85*(11), 1403-1408. doi: 10.1111/j.1360-0443.1990.tb01620.x

Goodwin, H., Haycraft, E., Taranis, L., & Meyer, C. (2011). Psychometric evaluation of the Compulsive Exercise Test (CET) in an adolescent population: Links with eating psychopathology. *European Eating Disorders Review, 19*(3), 269-279. doi: 10.1002/erv.1109.

Goodwin, H., Haycraft, E., Willis, A. M., & Meyer, C. (2011). Compulsive exercise: The role of personality, psychological morbidity, and disordered eating. *International Journal of Eating Disorders, 44*(7), 655-660. doi: 10.1002/eat.20902

Gothe, N., Hillman, C., & McAuley, E. (2012). The effect of acute yoga and aerobic exercise on word memory and anxiety. *BMC Complementary and Alternative Medicine, 12*(1), 127. doi: 10.1186/1472-6882-12-S1-P127. Retrieved December 31, 2014 from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373422/

Grandi, S., Clementi, C., Guidi, J., Benassi, M., & Tossani, E. (2011). Personality characteristics and psychological distress associated with primary exercise dependence: An exploratory study. *Psychiatry Research, 189*(2), 270-275. doi: 10.1016/j.psychres.2011.02.025

Granero, R., Penelo, E., Stinchfield, R., Fernández-Aranda, F., Aymamí, N., Gómez-Peña, M.,…Jiménez-Murcia, S. (2014). Contribution of Illegal Acts to Pathological Gambling Diagnosis: DSM-5 Implications. *Journal of Addictive Diseases, 33*(1), 41-52. doi: 10.1080/10550887.2014.882730

Grant, J. E., Potenza, M. N., Weinstein, A., & Gorelick, D. A. (2010). Introduction to Behavioral Addictions. *The American Journal of Drug and Alcohol Abuse, 36*(5), 233–241. doi: 10.3109/00952990.2010.491884

Griffiths, M. (1996). Behavioural addiction: an issue for everybody?. *Employee Counselling Today, 8*(3), 19-25. doi: 10.1108/13665629610116872

Griffiths, M. D. (1997). Exercise addiction: A case study. *Addiction Research, 5*(2), 161-168.

Griffiths, M. D. (2002). *Gambling and gaming addictions in adolescence*. Leicester: British Psychological Society/Wiley-Blackwell.

Griffiths, M. D. (2005). A'components' model of addiction within a biopsychosocial framework. *Journal of Substance Use, 10*(4), 191-197. doi: 10.1080/14659890500114359

Griffiths, M. D., Szabo, A., & Terry, A. (2005). The exercise addiction inventory: a quick and easy screening tool for health practitioners. *British Journal of Sports Medicine, 39*(6), e30-e30. doi: 10.1136/bjsm.2004.017020

Griffiths, M. D., Urbán, R., Demetrovics, Zs., Lichtenstein, M. B., de la Vega, R., Kun, B.,…Szabo, A. (2015). A cross-cultural re-evaluation of the Exercise Addiction Inventory (EAI) in five countries. *Sports Medicine - Open, 1*(1), 1-7. doi: 10.1186/s40798-014-0005-5

Grove, J. R., & Prapavessis, H. (1992). Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. *International Journal of Sport Psychology, 23*, 93-109.

Grüsser, S. M., & Thalemann, C. N. (2006). *Verhaltenssucht Diagnostik, Therapie, Forschung.* Bern: Huber.

Grüsser, S. M., Thalemann, R., & Griffiths, M. D. (2006). Excessive computer game playing: evidence for addiction and aggression? *CyberPsychology & Behavior, 10*(2), 290-292. doi: 10.1089/cpb.2006.9956.

Hagan, A., & Hausenblas, H. A. (2003). The relationship between exercise dependence symptoms and perfectionism. *American Journal of Health Studies, 18*(2/3), 133-137.

Hailey, B. J., & Bailey, L. A. (1982). Negative addiction in runners: A quantitative approach. *Journal of Sport Behavior, 5*(3), 150-153.

dc_912_14

Hall, C. R. (1995). Exercise addiction: Motivation for participation in sport and exercise. *The motivational function of mental imagery for participation in sport and exercise* (pp. 15-21). London: British Psychological Society.

Hall, H. K., Hill, A. P., Appleton, P. R., & Kozub, S. A. (2009). The mediating influence of unconditional self-acceptance and labile self-esteem on the relationship between multidimensional perfectionism and exercise dependence. *Psychology of Sport and Exercise, 10*(1), 35–44. doi:10.1016/j.psychsport.2008.05.003

Hall, H. K., Kerr, A. W., Kozub, S. A., & Finnie, S. B. (2007). Motivational antecedents of obligatory exercise: The influence of achievement goals and multidimensional perfectionism. *Psychology of Sport and Exercise, 8*(3), 297-316. doi: 10.1016/j.psychsport.2006.04.007

Hamer, M., & Karageorghis, C. I. (2007). Psychobiological mechanisms of exercise dependence. *Sports Medicine, 37*(6), 477-484. doi: 10.2165/00007256-200737060-00002

Hansen, C. J., Stevens, L. C., & Coast, J. R. (2001). Exercise duration and mood state: How much is enough to feel better? *Health Psychology, 20*(4), 267-275. doi: 10.1037/0278-6133.20.4.267

Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology, 11*(3), 304-317.

Harris, M. B. (1981a). Runners' perceptions of the benefits of running. *Perceptual and Motor Skills, 52*(1), 153-154. doi: 10.2466/pms.1981.52.1.153

Harris, M. B. (1981b). Women runners' views of running. *Perceptual and Motor Skills, 53*(2), 395-402. doi: 10.2466/pms.1981.53.2.395

Harriss, D. J., & Atkinson, G. (2011). Update–ethical standards in sport and exercise science research. *International Journal of Sports Medicine, 32*(11), 819-821. doi: 10.1055/s-0031-1287829

Harte, J. L., Eifert, G. H., & Smith, R. (1995). The effects of running and meditation on beta-endorphin, corticotropin-releasing hormone and cortisol in plasma, and on mood. *Biological Psychology, 40*(3), 251-265. doi: 10.1016/0301-0511(95)05118-T

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A.,…Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1081-1093. doi: 10.1161/CIRCULATIONAHA.107.185649

Hauck, E. R., & Blumenthal, J. A. (1992). Obsessive and compulsive traits in athletes. *Sports Medicine, 14*(4), 215-227. doi: 10.2165/00007256-199214040-00001

Hausenblas, H. A., & Fallon, E. A. (2002). Relationship among body image, exercise behavior, and exercise dependence symptoms. *International Journal of Eating Disorders, 32*(2), 179-185. doi: 10.1002/eat.10071

Hausenblas, H. A., Gauvin, L., Downs, D. S., & Duley, A. R. (2008). Effects of abstinence from habitual involvement in regular exercise on feeling states: an ecological momentary assessment study. *British Journal of Health Psychology, 13*(2), 237-255. doi: 10.1348/135910707X180378

Hausenblas, H. A., & Giacobbi Jr, P. R. (2004). Relationship between exercise dependence symptoms and personality. *Personality and Individual Differences, 36*(6), 1265-1273. doi: 10.1016/S0191-8869(03)00214-9

Hausenblas, H. A., & Symons Downs, D. (2002a). Exercise dependence: A systematic review. *Psychology of Sport and Exercise, 3*(2), 89-123.

Hausenblas, H. A., & Symons Downs, D. (2002b). How much is too much? The development and validation of the exercise dependence scale. *Psychology and Health, 17*(4), 387-404. doi: 10.1080/0887044022000004894

Hausenblas, H. A., & Symons Downs, D. (2002c). Relationship among sex, imagery and exercise dependence symptoms. *Psychology of Addictive Behaviours*, *16*(2), 169-172. doi: 10.1037/0893-164X.16.2.169

Hedges, L. V., & Olkin, L. (1985). *Statistical methods for meta-analysis*. Orlando, FL: Academic Press.

Helfer, S. G., Elhai, J. D., & Geers, A. L. (2014). Affect and exercise: positive affective expectations can increase post-exercise mood and exercise intentions. *Annals of Behavioral Medicine,* (ahead of print, September 2014). 1-11. doi: 10.1007/s12160-014-9656-1

Herring, M. P., O'Connor, P. J., & Dishman, R. K. (2010). The effect of exercise training on anxiety symptoms among patients: a systematic review. *Archives of Internal Medicine, 170*(4), 321-331. doi: 10.1001/archinternmed.2009.530

Herring, M. P., Puetz, T. W., O'Connor, P. J., & Dishman, R. K. (2012). Effect of exercise training on depressive symptoms among patients with a chronic illness: a systematic review and meta-analysis of randomized controlled trials. *Archives of Internal Medicine, 172*(2), 101-111. doi: 10.1001/archinternmed.2011.696

Hewson, C. M., Laurent, D., & Vogel, C. M. (1996). Proper methodologies for psychological and sociological studies conducted via the Internet. *Behavior Research Methods, Instruments, & Computers, 28*(2), 186-191. doi: 10.3758/BF03204763

Ho, C. W., Chan, S. C., Wong, J. S., Cheung, W. T., Chung, D. W., & Lau, T. F. (2014). Effect of Aerobic Exercise Training on Chinese Population with Mild to Moderate Depression in Hong Kong. *Rehabilitation Research and Practice, 2014*. Article ID 627376. doi: 10.1155/2014/627376. Retrieved December 23, 2014 from: http://www.hindawi.com/journals/rerp/2014/627376/

Hoffman, M. D., & Hoffman, D. R. (2008). Exercisers achieve greater acute exercise-induced mood enhancement than nonexercisers. *Archives of Physical Medicine & Rehabilitation, 89*(2), 358-363. doi: 10.1016/j.apmr.2007.09.026

Hoffmann, P. (1997). The endorphin hypothesis. In W. P. Morgan (Ed.), *Physical Activity and Mental Health* (pp. 163-177). Washington: Taylor & Francis.

Hollander, B. J., & Seraganian, P. (1984). Aerobic fitness and psychophysiological reactivity. *Canadian Journal of Behavioral Science*, *16*(3), 257-261. doi: 10.1037/h0080836

Holmes, D. S., & Roth, D. L. (1985). Association of aerobic fitness with pulse rate and subjective responses to psychological stress. *Psychophysiology, 22*(5), 525-529. doi: 10.1111/j.1469-8986.1985.tb01644.x

Holmes, D. S., & Roth, D. L. (1988). Effects of aerobic exercise training and relaxation training on cardiovascular activity during psychological stress. *Journal of Psychosomatic Research, 32*(4), 469-414. doi: 10.1016/0022-3999(88)90031-1

Homan, K. (2010). Athletic-ideal and thin-ideal internalization as prospective predictors of body dissatisfaction, dieting, and compulsive exercise. *Body Image, 7*(3), 240-245. doi: 10.1016/j.bodyim.2010.02.004

Hormuth, S. (1986). The random sampling of experiences in situ. *Journal of Personality, 54*(1), 262-293. doi: 10.1111/j.1467-6494.1986.tb00395.x

Howard, J. H., Cunningham, D. A., & Rechnitzer, P. A. (1987). Personality and fitness decline in middle-aged men. *International Journal of Sport Psychology, 18*(2), 100-111.

Howard, R. A., Freedman, D. M., Park, Y., Hollenbeck, A., Schatzkin, A., & Leitzmann, M. F. (2008). Physical activity, sedentary behavior, and the risk of colon and rectal cancer in the NIH-AARP Diet and Health Study. *Cancer Causes & Control, 19*(9), 939-953. doi: 10.1007/s10552-008-9159-0

Huang, A. M., Jen, C. J., Chen, H. F., Yu, L., Kuo, Y. M., & Chen, H. I. (2006). Compulsive exercise acutely upregulates rat hippocampal brain-derived neurotrophic factor. *Journal of Neural Transmission, 113*(7), 803-811. doi: 10.1007/s00702-005-0359-4

Hughes, J. R. (1984). Psychological effects of habitual aerobic exercise: A critical review. *Preventive Medicine, 13*(1), 66-78. doi: 10.1016/0091-7435(84)90041-0

Hurst, R., Hale, B., Smith, D., & Collins, D. (2000). Exercise dependence, social physique anxiety, and social support in experienced and inexperienced bodybuilders and weightlifters. *British Journal of Sports Medicine, 34*(6), 431-435. doi: 10.1136/bjsm.34.6.431

Ismail, A. H., & Young, R. J. (1977). Effect of chronic exercise on the personality of adults. *Annals of the New York Academy of Sciences, 301*(1), 958-969. doi: 10.1111/j.1749-6632.1977.tb38262.x

Iwamoto, G. A., & Kaufman, M. P. (1987). Caudal ventrolateral medullary cells responsive to muscular contraction. *Journal of Applied Physiology, 62*(1), 149-157.

Jackson, E. M., & Dishman, R. K. (2006). Cardiorespiratory fitness and laboratory stress: A meta-regression analysis. *Psychophysiology, 43*(1), 57-72. doi: 10.1111/j.1469-8986.2006.00373.x

Jambor, E. A., Rudisill, M. E., Weekes, E. M., & Michaud, T. J. (1994). Association among fitness components, anxiety, and confidence following aerobic training in aquarunning. *Perceptual and Motor Skills, 78*(2), 595-602. doi: 10.2466/pms.1994.78.2.595

Jamieson, J., Flood, K., & Lavoie, N. (1994). Physical fitness and heart rate recovery from stress. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement, 26*(4), 566. doi: 10.1037/0008-400X.26.4.566

Jasnoski, M. L., & Holmes, D. S. (1981). Influence of initial aerobic fitness, aerobic training and changes in aerobic fitness on personality functioning. *Journal of Psychosomatic Research, 25*(6), 553-556. doi: 10.1016/0022-3999(81)90109-4

Jasnoski, M. L., Holmes, D. S., Solomon, S., & Aguiar, C. (1981). Exercise, changes in aerobic capacity, and changes in self-perceptions: An experimental investigation. *Journal of Research in Personality, 15*(4), 460-466. doi: 10.1016/0092-6566(81)90042-8

Jibaja-Rusth, M. L. (1989). *The development of a psycho-social risk profile for becoming an obligatory runner* (Unpublished doctoral dissertation). University of Houston, Houston.

Johnson, M. (2000). *Understanding exercise addiction.* New York, NY: The Rosen Publishing Group.

Johnson, M. D. (1994). Disordered eating in active and athletic women. *Clinics in Sports Medicine, 13*(2), 355-369.

Johnson, R. (1995). Exercise dependence: When runners don't know when to quit. *Sports Medicine and Arthroscopy Review, 3*(4), 267-273.

Johnson, T., & Attmann, J. (2009). Compulsive buying in a product specific context: clothing. *Journal of Fashion Marketing and Management: An International Journal, 13*(3), 394-405. doi: 10.1108/13612020910974519

Jonas S., & Phillips, E. M. (2012). *ACSM's Exercise Is MedicineTM: A Clinician's Guide to Exercise Prescription.* Philadelphia (PA): Wolters Kluwer, Lippincott Williams & Wilkins.

Jones, R. D., & Weinhouse, S. (1979). Running as self therapy. *The Journal of Sports Medicine and Physical Fitness, 19*(4), 397-404.

Joseph, P., & Robbins, J. M. (1981). Worker or runner? The impact of commitment to running and work on self-identification. In M. Sacks & M. Sachs (Eds.), *Psychology of Running* (pp. 131-146). Champaign, ILL: Human Kinetics.

Kaminker, L. (1998). *Exercise Addiction: When Fitness Becomes an Obsession*. New York, NY: The Rosen Publishing Group.

Karageorghis, C. I., Jones, L., & Low, D. C. (2006). Relationship between exercise heart rate and music tempo preference. *Research Quarterly for Exercise and Sport 77*(2), 240-250. doi: 10.1080/02701367.2006.10599357

Karvonen, M., Kentala, K., & Mustala, O. (1957). The effects of training heart rate: a longitudinal study. *Annales Medicinae Experimentalis et Biologiae Fenniae, 35*(3), 307-315.

Keller, S., & Seraganian, P. (1984). Physical fitness level and autonomic reactivity to psychosocial stress. *Journal of Psychosomatic Research, 28*(4), 219-281. doi: 10.1016/0022-3999(84)90050-3

Kerling, A., Tegtbur, U., Gützlaff, E., Kück, M., Borchert, L., Ates, Z.,…Kahl, K. G. (2015). Effects of Adjunctive exercise on physiological and psychological parameters in depression: A randomized pilot trial. *Journal of Affective Disorders* (January 15, 2015, ahead of print).

Kern, L. (2010). [Relationship between exercise dependence and big five personality]. *L'Encephale, 36*(3), 212-218. doi: 10.1016/j.encep.2009.06.007 (in French)

Kern, L., & Baudin, N. (2011). Validation française du questionnaire de dépendance de l'exercice physique (Exercise Dependence Questionnaire). *Revue Européenne de Psychologie Appliquée/European Review of Applied Psychology, 61*(4), 205-211. doi: 10.1016/j.erap.2011.08.001 (in French)

Kerr, J. H., & Vlaswinkel, E. H. (1990). Effects of exercise on anxiety: A review. *Anxiety research, 2*(4), 309-321.

Kety, S. S. (1966). Catecholamines in neuropsychiatric states. *Pharmacological Reviews, 18*(1), 787-798.

Kirkby, R. J. & Adams, J. (1996). Exercise dependence: The relationship between two measures. *Perceptual and Motor Skills 82*(2), 366. Retrieved January 4, 2015 from: http://europepmc.org/abstract/MED/8724903

Kjaer, M., & Dela, F. (1996). Endocrine response to exercise. In L. Hoffman-Goetz (Ed.), *Exercise and immune function* (pp. 6–8). Boca Raton, FL: CRC Press

Klaperski, S., von Dawans, B., Heinrichs, M. & Fuchs; R. (2014). Effects of a12-week endurance training on the physiological response to psychosocial stress in men: A randomized controlled trial. *Journal of Behavioral Medicine*. Advance online publication. doi: 10.1007/s10865-014-9562-9

Knight, P. O., Schocken, D. D., Powers, P. S., Feld, J., & Smith, J. T. (1987). Gender comparison in anorexia nervosa and obligate running. *Medicine and Science in Sports and Exercise, 19*(2), 396, S66 (Abstract).

Ko, C. H., Yen, J. Y., Chen, C. C., Chen, S. H., Wu, K., & Yen, C. F. (2006). Tridimensional personality of adolescents with internet addiction and substance use experience. *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie, 51*(14), 887-894.

Koltyn, K. F. (1997). The thermogenic hypothesis. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 213-226). Washington: Taylor and Francis.

Koltyn, K. F., & Schultes, S. S. (1997). Psychological effects of an aerobic exercise session and a rest session following pregnancy. *The Journal of Sports Medicine and Physical Fitness, 37*(4), 287-291.

Konzak, B., & Boudreau, F. (1984). Martial arts training and mental health: An exercise in self-help. *Canada's Mental Health, 32*(4), 2-8.

Konzak, B., & Klavora, P. (1980). Some psychological dimensions of karate participation: An examination of personality characteristics within the training context of a traditional martial art. In P. Klavora & K. A. W. Wipper (Eds.), *Psychological and Sociological Factors in Sport* (pp. 217-232). Toronto: University of Toronto Press.

Kop, W. J., Weinstein, A. A., Deuster, P. A., Whittaker, K. S., & Tracy, R. P. (2008). Inflammatory markers and negative mood symptoms following exercise withdrawal. *Brain, Behavior, and Immunity, 22*(8), 1190-1196. doi: 10.1016/j.bbi.2008.05.011

Korolenko Ts. P. (1991). Аддиктивное поведение. Общая характеристика и закономерности развития [Addictive behaviour. General characteristics and patterns of development.] *Review of Psychiatry and Medical Psychology, 1,* 8-15. (in Russian).

Kotbagi, G., Muller, I., Romo, L., & Kern, L. (2014). Pratique problématique d'exercice physique: un cas clinique. *Annales Médico-Psychologiques, Revue Psychiatrique , 172*(10), 883-887. doi: 10.1016/j.amp.2014.10.011 (in French)

dc_912_14

Krivoschekov, S. G., & Lushnikov, O. N. (2011). Psychophysiology of sports addictions (exercise addiction). *Human Physiology, 37*(4), 509-513. doi: 10.1134/S0362119711030030

Kropkó, P., & Bene, J. (2006). Megtettem mert elhittem [I did it because I believed it]. Siófok: Balatonpress Kft. ISBN 963-0606-275 (in Hungarian)

Kubitz, K. A., & Landers, D. M. (1993). The effects of aerobic training on cardiovascular responses to mental stress: An examination of underlying mechanisms. *Journal of Sport and Exercise Psychology, 15*, 326-326.

Kugler, J., Seelbach, H., & Kruskemper, G. M. (1994). Effects of rehabilitation exercise programmes on anxiety and depression in coronary patients: A meta analysis. *British Journal of Clinical Psychology, 33*(3), 401-410. doi: 10.1111/j.2044-8260.1994.tb01136.x

LaFontaine, P. T., DiLorenzo, T. M., Frensch, P. A., Stucky-Ropp, R. C., Bargman, E. P., & MacDonald, D. G. (1992). Aerobic exercise and mood: A brief review, 1985-1990. *Sports Medicine, 13*, 160-170. doi: 10.2165/00007256-199213030-00002

La Forge, R. (1995). Exercise-associated mood alterations: A review of interactive neurobiological mechanisms. *Medicine, Exercise, Nutrition and Health, 4*, 17-32.

Lamb, D. (1978). Use of behavioral measures in anxiety research. *Psychological Reports, 43*, 1079-1085. doi: 10.2466/pr0.1978.43.3f.1079

Landers, D. M., & Petruzzello, S. J. (1994). Physical activity, fitness and anxiety. In C. Bouchard, R. J. Shephard & T. Stephens (Eds.), *Physical activity, fitness and health: International proceedings and consensus statement* (pp. 868-882). Champaign, IL: Human Kinetics.

Landolfi, E. (2013). Exercise addiction. *Sports Medicine, 43*(2), 111-119. doi: 10.1007/s40279-012-0013-x

Lavey, R., Sherman, T., Mueser, K. T., Osborne, D. D., Currier, M., & Wolfe, R. (2005). The effects of yoga on mood in psychiatric inpatients. *Psychiatric Rehabilitation Journal, 28*(4), 399-402. doi: 10.2975/28.2005.399.402

Layton, C. (1988). *Unmasking the martial artist*. Hunstanton, Norfolk, England: Kime.

Lazarus, R. S. (1988). The psychology of stress and coping. In C. D. Spielberger & I. G. Sarason (Eds.), *Stress and Anxiety* (pp. 399-418). New York: Hemisphere Publishing.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York, NY: Springer Publishing Company.

Le, K., Donnellan, M. B., & Conger, R. (2014). Personality development at work: Workplace conditions, personality changes, and the corresponsive principle. *Journal of Personality, 82*, 44–56. doi: 10.1111/jopy.12032

Le Bon, O., Basiaux, P., Streel, E., Tecco, J., Hanak, C., Hansenne, M.,…Dupont, S. (2004). Personality profile and drug of choice; a multivariate analysis using Cloninger's TCI on heroin addicts, alcoholics, and a random population group. *Drug and Alcohol Dependence, 73*(2), 175-182. doi: 10.1016/j.drugalcdep.2003.10.006

Leddy, M. H., Lambert, M. J., & Ogles, B. M. (1994). Psychological consequences of athletic injury among high-level competitors. *Research Quarterly for Exercise and Sport, 65*(4), 347-354. doi: 10.1080/02701367.1994.10607639

Lee, D., Sui, X., Ortega, F. B., Kim, Y. S., Church, T. S. Winett, R. A. (2011). Comparison of leisure-time physical activity on cardiorespiratory fitness as predictors of all-cause mortality in men and women. *British Journal of Sports Medicine, 46*(6), 504-510. doi: 10.1136/bjsm.2009.066209

Lei, L., Yang, Y., & Liu, M. (2006). The relationship between adolescents' neuroticism, internet service preference and internet addiction. *Acta Psychologica Sinica, 38*(3), 375-381.

Leith, L. M. (1994). *Foundations of exercise and mental health*. Morgatown, WV: Fitness Information Technology.

Leith, L. M., & Taylor, A. H. (1990). Psychological aspects of exercise: A decade literature review. *Journal of Sport Behaviour, 13*(4), 219-239.

Lejoyeux, M., Avril, M., Richoux, C., Embouazza, H., & Nivoli, F. (2008). Prevalence of exercise dependence and other behavioral addictions among clients of a Parisian fitness room. *Comprehensive Psychiatry, 49*(4), 353-358. doi: 10.1016/j.comppsych.2007.12.005

Lejoyeux, M., Guillot, C., Chalvin, F., Petit, A., & Lequen, V. (2012). Exercise dependence among customers from a Parisian sport shop. *Journal of Behavioral Addictions, 1*(1), 28-34. doi: 10.1556/JBA.1.2012.1.3

Lesgold, A. (1991). Research methodology in the postinformatic age. *Behavior Research Methods, Instruments, and Computers, 23*(2), 109-111. doi: 10.3758/BF03203348

LeUnes, A., & Burger, J. (2000). Profile of Mood States research in sport and exercise psychology: past, present, and future. *Journal of Applied Sport Psychology, 12,* 5-15. doi: 10.1080/10413200008404210

Lewis, R. (1984). Exercise addiction. *Women's Sports, 1,* 14-17.

Léger, L. A. (1982). Energy cost of disco dancing. *Research Quarterly for Exercise and Sport, 53*(1), 46-49. doi: 10.1080/02701367.1982.10605224

Li, G., & Yin, J. C. (2008). The effects of shadowboxing on mood and beta-Ep in still condition of female college students. *Journal of Beijing Sport University, 31*(3), 356-358.

Lichtenstein, M. B., Christiansen, E., Bilenberg, N., & Støving, R. K. (2012). Validation of the exercise addiction inventory in a Danish sport context. *Scandinavian Journal of Medicine and Science in Sports*, *24*(2), 447–453. doi: 10.1111/j.1600-0838.2012.01515.x

Lichtenstein, M. B., Christiansen, E., Elklit, A., Bilenberg, N., & Støving, R. K. (2014a). Exercise addiction: a study of eating disorder symptoms, quality of life, personality traits and attachment styles. *Psychiatry Research, 215*(2), 410-416. doi: 10.1016/j.psychres.2013.11.010

Lichtenstein, M. B., Larsen, K. S., Christiansen, E., Støving, R. K., & Bredahl, T. V. G. (2014b). Exercise addiction in team sport and individual sport: Prevalences and validation of the exercise addiction inventory. *Addiction Research & Theory, 22*(5), 431-437. doi: 10.3109/16066359.2013.875537

dc_912_14

Lindwall, M., & Palmeira, A. (2009). Factorial validity and invariance testing of the Exercise Dependence Scale-Revised in Swedish and Portuguese exercisers. *Measurement in Physical Education and Exercise Science, 13*(3), 166-179. doi: 10.1080/10913670903050313

Long, B. C. (1993). A cognitive perspective on the stress-reducing effects of physical exercise. In P. Seraganian (Ed.), *Exercise psychology: The influence of physical exercise on psychological processes* (pp. 339-357). New York, NY: Wiley.

Lorr, M., & McNair, D. (1984). *Manual for the Profile of Mood States Bipolar Form*. San Diego, CA: Educational and Industrial Testing Service.

Lorr, M., McNair, D. M., & Droppleman, L. F. (1971). *Manual for the profile of mood states*. San Diego, CA: Educational and Industrial Testing Service.

Loumidis, K. S., & Wells, A. (1998). Assessment of beliefs in exercise dependence: The development and preliminary validation of the exercise beliefs questionnaire. *Personality and Individual Differences, 25*(3), 553-567. doi: 10.1016/S0191-8869(98)00103-2

Lynch, W. J., Peterson, A. B., Sanchez, V., Abel, J., & Smith, M. A. (2013). Exercise as a novel treatment for drug addiction: a neurobiological and stage-dependent hypothesis. *Neuroscience & Biobehavioral Reviews, 37*(8), 1622-1644. doi:10.1016/j.neubiorev.2013.06.011

Lyons, H. A., & Cromey, R. (1989). Compulsive jogging: Exercise dependence and associated disorder of eating. *The Ulster Medical Journal, 58*(1), 100-102.

Markoff, R. A., Ryan, P., & Young, T. (1982). Endorphins and mood changes in long-distance running. *Medicine and Science in Sports and Exercise, 14*(1), 11-15.

Martens, R. (1970). A social psychology of physical activity. *Quest, 14*, 8-17.

Martin, R. M., & Marcuse, F. L. (1958). Characteristics of volunteers and nonvolunteers in psychological experimentation. *Journal of Consulting Psychology, 22*(6), 475. doi: 10.1037/h0041496

Martinsen, E. W., Hoffart, A., & Solberg, O. Y. (1989). Aerobic and nonaerobic forms of exercise in the treatment of anxiety disorders. *Stress Medicine, 5*(2), 115- 120. doi: 10.1002/smi.2460050209

Maslow, A. H. (2013). *Toward a psychology of being*. New York, NY: Start Publishing LLC.

Mathers, S., & Walker, M. B. (1999). Extraversion and exercise addiction. *The Journal of Psychology, 133*(1), 125-128. doi: 10.1080/00223989909599727

Matheson, H., & Crawford-Wright, A. (2000). An examination of eating disorder profiles in student obligatory and non-obligatory exercisers. *Journal of Sport Behavior, 23*(1), 42-50.

McAuley, E., & Courneya, K. S. (1994). The Subjective Exercise Experience Scale (SEES): Development and preliminary validation. *Journal of Sport and Exercise Psychology, 16*, 163-177.

McAuley, E., Courneya, K. S., & Lettunich, J. (1991). Effects of acute and long-term exercise on self-efficacy responses in sedentary, middle-aged males and females. *The Gerontologist*, *31*(4), 534-542. doi: 10.1093/geront/31.4.534

McDonald, D. G., & Hodgdon, J. A. (1991). *The psychological effects of aerobic fitness training: Research and theory*. New York, NY, US: Springer-Verlag Publishing. doi: 10.1007/978-1-4612-3182-0

McGowan, R. W., Pierce, E. E., & Jordan, D. (1991). Mood alterations with a single bout of physical activity. *Perceptual and Motor Skills, 72,* 1203-1209. doi: 10.2466/pms.1991.72.3c.1203

McKinney, C. H., Tims, F. C., Kumar, A. M., & Kumar, M. (1997). The effect of selected classical music and spontaneous imagery on plasma β-endorphin. *Journal of Behavioral Medicine, 20*(1), 85-99. doi: 10.1023/A:1025543330939

McLachlan, C. D., Hay, M., & Coleman, G. J. (1994). The effects of exercise on the oral consumption of morphine and methadone in rats. *Pharmacology Biochemistry and Behavior, 48*(2), 563-568. doi: 10.1016/0091-3057(94)90572-X

McMillian, D. J., Moore, J. H., Hatler, B. S., & Taylor, D. C. (2006). Dynamic vs. static-stretching warm up: the effect on power and agility performance. *The Journal of Strength & Conditioning Research, 20*(3), 492-499.

McNally, G. P., & Akil, H. (2002). Role of corticotropin-releasing hormone in the amygdala and bed nucleus of the stria terminalis in the behavioral, pain modulatory, and endocrine consequences of opiate withdrawal. *Neuroscience, 112*(3), 605-617. doi: 10.1016/S0306-4522(02)00105-7

McNamara, J., & McCabe, M. P. (2012). Striving for success or addiction? Exercise dependence among elite Australian athletes. *Journal of Sports Sciences, 30*(8), 755-766. doi: 10.1080/02640414.2012.667879

McPherson, B. D., Paivio, A., Yuhasz, M. S., Rechnitzer, P. A., Pickard, H. A., & Lefcoe, N. B. (1967). Psychological effects of an exercise program for postinfarct and normal adult men. *Journal of Sports Medicine and Physical Fitness, 7*(2), 95-102.

Mellion, M. B., & Burst, M. D. (1996). Exercise Addiction. *Team Physician Handbook. Lippencott*, 248-254.

Menczel, Z., Kovacs, E., Farkas, J., Magi, A., Eisinger, A., Kun, B., & Demetrovics, Zs. (2013). Prevalence of exercise dependence and eating disorders among clients of fitness centers in Budapest. *Journal of Behavioral Addictions 2*, 23-24. (Abstract).

Meyer, C., Taranis, L., Goodwin, H., & Haycraft, E. (2011). Compulsive exercise and eating disorders. *European Eating Disorders Review, 19*(3), 174-189. doi: 10.1002/erv.1122

Michael Jr, E. D. (1957). Stress adaptation through exercise. Research Quarterly. *American Association for Health, Physical Education and Recreation, 28*(1), 50-54.

Michael, J. (1975). Positive and negative reinforcement, a distinction that is no longer necessary; or a better way to talk about bad things. *Behaviorism, 3*(1), 33-44.

Michalak, E. E., & Szabo, A. (1998). Guidelines for Internet research: An update. *European Psychologist, 3*(1), 70-75. doi: 10.1027//1016-9040.3.1.70

Michela Marzano-Parisoli, M. (2001). The contemporary construction of a perfect body image: Bodybuilding, exercise addiction, and eating disorders. *Quest, 53*(2), 216-230. doi: 10.1080/00336297.2001.10491741

Mickel, H. (1979). The true runner becomes hooked on a feeling. *Runner's World*, April, 1979, 30-31.

dc_912_14

Milani, R. V., & Lavie, C. J. (2009). Reducing psychosocial stress: a novel mechanism of improving survival from exercise training. *The American Journal of Medicine, 122*(10), 931-938. doi: 10.1016/j.amjmed.2009.03.028

Miller, K. J., & Mesagno, C. (2014). Personality traits and exercise dependence: Exploring the role of narcissism and perfectionism. *International Journal of Sport and Exercise Psychology, 12*(4), 368-381. doi: 10.1080/1612197X.2014.932821

Minjung, W., Sungwoon, K., Jingu, K., Petruzzello, S. J., & Hatfield, B. D. (2010). The influence of exercise intensity on frontal electroencephalographic asymmetry and self-reported affect. *Research Quarterly for Exercise & Sport, 81*(3), 349-359. doi: 10.1080/02701367.2010.10599683

Modolo, V. B., Antunes, H. K. M., Gimenez, P. R. B. D., Santiago, M. L. D. M., Tufik, S., & Mello, M. T. D. (2011). Negative addiction to exercise: are there differences between genders? *Clinics, 66*(2), 255-260. doi: 10.1590/S1807-59322011000200013

Mondin, G. W., Morgan, W. P., Piering, P. N., Stegner, A. J., Stotesbery, C. L., Trine, M. R., & Wu, M. (1996). Psychological consequences of exercise deprivation in habitual exercisers. *Medicine and Science in Sports and Exercise, 28*(9), 1199-1203. doi: 10.1097/00005768-199609000-00018

Mónok, K., Berczik, K., Urbán, R., Szabo, A., Griffiths, M. D., Farkas, J.,…Demetrovics, Zs. (2012). Psychometric properties and concurrent validity of two exercise addiction measures: A population wide study. *Psychology of Sport and Exercise, 13*(6), 739-746. doi: 10.1016/j.psychsport.2012.06.003

Moreno-Dominguez, S., Rodríguez-Ruiz, S., Martín, M., & Warren, C. S. (2012). Experimental effects of chocolate deprivation on cravings, mood, and consumption in high and low chocolate-cravers. *Appetite, 58*(1), 111-116. doi: 10.1016/j.appet.2011.09.013

Morgan, J. F. (2008). *The invisible man: A self-help guide for men with eating disorders, compulsive exercise and bigorexia*. Hove, UK: Routledge.

Morgan, W. P. (1979). Anxiety reduction following acute physical activity. *Psychiatric Annals*, *9*, 141-147.

Morgan, W. P. (1985). Affective beneficence of vigorous physical activity. *Medicine and Science in Sports and Exercise, 17*, 94-100. doi: 10.1249/00005768-198502000-00015

Morgan, W. P., & Goldston, S. E. (1987). *Exercise and Mental Health*. Washington, DC: Hemisphere Publishing Corporation.

Morgan, W. P., & O'Connor, P. J. (1988). Exercise and mental health. In R. K. Dishman (Ed.), *Exercise Adherence: Its impact on Public Health* (pp. 91-121). Champaign, IL: Human Kinetics.

Morris, M. (1989). Running round the clock. *Running, 104,* (Dec.) 44-45.

Morris, M., Steinberg, H., Sykes, E. A., & Salmon, P. (1990). Effects of temporary withdrawal from regular running. *Journal of Psychosomatic Research, 34*(5), 493-500. doi: 10.1016/0022-3999(90)90023-W

Murray, S. B., Maguire, S., Russell, J., & Touyz, S. W. (2012). The emotional regulatory features of bulimic episodes and compulsive exercise in muscle dysmorphia: A case report. *European Eating Disorders Review, 20*(1), 68-73. doi: 10.1002/erv.1088

dc_912_14

Müller, A., Cook, B., Zander, H., Herberg, A., Müller, V., & de Zwaan, M. (2014). Does the German version of the Exercise Dependence Scale measure exercise dependence?. *Psychology of Sport and Exercise, 15*(3), 288-292. doi: 10.1016/j.psychsport.2013.12.003

Nascimento, S. L., Pudwell, J., Surita, F. G., Adamo, K. B., & Smith, G. N. (2014). The effect of physical exercise strategies on weight loss in postpartum women: a systematic review and meta-analysis. *International Journal of Obesity, 38*(5), 626-635. doi: 10.1038/ijo.2013.183

Niven, A., Rendell, E., & Chisholm, L. (2008). Effects of 72-h of exercise abstinence on affect and body dissatisfaction in healthy female regular exercisers. *Journal of Sports Sciences*, *26*(11), 1235-1242. doi: 10.1080/02640410802027378

Norris, R., Carroll, D., & Cochrane, R. (1990). The effects of aerobic and anaerobic training on fitness, blood pressure, and psychological stress and well-being. *Journal of Psychosomatic Research, 34,* 367-375. http://dx.doi.org/10.1016/0022-3999(90)90060-H

Norris, R., Carroll, D., & Cochrane, R. (1992). The effects of physical activity and exercise training on psychological stress and well-being in an adolescent population. *Journal of Psychosomatic Research, 36*(1), 55-65. doi: 10.1016/0022-3999(92)90114-H

O'Brien, C., Volkow, N., & Li, T. K. (2006). What's in a word? Addiction versus dependence in DSM-V. *American Journal of Psychiatry, 163*(5), 764-765.

O'Connor, P. J., Raglin, J. S., & Martinsen, E. W. (2000). Physical activity, anxiety and anxiety disorders. *International Journal of Sport Psychology, 31,* 136-155.

O'Donovan, G., Blazevich, A. J., Boreham, C., Cooper, A. R., Crank, H., Ekelund, U.,…Stamatakis, E. (2010). The ABC of Physical Activity for Health: a consensus statement from the British Association of Sport and Exercise Sciences. *Journal of Sports Sciences*, *28*(6), 573-591. doi: 10.1080/02640411003671212

Ogden, J., Veale, D., & Summers, Z. (1997). The development and validation of the Exercise Dependence Questionnaire. *Addiction Research, 5*(4), 343-356. doi: 10.3109/16066359709004348

Ohzeki, T., Tachikawa, H., Tanimoto, K., Hanaki, K., Motozumi, H., Ohtahara, H.,…Shiraki, K. (1994). Excessive food aversion, compulsive exercise and decreased height gain due to fear of obesity in a prepubertal girl. *Psychotherapy and Psychosomatics, 62*(3-4), 203-206. doi: 10.1159/000288924

Olivardia, R. (2009). Muscle dysmorphia. In J. F. Morgan. (Ed.), *The Invisible Man: A Self-Help Guide for Men With Eating Disorders, Compulsive Exercise and Bigorexia.* (pp. 36-45). New York, NY: Rutledge Press.

Otto, J. (1990). The effects of physical exercise on psychophysiological reactions under stress. *Cognition and Emotion, 4*(4), 341-358. doi: 10.1080/02699939008408082

Owen, N., Salmon, J., Koohsari, M. J., Turrell, G., & Giles-Corti, B. (2014). Sedentary behaviour and health: mapping environmental and social contexts to underpin chronic disease prevention. *British Journal of Sports Medicine, 48*(3), 174-177. doi: 10.1136/bjsports-2013-093107

Owen, N., Sparling, P. B., Healy, G. N., Dunstan, D. W., & Matthews, C. E. (2010). Sedentary behavior: emerging evidence for a new health risk. *Mayo Clinic Proceedings, 85*(12), 1138. Retrieved December 30, 2014 from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996155/

Paluska, S. A., & Schwenk, T. L. (2000). Physical activity and mental health. *Sports Medicine, 29*(3), 167-180. doi: 10.2165/00007256-200029030-00003

Parente, D. (2000). Influence of aerobic and stretching exercise on anxiety and sensation-seeking mood state. *Perceptual and Motor Skills, 90*, 347-348. doi: 10.2466/pms.2000.90.1.347

Parfitt, G., Rose, E. A., & Markland, D. (2000). The effect of prescribed and preferred intensity exercise on psychological affect and the influence of baseline measures of affect. *Journal of Health Psychology, 5*, 231-240. doi: 10.1177/135910530000500213

Pasman, L., & Thompson, J. K. (1988). Body image and eating disturbance in obligatory runners, obligatory weightlifters, and sedentary individuals. *International Journal of Eating Disorders, 7*(6), 759-777. doi: 10.1002/1098-108X(198811)7:6<759::AID-EAT2260070605>3.0.CO;2-G

Patel, A. V., Rodriguez, C., Pavluck, A. L., Thun, M. J., & Calle, E. E. (2006). Recreational physical activity and sedentary behavior in relation to ovarian cancer risk in a large cohort of US women. *American Journal of Epidemiology, 163*(8), 709-716. doi: 10.1093/aje/kwj098

Pennebaker, J. W. (1982). *The psychology of physical symptoms*. New York: Springer-Verlag.

Petrovic, P., Kalso, E., Petersson, K. M., & Ingvar, M. (2002). Placebo and opioid analgesia -- imaging a shared neural network. *Science, 295*(5560), 1737–1740. doi: 10.1126/science.1067176

Petruzzello, S. J., Landers, D. M., Hatfield, B. D., Kubitz, K. A., & Salazar, W. (1991). A meta-analysis on the anxiety-reducing effects of acute and chronic exercise: Outcomes and Mechanisms. *Sports Medicine, 11*, 143-182. doi: 10.2165/00007256-199111030-00002

Petruzzello, S. J., Snook, E. M., Gliottoni, R. C., & Motl, R. W. (2009). Anxiety and mood changes associated with acute cycling in persons with multiple sclerosis. *Anxiety, Stress & Coping, 22*(3), 297-307. doi: 10.1080/10615800802441245

Péronnet, F., & Szabo, A. (1993). Sympathetic response to psychosocial stressors in humans: Linkage to physical exercise and training. In P. Seraganian (Ed.), *Exercise Psychology: The Influence of Physical Exercise on Psychological Processes* (pp. 172-2 17). New York, NY: John Wiley & Sons.

Pierce, E. F. (1994). Exercise dependence syndrome in runners. *Sports Medicine, 18*(3), 149-155. doi: 10.2165/00007256-199418030-00001

Pierce, E. F., Daleng, M. L., & McGowan, R. W. (1993). Scores on exercise dependence among dancers. *Perceptual and Motor Skills, 76*(2), 531-535. doi: 10.2466/pms.1993.76.2.531

Pierce, E. F., Rohaly, K. A., & Fritchley, B. (1997). Sex differences on exercise dependence for men and women in a marathon road race. *Perceptual and Motor Skills, 84*(3), 991-994. doi: 10.2466/pms.1997.84.3.991

Pinto, J., Carvalho, J., & Nobre, P. J. (2013). The relationship between the FFM personality traits, state psychopathology, and sexual compulsivity in a sample of male college students. *The Journal of Sexual Medicine, 10*(7), 1773-1782. doi: 10.1111/jsm.12185

Poole, L., Hamer, M., Wawrzyniak, A. J., & Steptoe, A. (2011). The effects of exercise withdrawal on mood and inflammatory cytokine responses in humans. *Stress, 14*(4), 439-447. doi: 10.3109/10253890.2011.557109

Powell, K. E., & Blair, S. N. (1994). The public health burdens of sedentary living habits: Theoretical but realistic estimates. *Medicine and Science in Sports and Exercise, 26*, 851-856.

Price D. D., Finniss, D. G., & Benedetti, F. (2008). A comprehensive review of the placebo effect: recent advances and current thought. *Annual Review of Psychology, 59*, 565-590. doi: 10.1146/annurev.psych.59.113006.095941

Pritchard, M. E., & Beaver, J. L. (2012). Do exercise motives predict obligatory exercise?. *Eating Behaviors, 13*(2), 139-141. doi: 10.1016/j.eatbeh.2011.11.012

Pronk, N. P., Pronk, S. J., & Sisco, A. W. (1995). Accuracy of the palpation technique to assess exercise heart rate during bench stepping exercise. *Journal of Strength and Conditioning Research, 9*(1), 27-31. doi: 10.1519/1533-4287(1995)0092.3.CO;2

Pugh, N. E., & Hadjistavropoulos, H. D. (2011). Is anxiety about health associated with desire to exercise, physical activity, and exercise dependence?. *Personality and Individual Differences, 51*(8), 1059-1062. doi: 10.1016/j.paid.2011.08.025

Raglin, J. S. (1990). Exercise and mental health: beneficial and detrimental effects. *Sports Medicine, 9*, 323-329. doi: 10.2165/00007256-199009060-00001

Raglin, J. S., & Morgan, W. P. (1985). Influence of vigorous exercise on mood state. *The Behavior Therapist. 8*(9), 179-183.

Raglin, J. S., & Wilson, M. (1996). State anxiety following 20 minutes of bicycle ergometer exercise at selected intensities. *International Journal of Sports Medicine, 17*(6), 467-471. doi: 10.1055/s-2007-972880

Rahnama, N., Nouri, R., Rahmaninia, F., Damirchi, A., & Emami, H. (2010). The effects of exercise training on maximum aerobic capacity, resting heart rate, blood pressure and anthropometric variables of postmenopausal women with breast cancer. *Journal of Research in Medical Sciences: the Official Journal of Isfahan University of Medical Sciences, 15*(2), 78. Retrieved December 29, 2014 from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3082798/

Ransford, C. P. (1982). A role of amines in the antidepressant effects of exercise: a review. *Medicine and Science in Sports & Exercise, 14*(1), 1-10.

Reed, J., & Ones, D. S. (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7*(5), 477-514. doi: 10.1016/j.psychsport.2005.11.003

Rejeski, W. J., Best, D. L., Griffith, P., & Kenney, E. (1987). Sex-role orientation and the responses of men to exercise stress. *Research Quarterly for Exercise and Sport, 58*(3), 260-264. doi: 10.1080/02701367.1987.10605459

dc_912_14

Rendi, M., Szabo, A., & Szabó, T. (2007). Exercise and Internet Addiction: Communalities and Differences Between Two Problematic Behaviours. *International Journal of Mental Health and Addiction, 5*(3), 219-232. doi: 10.1007/s11469-007-9087-3

Richert, A. J., & Hummers, J. A. (1986). Patterns of physical activity in college students at possible risk for eating disorder. *International Journal of Eating Disorders, 5*(4), 775-763. doi: 10.1002/1098-108X(198605)5:4<757::AID-EAT2260050414>3.0.CO;2-0

Robbins, J. M. & Joseph, P. (1980). Commitment to running: Implications for the family and work. *Sociological Symposium, 30*, 87-108.

Robbins, J. M., & Joseph, P. (1985). Experiencing exercise withdrawal: Possible consequences of therapeutic and mastery running. *Journal of Sport Psychology, 7*(1), 23-39.

Rodgers, W. M., Hall, C. R., Blanchard, C. M., & Munroe, K. J. (2001). Prediction of obligatory exercise by exercise-related imagery. *Psychology of Addictive Behaviors, 15*(2), 152-154. doi: 10.1037/0893-164X.15.2.152

Rokka, S., Mavridis, G., & Kouli, O. (2010). The impact of exercise intensity on mood state of participants in dance aerobics programs. *Physical Culture & Tourism, 17*(3), 241-245.

Rosen, E. (1951). Differences between volunteers and non-volunteers for psychological studies. *Journal of Applied Psychology, 35*(3), 185-193.

Rosenfeldt, F., Braun, L., Spitzer, O., Bradley, S., Shepherd, J., Bailey, M.,…Esmore, D. (2011). Physical conditioning and mental stress reduction: a randomised trial in patients undergoing cardiac surgery. *BMC Complementary and Alternative Medicine, 11*, 20. doi:10.1186/1472-6882-11-20. Retrieved December 23, 2014 from: http://www.biomedcentral.com/1472-6882/11/20/

Rozin, P., & Stoess, C. (1993). Is there a general tendency to become addicted? *Addictive Behaviors, 18*(1), 81-87. doi: 10.1016/0306-4603(93)90011-W

Rudy, E. B., & Estok, P. J. (1989). Measurement and significance of negative addiction in runners. *Western Journal of Nursing Research, 11*(5), 548-558. doi: 10.1177/019394598901100504

Rushton, J. P., Brainerd, C. J., & Pressley, M. (1983). Behavioral development and construct validity: The principle of aggression. *Psychological Bulletin, 94*(1), 18-38. doi: 10.1037/0033-2909.94.1.18

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychol Review, 110*(1), 145–172. doi: 10.1037/0033-295X.110.1.145

Russell, J. A. (2009). Emotion, core affect, and psychological construction. *Cognition and Emotion, 23*(7), 1259-1283. doi: 10.1080/02699930902809375

Ryan, T., Chester, A., Reece, J., & Xenos, S. (2014). The uses and abuses of Facebook: A review of Facebook addiction. *Journal of Behavioral Addictions, 3*(3), 133-148. doi: 10.1556/JBA.3.2014.016

Saanijoki, T., Tuominen, L., Nummenmaa, L., Arponen, E., Kalliokoski, K., & Hirvonen, J. (2014). Physical exercise activates the μ-opioid system in human brain. *The Journal of Nuclear Medicine, 55*(1), 1909. Retrieved December 30, 2014 from: http://jnumedmtg.snmjournals.org/cgi/content/meeting_abstract/55/1_MeetingAbstracts/1909

dc_912_14

Sachs. M. L. (1981) Running addiction. In M. Sacks & M. Sachs (Eds.), *Psychology of Running* (pp. 116-126). Champaign, ILL: Human Kinetics.

Sachs, M. L. (1982). *Compliance and addiction to exercise*. Lexington, MA: The Collamore Press. ISBN-10: 0669045098

Sachs, M. L., & Buffone, G. W. (1982). Psychological considerations in exercise, including exercise as psychotherapy, exercise addiction, and the psychology of running. Manuscript, Department of Science and Physical Activity, University of Quebec at Three Rivers, Quebec, Canada.

Sachs, M. L., & Pargman, D. (1979). Running addiction: A depth interview examination. *Journal of Sport Behaviour, 2*(3), 143-155.

Sachs, M. L., & Pargman, D. (1984). Running addiction. In M. L. Sachs & G. W. Buffone (Eds.), *Running as therapy: An integrated approach* (pp. 231-252). Lincoln, NE: University of Nebraska Press.

Sandlund, E. S., & Norlander, T. (2000). The effects of tai chi chuan relaxation and exercise on stress responses and well-being: An overview of research. *Journal of Stress Management, 7*(2), 139-149. doi: 10.1023/A:1009536319034

Sarason, I. G., & Sarason, B. R. (1990). Test anxiety. In H. Leitenberg (Ed.), *Handbook of social and evaluative anxiety* (pp. 475-496). New York, NY: Plenum Press.

Saris, W. E. (1991). *Computer-assisted interviewing*. [Sage Paper series on Quantitative Applications in the Social Sciences]. Newbury Park, CA: Sage University.

Schlicht, W. (1994). Does physical exercise reduce anxious emotions? A meta analysis. *Anxiety, Stress and Coping, 6*(4), 275-288. doi: 10.1080/10615809408248802

Schwartz, G. E., Davidson, R. J., & Goleman, D. J. (1978). Patterning of cognitive and somatic processes in the self-regulation of anxiety: Effects of meditation versus exercise. *Psychosomatic Medicine, 40*(4), 321-328.

Scully, D., Kremer, J., Meade, M. M., Graham, R., & Dudgeon, K. (1998). Physical exercise and psychological well-being: A critical review. *British Journal of Sports Medicine, 32*(2), 111-120. doi: 10.1136/bjsm.32.2.111

Seraganian, P., Roskies, E., Hanley, J. A., Oseasohn, R., & Collu, R. (1987). Failure to alter psychophysiological reactivity in type a men with physical exercise or stress management programs. *Psychology and Health, 1*(3), 195-213. doi: 10.1080/08870448708400326

Sewell, D. F., Clough, P. J., & Robertshaw, L. (1995). Exercise addiction, mood and body image: A complex interrelationship. In J. Anett (Ed.), *Exercise addiction: Motivation for participation in sport and exercise* (pp. 34-39). England: BPS Books (British Psychological Society), ISBN-10: 1854332015

Sforzo, G. A. (1988). Opioids and exercise. *Sports Medicine, 7*(2), 109-124. doi: 10.2165/00007256-198907020-00003

Sforzo, G. A., Seeger, T. F., Pert, C. B., Pert, A., & Dotsen, C. O. (1986). In vivo opioid receptor occupation in the rat brain following exercise. *Medicine and Science in Sports and Exercise, 18*, 380-384. doi: 10.1249/00005768-198608000-00003

Shaffer, H. J., Hall, M. N., & Vander Bilt, J. (2000). " Computer addiction": a critical consideration. *American Journal of Orthopsychiatry, 70*(2), 162-168.

dc_912_14

doi: 10.1037/h0087741

Sicilia, Á., & González-Cutre, D. (2011). Dependence and Physical Exercise: Spanish Validation of the Exercise Dependence Scale-Revised (EDS-R). *The Spanish Journal of Psychology, 14*(01), 421-431. doi: 10.5209/rev_SJOP.2011.v14.n1.38

Silverman, M. N., & Deuster, P. A. (2014). Biological mechanisms underlying the role of physical fitness in health and resilience. *Interface Focus, 4*(5), doi: 10.1098/rsfs.2014.0040

Sinyor, D., Golden, M., Steinert, Y., & Seraganian, P. (1986). Experiemental manipulation of aerobic fitness and the response to psychosocial stress: Heart rate and self-report measures. *Psychosomatic Medicine*, *48*(5), 324-331.

Sinyor, D., Peronnet, F., Brisson, G., & Seraganian, P. (1988). Failure to alter sympathoadrenal response to psychosocial stress following aerobic training. *Physiology and Behavior, 42*(3), 293-296. doi: 10.1016/0031-9384(88)90085-6

Slay, H. A., Hayaki, J., Napolitano, M. A., & Brownell, K. D. (1998). Motivations for running and eating attitudes in obligatory versus non-obligatory runners. *International Journal of Eating Disorders, 23*, 267-275. doi: 10.1002/(SICI)1098-108X(199804)23:3<267::AID-EAT4>3.0.CO;2-H

Sloan, R. P., Shapiro, P. A., DeMeersman, R. E., Bagiella, E., Brondolo, E. N., McKinley, P. S.,…Myers, M. M. (2011). Impact of aerobic training on cardiovascular reactivity to and recovery from challenge. *Psychosomatic Medicine*, *73*(2), 134-141. doi: 10.1097/PSY.0b013e31820a1174

Smith, D. K., Hale, B. D., & Collins, D. (1998). Measurement of exercise dependence in bodybuilders. *Journal of Sports Medicine and Physical Fitness, 38*(1), 66–74.

Smith, D. K., Wright, C., & Winrow, D. (2010). Exercise dependence and social physique anxiety in competitive and non-competitive runners. *International Journal of Sport and Exercise Psychology, 8*(1), 61-69. doi: 10.1080/1612197X.2010.9671934

Snowball, J., & Szabo, A. (1999). Anxiety, affect and exercise: Preliminary evidence lends support to the Distraction Hypothesis. *Journal of Sport Sciences, 17*, 67-68.

Sothmann, M. S., Hart, B. A., & Horn, T. S. (1991). Plasma catecholamine response to acute psychological stress in humans: Relation to aerobic fitness and exercise training. *Medicine and Science in Sports and Exercise*, *23*(7), 860-867.

Spano, L. (2001). The relationship between exercise and anxiety, obsessive-compulsiveness, and narcissism. *Personality and Individual Differences, 30*(1), 87-93. doi: 10.1016/S0191-8869(00)00012-X

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State Trait Anxiety Inventory.* Palo Alto, CA: Consulting Psychologists Press.

Stanforth, D., Steinhardt, M., Mackert, M., Stanforth, P. R., & Gloria, C. T. (2011). An investigation of exercise and the placebo effect. *American Journal of Health Behaviour, 35*(3), 257-268.

Steffen, J. J., & Brehm, B. J. (1999). The dimensions of obligatory exercise. *Eating Disorders, 7*(3), 219-226. doi: 10.1080/10640269908249287

Stein, P. K., & Boutcher, S. H. (1992). The effect of participation in exercise training program on cardiovascular reactivity in sedentary middle-aged males. *International Journal of Psychophysiology, 13,* 215-223. doi: 10.1016/0167-8760(92)90071-I

Steinberg, H., Sykes, E. A., & LeBoutillier, N. (1995). Exercise addiction: Indirect measures of "endorphins". In J. Annett, B. Cripps & H. Steinberg (Eds.), *Exercise addiction: Motivation for participation in sport and exercise* (pp. 1-5). London: British Psychological Society.

Steinberg, H., Sykes, E. A., & Morris, M. (1988). Exercise addiction: The opiate connection. *Sport, Health, Psychology and Exercise Symposium Proceedings*. London: The Sports Council, Health Education Authority.

Stewart-Williams, S., & Podd, J. (2004). The placebo effect: Dissolving the expectancy versus conditioning debate. *Psychological Bulletin, 130*(2), 324-340. doi: 10.1037/0033-2909.130.2.324

Stinson, F. S., Dawson, D. A., Goldstein, R. B., Chou, S. P., Huang, B., Smith, S. M.,…Grant, B. F. (2008). Prevalence, correlates, disability, and comorbidity of DSM-IV narcissistic personality disorder: results from the wave 2 national epidemiologic survey on alcohol and related conditions. *The Journal of Clinical Psychiatry, 69*(7), 1033-1045.

Stoll, O. (1997). Endorphine, Laufsucht und runner's high. Aufstieg und niedergang eines mythos (Endogenous opiates, "runner's high" and "Exercise Addiction" - The rise and decline of a myth). *Leipziger Sportwissenschaftliche Beitraege, 28*(1), 102-121. (in German)

Strobel, M., Tumasjan, A., & Spörrle, M. (2011). Be yourself, believe in yourself, and be happy: Self-efficacy as a mediator between personality factors and subjective well-being. *Scandinavian Journal of Psychology, 52*(1), 43-48. doi: 10.1111/j.1467-9450.2010.00826.x

Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of Neural Transmission, 116*(6), 777-784. doi: 10.1007/s00702-008-0092-x

Sullivan, A. B., Covington, E., & Scheman, J. (2010). Immediate benefits of a brief 1-minute exercise protocol in a chronic pain population: A pilot study. *Pain Medicine, 11*(4), 524-529. doi: 10.1111/j.1526-4637.2009.00789.x

Summers, J. J. & Hinton, E. R. (1986). Development of scales to measure participation in running. In L. E. Unestahl (Ed.), *Contemporary Sport Psychology* (pp. 73-84). Oreboro, Sweden:Veje Publishing.

Summers, J. J., Machin, V. J. & Sargent, G. I . (1983). Psychosocial factors related to marathon running. *Journal of Sport Psychology, 5,* 314-331.

Summers, J. J., Sargent, G. I., Levey, A. J., & Murray, K. D. (1982). Middle-aged, non-elite marathon runners: A profile. *Perceptual and Motor Skills 54*(3), 963-969. doi: 10.2466/pms.1982.54.3.963

Sussman, S., Leventhal, A., Bluthenthal, R. N., Freimuth, M., Forster, M., & Ames, S. L. (2011b). A Framework for the Specificity of Addictions. *International Journal of Environmental Research and Public Health, 8*(8), 3399-3415. doi: 10.3390/ijerph8083399

dc_912_14

Sussman, S., Lisha, N., & Griffiths, M. D. (2011a). Prevalence of the Addictions: A Problem of the Majority or the Minority?. *Evaluation & the Health Professions, 34*(1), 3-56. doi: 10.1177/0163278710380124

Symons Downs, D., Hausenblas, H. A., & Nigg, C. R. (2004). Factorial validity and psychometric examination of the Exercise Dependence Scale-Revised. *Measurement in Physical Education and Exercise Science, 8*(4), 183-201. doi: 10.1207/s15327841mpee0804_1

Szabo, A. (1992). Habitual exercise participation and personality. *Perceptual and Motor Skills, 74*, 978. doi: 10.2466/pms.1992.74.3.978. Retrieved January 2, 2015 from: http://www.amsciepub.com/doi/abs/10.2466/pms.1992.74.3.978

Szabo, A. (1993). The combined effects of orthostatic and mental stress on heart rate, T-wave amplitude, and pulse transit time. *European Journal of Applied Physiology and Occupational Physiology, 67*(6), 540-544. doi: 10.1007/BF00241651

Szabo, A. (1995). The impact of exercise deprivation on well-being of habitual exercisers. *The Australian Journal of Science and Medicine in Sport, 27*, 68-75.

Szabo, A. (1997). Cross sectional research on the Internet. *Journal of Physical Education and Sport Sciences, 10*(1), 14-22.

Szabo, A. (1998). Studying the psychological impact of exercise deprivation: Are experimental studies hopeless? *Journal of Sport Behavior, 21*(2), 139-147.

Szabo, A. (2000). Physical activity a s a source of psychological dysfunction. In S. J. H. Biddle, K. R. Fox & S. H. Boutcher (Eds.), *Physical activity and psychological well-being* (pp. 130-153). London: Routlegde.

Szabo, A. (2001). *The dark side of sports and exercise: Research Dilemmas.* Proceedings of the 10th World Congress of Sport Psychology, Skiathos, Greece.

Szabo, A. (2003a). The acute effects of humor and exercise on mood and anxiety. *Journal of Leisure Research, 35*(2), 152-162.

Szabo, A. (2003b). Acute psychological benefits of exercise performed at self-selected workloads: Implications for theory and practice. *Journal of Sports Science and Medicine, 2*, 77-87.

Szabo, A. (2006). Comparison of the Psychological Effects of Exercise and Humor. In A. M. Lane (Ed.), *Mood and Human Performance: Conceptual, Measurement, and Applied Issues* (pp. 201-216). New York, NY: Nova Science Publishers.

Szabo, A. (2010). *Addiction to exercise: A symptom or a disorder*? New York: Nova Science Publishers.

Szabo, A. (2013). Acute psychological benefits of exercise: Reconsideration of the placebo effect. *Journal of Mental Health, 22*(5), 449-455. doi: 10.3109/09638237.2012.734657

Szabo, A. (2014). Sport and exercise psychology research and Olympic success: An analytical and correlational investigation. *European Journal of Sport Science, 14*(3), 273-278. doi: 10.1080/17461391.2013.827241

Szabo, A., Ainsworth, S. E., & Danks, P. K. (2005). Experimental comparison of the psychological benefits of aerobic exercise, humor, and music. *Humor, 18*(3), 235-246. doi: 10.1515/humr.2005.18.3.235, Szabo, A., & Ábrahám, J. (2013). The psychological benefits of recreational running: A field study. *Psychology, Health & Medicine, 18*(3), 251-261. doi: 10.1080/13548506.2012.701755

Szabo, A., Billett, E., & Turner, J. (2001). Phenylethylamine, a possible link to the antidepressant effects of exercise?. *British Journal of Sports Medicine, 35*(5), 342-343. doi: 10.1136/bjsm.35.5.342

Szabo, A., Brown, T. G., Gauvin, L., & Seraganian, P. (1993b). Aerobic fitness does not influence directly heart rate reactivity to mental challenge. *Acta Physiologica Hungarica*, *81*(3), 229-237.

Szabo, A., de la Vega, R., Ruiz-Barquín, R., & Rivera, O. (2013b). Exercise addiction in Spanish athletes: Investigation of the roles of gender, social context and level of involvement. *Journal of Behavioral Addictions, 2*(4), 249-252. doi: 10.1556/JBA.2.2013.4.9

Szabo, A., & Frenkl, R. (1996). Consideration of research on Internet: Guidelines and implications for human movement studies. *Clinical Kinesiology, 50(*3), 58-65.

Szabo, A., Frenkl, R., & Caputo, A. (1996). Deprivation feelings, anxiety, and commitment in various forms of physical activity: A cross-sectional study on the Internet. *Psychologia: An International Journal of Psychology in the Orient,39*(4), 223-230.

Szabo, A., Frenkl, R., & Caputo, A. (1997). Relationships between addiction to running, commitment to running and deprivation from running: A study on the internet. *European Yearbook of Sport Psychology, 1*, 130-147.

Szabo, A., Frenkl, R., Janek, Gy., Kálmán, L., & Lászay, D. (1998a). Runners anxiety and mood on running and non-running days: An in-situ daily monitoring study. *Psychology, Health & Medicine, 3*(2), 193-199. doi: 10.1080/13548509808402235

Szabo, A., & Gauvin, L. (1992). Reactivity to written mental arithmetic: Effects of exercise lay-off and habituation. *Physiology and Behavior, 51*, 501-506. doi: 10.1016/0031-9384(92)90171-W

Szabo, A., Gáspár, Z., & Ábrahám, J. (2013a). Acute effects of light exercise on subjectively experienced well-being: Benefits in only three minutes. *Baltic Journal of Health and Physical Activity, 5*(4), 261-266. doi: 10.2478/bjha-2013-0024

Szabo, A., & Griffiths, M. D. (2007). Exercise addiction in British sport science students. *International Journal of Mental Health and Addiction, 5*(1), 25-28. doi: 10.1007/s11469-006-9050-8

Szabo, A., Griffiths, M. D. & Demetrovics, Zs. (2013c). Psychology and exercise. In D. Bagchi, S. Nair & C. K. Sen (Eds.), *Nutrition and Enhanced Sports Performance* (Chapter 6, pp. 65-73;). New York, NY: Academic Press. ISBN: 978-0-12-396454-0

Szabo A., Meskó, A., Caputo, A., & Gill, É. (1998b). Examination of exercise-induced feeling states in four modes of exercise. *International Journal of Sport Psychology, 29*, 376-390.

Szabo, A., & Parkin, A. M. (2001). The psychological impact of training deprivation in martial artists. *Psychology of Sport and Exercise, 2*(3), 187-199. doi: 10.1016/S1469-0292(01)00004-8

dc_912_14

Szabo, A., Péronnet, F., Boudreau, G., Côté, L., Gauvin, L., & Seraganian, P. (1993a). Psychophysiological profiles in response to various challenges during recovery from acute aerobic exercise. *International Journal of Psychophysiology, 14*, 285-294. doi: 10.1016/0167-8760(93)90042-N

Szabo, A., Péronnet, F., Frenkl, R., Farkas, A., Petrekanits, M., Mészáros, J.,…Szabó, T. (1994). Blood pressure and heart rate reactivity to mental strain in adolescent judo athletes. *Physiology & Behavior, 56*(2), 219-224. doi: 10.1016/0031-9384(94)90187-2

Szabo, A., & Tsang, T. C. E., (2003). Motivation for increased self-selected exercise intensity following psychological distress: Laboratory based evidence for catharsis. *Journal of Psychosomatic Research, 55*(2), 133 (Abstract). doi: 10.1016/S0022-3999(03)00308-8

Szymanski, L. A., & Chrisler, J. C. (1990). Eating disorders, gender role, and athletic activity. *Psychology: A Journal of Human Behavior, 27*(4), 20-29.

Takenaka, K. (1992). Psychophysiological reactivity to stress and aerobic fitness. *Japan Journal of Physical Education, 37*, 229-242.

Tamanaeifar, M. R., Arfeei, F. S., & Gandomi, Z. (2014). Relationship between internet addiction with neuroticism in high school students, Kashan, Iran. *Bimonthly Journal of Hormozgan University of Medical Sciences, 17*(1), 69-75.

Taranis, L., & Meyer, C. (2010). Perfectionism and compulsive exercise among female exercisers: High personal standards or self-criticism?. *Personality and Individual Differences*, *49*(1), 3-7. doi:10.1016/j.paid.2010.02.024

Tata, P., Fox, J., & Cooper, J. (2001). An investigation into the influence of gender and parenting styles on excessive exercise and disordered eating. *European Eating Disorders Review, 9* (3), 194-206. doi: 10.1002/erv.394

Taylor, D. V., Boyajian, J. G., James, N., Woods, D., Chicz-Demet, A., Wilson, A. F., & Sandman, C. A. (1994). Acidosis stimulates -endorphin release during exercise. *Journal of Applied Physiology, 77*(4), 1913-1918.

Terry, A., Szabo, A., & Griffiths, M. D. (2004). The exercise addiction inventory: a new brief screening tool. *Addiction Research and Theory, 12*(5), 489-499.

Thaxton, L. (1982). Physiological and psychological effects of short term exercise addiction on habitual runners. *Journal of Sport Psychology, 4*, 73-80.

Thayer, A. E. (1989). *The Biopsychology of Mood and Arousal*. New York, NY: Oxford University Press.

Thiel, A., Gottfried, H., & Hesse, F. W. (1993). Subclinical eating disorders in male athletes. *Acta Psychiatrica Scandinavica, 88*(4), 259-265. doi: 10.1111/j.1600-0447.1993.tb03454.x

Thome, J. L., & Espelage, D. L. (2007). Obligatory exercise and eating pathology in college females: replication and development of a structural model. *Eating Behaviors, 8*(3), 334-349. doi: 10.1016/j.eatbeh.2006.11.009

Thompson, J. K. (1990). *Body Image Disturbance: Assessment and Treatment*. Elmsford, NY: Pergamon.

Thompson, J. K., & Blanton, P. (1987). Energy conservation and exercise dependence: A sympathetic arousal hypothesis. *Medicine and Science in Sports and Exercise, 19*, 91-97. doi: 10.1249/00005768-198704000-00005

dc_912_14

Thornberry, O., Rowe, B., & Biggar, R. (1991). Use of CAPI with the US National Health Interview Survey. *Bulletin de Methodologie Sociologique, 30*(1), 27-43. doi: 10.1177/075910639103000103

Thornton, E. W., & Scott, S. E. (1995). Motivation in the committed runner: Correlations between self-report scales and behaviour. *Health Promotion International, 10*(3), 177-184. doi: 10.1093/heapro/10.3.177

Thorp, A. A., Owen, N., Neuhaus, M., & Dunstan, D. W. (2011). Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996–2011. *American Journal of Preventive Medicine, 41*(2), 207-215. doi: 10.1016/j.amepre.2011.05.004

Thurstone, L. L., & Thurstone, T. G. (1979). *Primary Mental Abilities Test*. Madrid: TEA Ediciones.

Tooman, M. E., Harris, D. V., & Mutrie, N. (Eds.). (1985). *The effect of running and its deprivation on muscle tension, mood and anxiety:* Paper Presented at the Congress of the International Society for Sports Psychology. Copenhagen, Denmark.

Trembath, E. M., Szabo, A., & Baxter, M. J. (2002). Participation motives in leisure center physical activities. *Athletic Insight: The Online Journal of Sports Psychology, 4*(3), 28-41. Retrieved December 27, 2014 from: https://athleticinsight.com/Vol4Iss3/LeisurePDF.pdf

Tseng, C. N., Gau, B. S., & Lou, M. F. (2011). The effectiveness of exercise on improving cognitive function in older people: A systematic review. *Journal of Nursing Research, 19*(2), 119-131. doi: 10.1097/JNR.0b013e3182198837

Tu, R. H., Zeng, Z. Y., Zhong, G. Q., Wu, W. F., Lu, Y. J., Bo, Z. D.,…Yao, L. M. (2014). Effects of exercise training on depression in patients with heart failure: a systematic review and meta-analysis of randomized controlled trials. *European Journal of Heart Failure. 16*(7), 749–757. doi: 10.1002/ejhf.101

Tuson, K. M., & Sinyor, D. (1993). On the Affective benefits of acute aerobic exercise: Taking stock after twenty years of research. In P. Seraganian (Ed.), *Exercise psychology: The influence of physical exercise on psychological processes*. (pp. 80-121). New York, NY: John Wiley & Sons.

Valentine, E., & Evans, C. (2001). The effects of solo singing, choral singing and swimming on mood and physiological indices. *British Journal of Medical Psychology, 74*(1), 115-120. doi: 10.1348/000711201160849

van Doornen, L. J. P., de Geus, E. J. C., & Orlebeke, J. F. (1988). Aerobic fitness and the physiological stress response: A critical evaluation. *Social Science and Medicine, 26*(3), 303-307. doi:10.1016/0277-9536(88)90394-2

van Zijderveld, G. A., van Doornen, L. J. P., & Orlebeke, J. F. (1992). The psychophysiological effects of adrenaline infusions as a function of trait anxiety and aerobic fitness. *Anxiety Research, 4*(4), 257-274. doi: 10.1080/08917779208248795

Veale, D. (1993). Exercise addiction. International Coaching Foundation: Coaching Focus. *Eating Disorders in Sport, 22,* 17-19.

Villella, C., Martinotti, G., Di Nicola, M., Cassano, M., La Torre, G., Gliubizzi, M. D.,…Conte, G. (2011). Behavioural addictions in adolescents and young adults: results from a prevalence study. *Journal of Gambling Studies, 27*(2), 203-214. doi: 10.1007/s10899-010-9206-0.

Wakefield, M. A., Loken, B., & Hornik, R. C. (2010). Use of mass media campaigns to change health behaviour. *The Lancet, 376*(9748), 1261-1271. doi: 10.1016/S0140-6736(10)60809-4

Wann, D. L., Inman, S., Ensor, C. L., Gates, R. D., & Caldwell, D. S. (1999). Assessing the psychological well-being of sport fans using the Profile of Mood States: the importance of team identification. *International Sports Journal*, *3*(1), 81-90.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal, 174*(6), 801-809. doi: 10.1503/cmaj.051351

Warner, R., & Griffiths, M. D. (2006). A qualitative thematic analysis of exercise addiction: An exploratory study. *International Journal of Mental Health and Addiction, 4*(1), 13-26. doi: 10.1007/s11469-006-9000-5

Warr, P. (1990). The measurement of well-being and other aspects of mental health. *Journal of Occupational Psychology*, *63*(3), 193-210. doi: 10.1111/j.2044-8325.1990.tb00521.x

Warren, T. Y., Barry, V., Hooker, S. P., Sui, X., Church, T. S., & Blair, S. N. (2010). Sedentary behaviors increase risk of cardiovascular disease mortality in men. *Medicine and Science in Sports and Exercise*, *42*(5), 879-885. doi: 10.1249/MSS.0b013e3181c3aa7e

Watson, D., Clark, L. A., & Tellegan, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070. doi: 10.1037/0022-3514.54.6.1063

Waxer, P. H. (1977). Non-verbal cues for anxiety: An examination of emotional leakage. *Journal of Abnormal Psychology*, *86*(3), 306-314. doi: 10.1037/0021-843X.86.3.306

Wegner, M., Helmich, I., Machado, S., E. Nardi, A., Arias-Carrion, O., & Budde, H. (2014). Effects of exercise on anxiety and depression disorders: Review of meta-analyses and neurobiological mechanisms. *CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders), 13*(6), 1002-1014.

Weinstein, A. A., Deuster, P. A., & Kop, W. J. (2007). Heart rate variability as a predictor of negative mood symptoms induced by exercise withdrawal. *Medicine & Science in Sports & Exercise*, *39*(4), 735-741. doi: 10.1249/mss.0b013e31802f590c

Weinstein, A. A., & Weinstein, Y. (2014). Exercise Addiction-Diagnosis, Bio-Psychological Mechanisms and Treatment Issues. *Current Pharmaceutical Design*, *20*(25), 4062-4069. doi: 10.2174/13816128113199990614

Westerterp, K. R. (2014). Measurement of Energy Expenditure. In *Translational Research Methods for Diabetes, Obesity and Cardiometabolic Drug Development* (pp. 169-187). London, UK: Springer.

Wichers, M., Peeters, F., Rutten, B. P., Jacobs, N., Derom, C., Thiery, E.,…van Os, J. (2012). A time-lagged momentary assessment study on daily life physical activity and affect. *Health Psychology, 31*(2), 135-144. doi: 10.1037/a0025688

Wichmann, S., & Martin, D. R. (1992). Exercise excess. *The Physician and Sportsmedicine, 20*(5), 193-200.

Wilkinson, L. (1989). *SYSTAT: The system for statistics*. Evanston, IL: SYSTAT.

Williams, J. M., & Krane, V. (1992). Coping styles and self-reported measures of state anxiety and self-confidence. *Journal of Applied Sport Psychology, 4*(2), 134-143. doi: 10.1080/10413209208406457

Williamson, D. A., Netemeyer, R. G., Jackman, L. P., Anderson, D. A., Funsch, C. L., & Rabalais, J. Y. (1995). Structural equation modeling of risk factors for the development of eating disorder symptoms in female athletes. *International Journal of Eating Disorders*, *17*(4), 387-393. doi: 10.1002/1098-108X(199505)17:4<387::AID-EAT2260170411>3.0.CO;2-M

Wilson, K. E., & Dishman, R. K. (2015). Personality and physical activity: A systematic review and meta-analysis. *Personality and Individual Differences, 72*, 230-242. doi: 10.1016/j.paid.2014.08.023

Wilson, V. E., Berger, B. G., & Bird, E. I. (1981). Effects of running and of an exercise class on anxiety. *Perceptual and Motor Skills, 53*(2), 472-474. doi: 10.2466/pms.1981.53.2.472

Wingate, C. F. (1993). *Exploring the Karate Way of Life: Coping, Commitment, and Psychological Well-being Among Traditional Karate Participants.* (Ph.D. Thesis). Temple University, Philadelphia.

Wittig, A. F., Houmard, J. A., & Costill, D. L. (1989). Psychological effects during reduced training in distance runners. *International Journal of Sports Medicine, 10*(2), 97-100. doi: 10.1055/s-2007-1024882

Wittig, A. F., McConell, G. K., Costill, D. L., & Schurr, K. T. (1992). Psychological effects during reduced training volume and intensity in distance runners. *International Journal of Sports Medicine, 13*(6), 497-499. doi: 10.1055/s-2007-1021305

Wolf, E. M., & Akamatsu, T. J. (1994). Exercise involvement and eating disordered characteristics in college students. *Eating Disorders, 2*(4), 308-318. doi: 10.1080/10640269408249129

Wullimann, S. (2010). *Placebo expectancies as a mechanism in the psychological and physiological benefits of physical exercise* (Unpublished doctoral dissertation). Appalachian State University, Bonne, United States.

Wyatt, L. M. (1997). *Obsessive-compulsiveness and disordered eating in obligatory and non-obligatory exercisers* (Unpublished doctoral dissertation). California School of Professional Psychology, Los Angeles.

Yates, A. (1991). *Compulsive Exercise and the Eating Disorders: Toward an Integrated Theory of Activity.* New York: Brunner/Mazel Publishers.

Yates, A. (2013). *Compulsive Exercise and the Eating Disorders: Toward an Integrated Theory of Activity*. London: Routledge.

Yates, A., Leehey, K., & Shisslak, C. M. (1983). Running-An analogue of anorexia? *New England Journal of Medicine*, *308*(5), 251-255. doi: 10.1056/NEJM198302033080504

Yates, A., Shisslak, C. M., Allender, J. & Crago, M. (1992). Comparing obligatory to nonobligatory runners. *Psychosom. 33*(2), 180-189.

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doi: 10.1016/S0033-3182(92)71994-X

Yates, A., Shisslak, C. M., Crago, M., & Allender, J. (1994). Overcommitment to sport: Is there a relationship to the eating disorders? *Clinical Journal of Sport Medicine, 4*(1), 39-46.

Youngman, J. D. (2007). Risk for Exercise Addiction: A Comparison of Triathletes Training for Sprint-, Olympic-, Half-Ironman-, and Ironman-distance Triathlons. (Doctoral dissertation). Retrieved March 25, 2015 from: http://scholarlyrepository.miami.edu/oa_dissertations/12/

Zervas, Y., Ekkekakis, P., Emmanuel, C., Psychoudaki, M., & Kakkos, V. (1993). The acute effects of increasing levels of aerobic exercise intensity on mood states. In S. Serpa, J. Alves, V. Ferreira & A. Paula-Brito (Eds.), *Proceedings: VIII World Congress of Sport Psychology. Sport psychology: integrated approach* (pp. 620-624). Lisbon, Portugal: International Society of Sport Psychology.

Zmijewski, C. F., & Howard, M. O. (2003). Exercise dependence and attitudes toward eating among young adults. *Eating Behaviors, 4*(2), 181-195. doi: 10.1016/S1471-0153(03)00022-9

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7.0 Glossary of Frequently Used or Important Words

(Psychology Glossary From SparkNotes Psychology Guide Series))

Achievement motive **-** An impulse to master challenges and reach a high standard of excellence.
Adaptation **-** An inherited characteristic that increases in a population because it provides a survival or reproductive advantage.
Adaptive behaviours **-** behaviours that increase reproductive success**.**
Anorexia nervosa **-** A disorder characterized by refusal to maintain a body weight in the normal range, intense fear about gaining weight, and highly distorted body image.
Appraisal **-** The process of evaluating an environmental challenge to determine whether resources are available for dealing with it.
Attributions **-** Inferences people make about the causes of events and behaviour.
Autonomic nervous system **-** The part of the peripheral nervous system connected to the heart, blood vessels, glands, and smooth muscles.
Bias **-** The distortion of results (by a variable that is not part of the hypothesis).
Biopsychosocial **-** The idea that physical illness is the result of a complicated interaction among biological, psychological, and sociocultural factors.
Blood-brain barrier - A membrane that lets some substances from the blood into the brain but keeps out others.
Bulimia nervosa **-** A disorder involving binge eating followed by compensatory behaviours such as vomiting, fasting, excessive exercise, or use of laxatives, diuretics, and other medications to control body weight.
Case study **-** A research method in which an individual subject is studied in depth.
Catecholamines - Hormones released by the adrenal medulla in response to stress.
Catharsis - The release of tension that results when repressed thoughts or memories move into a patient’s conscious mind.
Central nervous system - The part of the nervous system that includes the brain and the spinal cord.
Classical conditioning **-** A type of learning in which a subject comes to responding to a neutral stimulus as he would to another stimulus by learning to associate the two stimuli. It can also be called respondent conditioning or Pavlovian conditioning.
Cognitive appraisal **-** The idea that people’s experiences of emotions depends on the way they appraise or evaluate the events around them.
Commitment - The intent to continue sport or exerciser even in the face of difficulties.
Compensation - According to Alfred Adler, the process of striving to get rid of normal feelings of inferiority.
Compulsions **-** Repetitive behaviours that help to prevent or relieve anxiety.
Concept **-** A mental category that groups similar objects, events, qualities, or actions.
Conditioned response - In classical and operant conditioning, a response that resembles an unconditioned response, achieved by pairing a conditioned stimulus with an unconditioned stimulus.
Conflict **-** The experience of having two or more incompatible desires or motives.

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Conscious **-** The part of the mind that contains all the information that a person is paying attention to at a particular time.
Control group **-** A group of subjects in an experiment that receives the same treatment and is treated exactly like the experimental group, except with respect to the independent variable.
Coping **-** Efforts to manage stress.
Correlation coefficient **-** A measurement that indicates the strength of the relationship between two variables. In a positive correlation, one variable increases as the other increases. In a negative correlation, one variable decreases as the other increases.
Correlational research method **-** A research method that provides information about the relationship between variables. It is also called a descriptive research method.
Denial **-** A defence mechanism that involves refusing to acknowledge something that is obvious to others.
Diagnosis **-** The process of distinguishing among disorders.
Diagnostic and Statistical Manual of Mental Disorders (DSM) **-** A reference book used by psychologists and psychiatrists to diagnose psychological disorders.
Dopamine - A neurotransmitter involved in voluntary movement, learning, memory, and
Eating disorders **-** Disorders characterized by problematic eating patterns, extreme concerns about body weight, and inappropriate behaviours aimed at controlling body weight.
Ego **-** The component of the personality that manages the conflict among the id, the superego, and the constraints of the real world.
Emotion - A complex, subjective experience that is accompanied by biological and behavioural changes, often subconscious to some extent.
Endorphins - A group of neurotransmitters involved in pain relief, pleasure, and modulating the action of other neurotransmitters.
Etiology,or Aetiology - The cause or origin of a disorder.
Evolution - A change in the frequency of genes in a population.
Expected value **-** The process of adding the value of a win times the probability of a win to the value of a loss times the probability of a loss in order to make a decision.
Experimental group **-** A group of subjects in an experiment for whom the independent variable is manipulated.
Extraneous variable **-** A variable other than the independent variable that could affect the dependent variable. It is not part of the hypothesis.
Extrinsic motivation **-** The motivation to act for external rewards.
Galvanic skin response - An increase in the skin's rate of electrical conductivity. It is also known as an electrodermal response.
Glucose - A simple sugar that acts as an energy source for cells.
Homeostasis - Maintenance of a state of physiological equilibrium in the body.
Hormones **-** Chemicals that are produced in glands and released into the bloodstream, involved in regulating body functions.
Hypothesis - A testable prediction of what is going to happen given a certain set of conditions**.**
Incentive **-** An environmental stimulus that pulls people to act in a particular way.
Independent variable **-** The variable that is manipulated in an experiment.

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Informed consent **-** A subject's voluntary agreement to participate in a research study, given after he or she has learned enough about the study to make a knowledgeable decision to participate.
Laboratory study **-** An observational research method in which information about subjects is collected in a laboratory setting.
Learned helplessness - A tendency to give up passively in the face of unavoidable stressors.
Magnetic resonance imaging (MRI) **-** A method for studying the brain that uses magnetic fields and radio waves to produce pictures of the brain.
Meditation **-** The practice of focusing attention.
Mood disorders **-** Disorders characterized by marked disturbances in an emotional state, which affect thinking, physical symptoms, social relationships, and behaviour.
Motivation **-** An internal process that makes a person move toward a goal.
Motive **-** An impulse that causes a person to act.
Naturalistic observation **-** A method of collecting information about subjects in a natural setting without interfering with them in any way.
Negative reinforcement **-** In operant conditioning, the removal of a stimulus after a response so that the response will be more likely to occur.
Norepinephrine **-** A neurotransmitter involved in learning, memory, dreaming, awakening, emotion, and responses to stress.
Obsessions **-** Persistent ideas, thoughts, impulses, or images that cause anxiety or distress.
Optimism **-** The tendency to expect positive outcomes.
Parasympathetic nervous system **-** Part of the autonomic nervous system that keeps the body still and conserves energy. It is active during states of relaxation.
Personality **-** The collection of characteristic thoughts, feelings, and behaviours that make up a person.
Physical dependence - Addiction based on a need to avoid withdrawal symptoms.
Pineal gland - A gland that secretes melatonin.
Placebo effect - The effect on a subject of receiving a fake drug or treatment. Expectations of improvement contribute to placebo effects.
Population **-** The collection of individuals from which a sample is drawn.
Positive correlation - A relationship between two variables in which as one variable increases, the other does too.
Positive reinforcement - In operant conditioning, the presentation of a stimulus after a response so that the response will be more likely to occur.
Punishment - The delivery of a consequence that decreases the likelihood that a response will occur.
Rationalization - A defence mechanism that involves using incorrect, but self-serving explanations to justify unacceptable behaviour, thoughts, or feelings.
Reaction time **-** The amount of time a subject takes to respond to a stimulus.
Reinforcement **-** The delivery of a consequence that increases the likelihood that a response will occur.
Reliability **-** The ability of a test to produce the same result when administered at different times to the same group of people.
Self-efficacy **-** Confidence in one's ability to meet challenges effectively.

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Self-report data **-** Information that people being surveyed give about themselves.
Self-report inventory **-** A paper-and-pen test that requires people to answer questions about their typical behaviour.
Sensation **-** Occurs when physical energy from objects in the world or in the body stimulates the sense organs.
Stress **-** The experience of being threatened by taxing circumstances. It also sometimes refers to circumstances that threaten well-being, to the response people have to threatening circumstances, or to the process of evaluating and coping with threatening circumstances.
Stressors **-** Circumstances or events that are psychologically or physically demanding.
Subjective well-being - The perception people have about their happiness and satisfaction with life.
Substance abuse - According to the DSM, a maladaptive pattern of drug use that results in repeated negative consequences such as legal, social, work-related, or school-related problems.
Survey **-** A method of getting information about a specific behaviour, experience, or event by means of interviews or questionnaires, using several participants.
Sympathetic nervous system - Part of the autonomic nervous system that prepares the body for action and expends energy.
Theory **-** An explanation that organizes separate pieces of information in a coherent way.
Unconscious - The part of the mind that contains thoughts, feelings, desires, and memories of which people have no awareness but that can influence people's behaviour.
Validity **-** The ability of a test to measure the characteristic it is supposed to measure.
Withdrawal symptoms **-** Symptoms such as sweating, nausea, or shakiness that occurs when drug usage ends In exercise addiction: An extreme urge to exercise, accompanied by nervousness and irritability.

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8.0 Index of Common or Important Terms

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9.0 Appendices

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9.1 Appendix A

The Exercise-Induced Feeling Inventory (EFI)

Name________________ Date__________ Time______ Group_____

Exercise Induced Feeling Inventory

Instructions: Please use the scale below to indicate the extent to which each word describes how you feel right now **(tick the appropriate box).** Please DO NOT let yourself be influenced by the previous ratings (if applicable), but try to ***indicate how you feel at this very moment.***.

FEELING STATE	*do not feel at all* **0**	*feel slightly* **1**	*feel moderately* **2**	*feel strongly* **3**	*feel very strongly* **4**
refreshed					
calm					
fatigued					
enthusiastic					
relaxed					
energetic					
happy					
tired					
revived					
peaceful					
worn-out					
upbeat					

Source: Gauvin, L., & Rejeski, W.J. (1993). The Exercise-Induced Feeling inventory: development and initial validation. *Journal of Sport and Exercise Psychology, 15*, 403-423.

9.2 Appendix B

Subjective Exercise Experience Scale (SEES)

This inventory contains a number of items designed to reflect how you feel at this particular moment in time (i.e., Right Now). Please circle the number on each item that indicates **HOW YOU FEEL RIGHT NOW.**

I FEEL:

	1	2	3	4	5	6	7
1. Great	1 not at all	2	3	4 moderately	5	6	7 very much so
2. Awful	1 not at all	2	3	4 moderately	5	6	7 very much so
3. Drained	1 not at all	2	3	4 moderately	5	6	7 very much so
4. Positive	1 not at all	2	3	4 moderately	5	6	7 very much so
5. Crummy	1 not at all	2	3	4 moderately	5	6	7 very much so
6. Exhausted	1 not at all	2	3	4 moderately	5	6	7 very much so
7. Strong	1 not at all	2	3	4 moderately	5	6	7 very much so
8. Discouraged	1 not at all	2	3	4 moderately	5	6	7 very much so
9. Fatigued	1 not at all	2	3	4 moderately	5	6	7 very much so
10. Terrific	1 not at all	2	3	4 moderately	5	6	7 very much so
11. Miserable	1 not at all	2	3	4 moderately	5	6	7 very much so
12. Tired	1 not at all	2	3	4 moderately	5	6	7 very much so

Subjective Exercise Experiences Scale: WB = 1+4+7+10 DISTRE = 2+5+8+11 FATIG = 3+6+9+12

Source: McAuley, E., & Courneya, K. (1994). The Subjective Exercise Experiences Scale (SEES): Development and preliminary validation. *Journal of Sport & Exercise Psychology, 16*, 163-177.

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9.3 Appendix C

Commitment to Running Scale (CRS)

Rate each question using the scale below:
5 = strongly agree 4 = agree 3 = uncertain 2 = disagree 1 = strongly disagree

1) I look forward to running		
2) I wish there were a more enjoyable way to stay fit		
3) Running is drudgery (unpleasant hard work)		
4) I do not enjoy running		
5) Running is vitally important to me		
6) Life is so much richer as a result of running		
7) Running is pleasant		
8) I dread the thought of running		
9) I would arrange or change my schedule to meet the need of running		
10) I have to force myself to go out running		
11) To miss a day's run is sheer relief		
12) Running is the high point of my day		

NOTE: Items in bold and italics are rated in reverse order (i.e. 5=1, 4=2, 3=3, 2=4 1=5)

Source: Carmack, M. A., & Martens, R. (1979). Measuring commitment to running: A survey of runners' attitudes and mental states. *Journal of Sport Psychology, 1*(1), 25-42.

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9.4 Appendix D

Spielberger's State Anxiety Inventory (SSAI)

SELF-EVALUATION QUESTIONNAIRE **STAI Form Y-1**

Please provide the following information:

Name______________________________________Date_____________S_____

Age__________________ Gender (*Circle*) **M** **F** T_____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

Source: Spielberger, C.D., Gorsuch, R.L., & Lushene, R. (1970). *State trait anxiety inventory manual*. Palo Alto, CA: Consulting Psychologists Press.

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9.5 Appendix E

The Profile of Mood States Inventory - Abbreviated form

Instructions: Please indicate how you feel right now by placing a circle around the appropriate number on the right of the adjectives describing various feeling states.

		Not at all	A Little	Moderately	Quite a	Extremely
1.	Tense	1	2	3	4	5
2.	Angry	1	2	3	4	5
3.	Worn Out	1	2	3	4	5
4.	Unhappy	1	2	3	4	5
5.	Proud	1	2	3	4	5
6.	Lively	1	2	3	4	5
7.	Confused	1	2	3	4	5
8.	Sad	1	2	3	4	5
9.	Active	1	2	3	4	5
10.	On-edge	1	2	3	4	5
11.	Grouchy	1	2	3	4	5
12.	Ashamed	1	2	3	4	5
13.	Energetic	1	2	3	4	5
14.	Hopeless	1	2	3	4	5
15.	Uneasy	1	2	3	4	5
16.	Restless	1	2	3	4	5
17.	Can’t	1	2	3	4	5
18.	Fatigued	1	2	3	4	5
19.	Competent	1	2	3	4	5
20.	Annoyed	1	2	3	4	5
21.	Discouraged	1	2	3	4	5
22.	Resentful	1	2	3	4	5
23.	Nervous	1	2	3	4	5
24.	Miserable	1	2	3	4	5
25.	Confident	1	2	3	4	5
26.	Bitter	1	2	3	4	5
27.	Exhausted	1	2	3	4	5
28.	Anxious	1	2	3	4	5
29.	Helpless	1	2	3	4	5
30.	Weary	1	2	3	4	5
31.	Satisfied	1	2	3	4	5
32.	Bewildered	1	2	3	4	5
33.	Furious	1	2	3	4	5
34.	Full of Pep	1	2	3	4	5
35.	Worthless	1	2	3	4	5
36.	Forgetful	1	2	3	4	5
37.	Vigorous	1	2	3	4	5
38.	Uncertain	1	2	3	4	5
39.	Bushed	1	2	3	4	5
40.	Embarrasse	1	2	3	4	5

Source: Grove, J.R. and Prapavessis, H. (1992). Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. *International Journal of Sport Psychology, 23,* 93-109.

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9.6 Appendix F

Spielberger's Trait Anxiety Inventory (STAI)

Self -Evaluation Questionnaire
Trait Form X -2

Name ____ **Date** __________________________

DIRECTIONS, A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate **how you generally feel**.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you **generally feel**.

	Almost never	Sometime	Often	Almost always
1. I feel pleasant	1	2	3	4
2. I tire quickly	1	2	3	4
3. I feel like crying	1	2	3	4
4. I wish I could be as happy as others seem to be...................................	1	2	3	4
5. I am losing out things because can't make up my mind soon enough......	1	2	3	4
6. I feel rested	1	2	3	4
7. I am "calm, cool, and collected".....	1	2	3	4
8. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
9. I worry too much over something that really doesn't matter	1	2	3	4
10. I am happy	1	2	3	4
11. I am inclined to take things hard ..	1	2	3	4
12. I lack self-confidence	1	2	3	4
13. I feel secure	1	2	3	4
14. I try to avoid facing a crisis or difficulty	1	2	3	4
15. I feel blue	1	2	3	4
16. I am content..................................	1	2	3	4
17. Some unimportant thought runs through my mind and bothers me .	1	2	3	4
18. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
19. I am a steady person	1	2	3	4
20. I become tense and upset when I think about my present concerns ...	1	2	3	4

Source: Spielberger, C.D., Gorsuch, R.L., & Lushene, R. (1970). *State trait anxiety inventory manual*. Palo Alto, CA: Consulting Psychologists Press.

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9.7 Appendix G

The Beck Depression Inventory

1. Sadness
0 I do not feel sad.
1 I feel sad much of the time.
2 I am sad all of the time.
3 I am so sad or unhappy that I can't stand it.

2. Pessimism
0 I am not discouraged about my future.
1 I feel more discouraged about my future than I used to be.
2 I do not expect things to work out for me.
3 I feel my fortune is hopeless and will get only worse.

3. Past Failure
0 I do not feel like a failure.
1 I have failed more than I should have.
2 As I look back, I see a lot of failures.
3 I feel I am a total failure as a person.

4. Loss of Pleasure
0 I get as much pleasure as I ever did from the things I enjoy.
1 I don't enjoy things as much as I used to.
2 I get very little pleasure from the things I used to enjoy.
3 I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings
0 I don't feel particularly guilty.
1 I feel guilty over many things I have done or should have done.
2 I feel quite guilty most of the time.
3 I feel guilty most of the time.

6. Punishment Feelings
0 I don't feel I am being punished.
1 I feel I may be punished.
2 I expect to be punished.
3 I feel I am being punished.

7. Self-Dislike
0 I feel the same about myself as ever.
1 I have lost confidence in myself.
2 I am disappointed in myself.
3 I dislike myself.

8. Self-Criticism
0 I don't criticize or blame myself more than usual.
1 I am more critical of myself than I used to be.
2 I criticize myself for all of my faults.
3 I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes
0 I don't have any thoughts of killing myself.
1 I have thoughts of killing myself, but I would 't carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.

10. Crying
0 I don't cry anymore than I used to.
1 I cry more than I used to.
2 I cry over every little thing.
3 I feel like crying, but I can't.

11. Agitation
0 I am no more restless or would up t han usual.
1 I feel more restless or would up than usual.
2 I am so restless or agitated that it's hard to stay still.
3 I am so restless that I have to keep moving or doing something.

12. Loss of Interest
0 I have not lost interest in other peop le or activities.
1 I am less interested in other people or things than before.
2 I have lost most of my interest in other people or things.
3 It's hard to get interested in anything.

13. Indecisiveness
0 I make decisions about as well as ever.
1 I find it more difficult to make decisions than usual.
2 I have much greater difficulty in making decisions than usual.
3 I have trouble making any decision.

14. Worthlessness
0 I do not feel I am worthless.
1 I don't consider myself as worthw hile and useful as I used to.
2 I feel more worthless as compared to other people.
3 I feel utterly worthless.

15. Loss of Energy
0 I have as much energy as ever.
1 I have less energy than I used to have.
2 I don't have enough energy to do very much.
3 I don't have enough energy to do anything.

16. Changes in Sleeping Patterns
0 I have not experienced any change in my sleeping pattern.
1 I sleep somewhat more/less than usual.
2 I sleep a lot more/less than usual.
3 I sleep most of th e day.
I wake up 1-2 hours early and can't get back to sleep.

17. Irritability
0 I am no more irritable than usual.
1 I am more irritable than usual.
2 I am much more irritable than usual.
3 I am irritable all the time.

18. Changes in Appe tite
0 I have not experienced any change in my appetite.
1 My appetite is somewhat greater/lesser than usual.
2 My appetite is much greater/lesser than usual.
3 I crave food all the time or I have no appetite at all.

19. Concentration Difficulty
0 I can concentrate as well as ever.
1 I can't concentrate as well as usual.
2 It's hard to keep my mind on anything for very long.
3 I find I can't concentrate on anything.

20. Tiredness or Fatigue
0 I am no more tired or fatigued than usual.
1 I get more tired or fatigued more easily than usual.
2 I am too tired or fatigued to do a lot of the things I used to do.
3 I am too tired or fatigued to do most of the things I used to do.

21. Loss of Interest in Sex
0 I have not noticed any r ecent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely .

Source: Beck, A.T. (1967). *Depression: Clinical, experimental, and theoretical aspects.* New York: Harper & Row.

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9.8 Appendix H

Satisfaction With Life Scale (SWLS)

Below are five statements with which you may agree or disagree. Using the 1-7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding. The 7-point scale is as follows:

1 = strongly disagree
2 = disagree
3 = slightly disagree
4 = neither agree nor disagree
5 = slightly agree
6 = agree
7 = strongly agree

__ 1. In most ways my life is close to my ideal.

__ 2. The conditions of my life are excellent.

__ 3. I am satisfied with my life.

__ 4. So far I have gotten the important things I want in life.

__ 5. If I could live my life over, I would change almost nothing.

The SWLS is in the public domain. Permission is not needed to use it.

Source: Diener, E., Emmons, R., Larsen, J., & Griffin, S. (1985). The Satisfaction With Life Scale. *Journal of Personality Assessment, 49*(1), 71-75.

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9.9 Appendix I

Name:
Date:

THE GENERAL HEALTH QUESTIONNAIRE

GHQ28

David Goldberg

Please read this carefully.

We should like to know if you have had any medical complaints and how your health has been in general, *over the past few weeks*. Please answer ALL the questions on the following pages simply by underlining the answer which you think most nearly applies to you. Remember that we want to know about present and recent complaints, not those that you had in the past.

It is important that you try to answer ALL the questions.

Thank you very much for your co-operation.

Have you recently

AI	**been feeling perfectly well and in good health?**	Better than usual	Same as usual	Worse than usual	Much worse than usual
A2	**been feeling in need of a good tonic?**	Not at all	No more than usual	Rather more than usual	Much more than usual
A3	**been feeling run down and out of sorts?**	Not at all	No more than usual	Rather more than usual	Much more than usual
A4	**felt that you are ill?**	Not at all	No more than usual	Rather more than usual	Much more than usual
A5	**been getting any pains in your head?**	Not at all	No more than usual	Rather more than usual	Much more than usual
A6	**been getting a feeling of tightness or pressure in your head?**	Not at all	No more than usual	Rather more than usual	Much more than usual
A7	**been having hot or cold spells?**	Not at all	No more than usual	Rather more than usual	Much more than usual

B1	**lost much sleep over worry?**	Not atall	No more than usual	Rather more than usual	Much more than usual
B2	**had dIfficulty in staying asleep once you are off?**	Not at all	No more than usual	Rather more than usual	Much more than usual
B3	**felt constantly under strain?**	Not at all	No more than usual	Rather more than usual	Much more than usual
B4	**been getting edgy and bad-tempered?**	Not at all	No more than usual	Rather more than usual	Much more than usual
B5	**been getting scared or panicky for no good reason?**	Not at all	No more than usual	Rather more than usual	Much more than usual
B6	**found everything getting on top of you?**	Not at all	No more than usual	Rather more than usual	Much more than usual
B7	**been feeling nervous and strung-up all the time?**	Not at all	No more than usual	Rather more than usual	Much more than usual

Please turn over

Source: Goldberg, D. (1978). *Manual of the General Health Questionnaire,* Windsor, UK: NFER.

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9.10 Appendix J

Deprivation Sensation Scale (DSS)

When you cannot exercise (fence) for involuntary reason or reasons that are beyond your control, you GENERALLY feel sensation of:

Please use the rating scale below and rate each item

1 = never ....7 = often

1) irritability	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2) restlesness	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3) frustration	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4) depression	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5) guilt	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6) insomnia	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7) constipation or irregularity	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8) muscle tension/soreness	**1**	**2**	**3**	**4**	**5**	**6**	**7**
9) general fatigue	**1**	**2**	**3**	**4**	**5**	**6**	**7**

NOTE: The internal reliability of the DSS on the Internet was good (Cronbach α = .81)

Source: Robbins, J.M., & Joseph, P. (1985). Experiencing exercise withdrawal: Possible consequences of therapeutic and mastery running. *Journal of Sport Psychology,* 7 (1), 23-39.

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9.11 Appendix K

Obligatory Running Questionnaire

Listed below are a series of statements about people's running habits. Please write in the left box, preceding the question, the number that reflects how often you feel that way.

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1 = never; 2 = sometimes; 3 = usually; 4 = always

□ 1) I run on a daily basis

□ 2) I also engage in other forms of exercise

□ 3) I run more than three days a week

□ 4) When I don't run I feel guilty

□ 5) I sometimes feel like I don't want to run, but I go ahead and push myself anyway

□ 6) My best friend likes to run

□ 7) When I miss a run, I feel concerned about my body possibly getting out of shape

□ 8) If I have planned to run at a particular time and something unexpected comes up (like an old friend pays a visit, or I have some work that needs immediate attention), I will usually skip my run at that time

□ 9) If I miss a planned run, I try to make up for it the next day

□ 10) I may miss a run for no good reason

□ 11) Sometimes I feel a need to run twice a day, even though I may feel a little tired

□ 12) If I feel that I have overeaten, I will try to make up for it by increasing the duration and/or intensity (speed) of my run

□ 13) When I miss a scheduled running session I may feel tense, irritable, or depressed

□ 14) Sometimes I feel that my mind wanders to thoughts about running

□ 15) I have had daydreams about running

□ 16) I keep a record of my running performance, such as how long I run, how far and/or how fast I run

□ 17) I have experienced a feeling of "euphoria" or "high" during or after a running session

□ 18) I frequently "push myself to the limits"

□ 19) I run even when advised against running (i.e., by a doctor, etc.)

□ 20) I will engage in other forms of exercise if I am unable to run

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Source: Thompson, J.K. (1990). *Body Image Disturbance: Assessment and Treatment*. Elmsford, NY: Pergamon.

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9.12 Appendix L

The most commonly reported psychological reactions to exercise deprivation

WHEN I CANNOT RUN, OR I HAVE TO STOP RUNNING, FOR AN INVOLUNTARY REASON

I Feel: 1 = not at all; 2 = somewhat; 3 = moderately so; 4 = very much so

1) tense ☐

2) restless ☐

3) guilty ☐

4) stressed ☐

5) lacking energy ☐

6) vigorous ☐

7) irritated ☐

8) energetic ☐

9) fat ☐

10) fatigued ☐

Based on research findings listed in section 3.1.2.4 (energetic and vigorous are dummy items).
The internal reliability of the scale was relatively high in the current study (Cronbach α = .75)

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9.13 Appendix M

Internet data-collection via e-mail responses (extract from the original)

The following statements may or may not describe your feelings about running. Read each statement and the WRITE BESIDE THEM the appropriate number that indicates how well the statement describes your feelings MOST OF THE TIME. There are no right or wrong answers. Do not spent too much time on any one item, but give the answers which seem to describe how you GENERALLY FEEL about running. Use the below presented rating scale:

1 = strongly disagree; 2 = disagree; 3 = uncertain; 4 = agree;

5 = strongly agree

1) I look forward to running 5
2) I wish there were a more enjoyable way to stay fit 2
3) Running is drudgery (struggle) 1
4) I do NOT enjoy running 1
5) Running is vitally important to me 5
6) Life is so much richer as a result of running 5
7) Running is pleasent 5
8) I dread the thought of running 1
9) I would arrange/change my schedule to meet the need to run 5
10) I have to force myself to run 1
11) To miss a day's run is sheer relief 1
12) Running is the high point of my day 4

WHEN I CANNOT RUN OR I HAVE TO STOP RUNNING FOR AN INVOLUNTARY REASON I FEEL:

1 = not at all; 2 = somewhat; 3 = moderately so; 4 = very much so

1) tense 3
2) restless 3
3) guilty 1
4) stressed 3
5) lacking energy 3
6) vigorous 1
7) irritated 3
8) energetic 1
9) fat 3
10) fatigued 2

Extract from a response data-file received through e-mail from Runner 37 (code name). The ratings were indicated right after the questionnaire or scale item (arrows). All ratings were manually entered into an electronic database for subsequent data analyses. All the entered data were checked and then re-checked by the researcher and an independent research assistant.

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9.14 Appendix N

Well-Being Questionnaire (WBQ)

Please indicate how you felt for most of the day by using the rating scale below:

Not at all 1 2 3 4 5 6 7 Extremely much

1. Angry/hostile ___
2. Happy ___
3. Irritated ___
4. Frustrated ___
5. Pleased ___
6. Guilty ___
7. Energetic ___
8. Stressed ___
9. Depressed/blue ___
10. Joyful ___
11. Unhappy ___
12. Worried/Anxious ___
13. Relaxed ___
14. Enjoyment/having fan ___

Identify the extent to which you experienced the following discomforts today by using the same rating scale as above.

1. Headache ___
2. Stomach pain ___
3. Chest pain ___
4. Nasal congestion ___
5. Cough/sore throat ___
6. Dizziness/vertigo ___
7. Breathlessness ___
8. Acne or pimple on skin ___
9. Muscle tension/ soreness ___
10. Cold symptoms ___

Source: Gauvin, L., & Szabo, A. (1992). Application of the experience sampling method to the study of the effects of exercise withdrawal on well-being. *Journal of Sport and Exercise Psychology, 14*, 361-374. (The scale has a "right-now" form for tapping feelings gauged in pre- post-intervention designs and ESM work).

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9.15 Appendix O

Articles a using different label for exaggerated and maladaptive exercise behaviour

Terms used	Author, year
Compulsive exercise	Chen et al., 2008; Dalle Grave, Calugi, & Marchesini, 2008; Davis, Katzman, & Kirsh, 1999; Goodwin, Haycraft, Willis, & Meyer, 2011; Goodwin, Haycraft, Taranis, & Meyer, 2011; Homan, 2010; Huang et al., 2006; Olivardia, 2009; Meyer, Taranis, Goodwin, & Haycraft, 2011; Morgan, 2008; Murray, Maguire, Russell, & Touyz, 2012; Ohzeki et al., 1994; Taranis & Meyer, 2010; Yates, 1991, 2013;
Exercise abuse	Calogero & Pedrotty, 2004; Davis, 2000; de la Torre, 1995;
Exercise addiction	Adams & Kirkby, 2002; Aidman & Woollard, 2003; Annett, Steinberg, & Cripps, 1995; Barrett, 1994; Basson, 2001; Berczik et al., 2012; Cole, 1998; Cox & Orford, 2004; Cripps, 1995; Crossman, Jamieson, & Henderson, 1987; Cumella, 2005; Dawson & Peco, 2004; Demetrovics & Kurimay, 2007; Di Nicola et al., 2010; Fisher & Wrisberg, 2004; Freimuth, Moniz, & Kim, 2011; Gapin, Etnier, & Tucker, 2009; Glasser, 1976; Griffiths, 1997; Griffiths, Szabo, & Terry, 2005; Hall, 1995; Johnson, 2000; Kaminker, 1998; Krivoschekov & Lushnikov, 2011; Landolfi, 2013; Lewis, 1984; Lichtenstein, Christiansen, Bilenberg, & Støving, 2012; Lynch, Peterson, Sanchez, Abel, & Smith, 2013; Mathers & Walker, 1999; Mellion & Burst, 1996; Michela Marzano-Parisoli, 2001; Modolo et al., 2011; Mónok et al., 2012; Rendi, Szabo, & Szabó, 2007; Sachs, 1982; Sachs & Buffone, 1982; Sewell, Clough, & Robertshaw, 1995; Steinberg, Sykes, & LeBoutillier, 1995; Steinberg, Sykes, & Morris, 1988; Szabo, 2010 ; Szabo & Griffiths, 2007; Terry, Szabo, & Griffiths, 2004; Thaxton, 1982; Veale, 1993; Warner & Griffiths, 2006
Exercise dependence	Adams, 2009; Adams & Kirkby, 1997, 1998; Adams, Miller, & Kraus, 2003; Allegre, Souville, Therme, & Griffiths, 2006; Blaydon & Lindner, 2002; Bamber, Cockerill, & Carroll, 2000a; Bamber, Cockerill, Rodgers, & Carroll, 2000b; Bamber, Cockerill, Rodgers, & Carroll, 2003; Bratland-Sanda, Sundgot-Borgen, Rø, Rosenvinge, Hoffart, & Martinsen, 2010; Cockerill & Riddington, 1996; Cook & Hausenblas, 2008; Edmunds, Ntoumanis, & Duda, 2006; Garman, Hayduk, Crider, & Hodel, 2004; Hagan & Hausenblas, 2003; Hamer & Karageorghis, 2007; Hausenblas, & Fallon, 2002; Hausenblas, & Giacobbi Jr, 2004; Hausenblas, & Symons Downs, 2002a; Hausenblas, & Symons Downs, 2002b; Hurst, Hale, Smith, & Collins, 2000; Lejoyeux, Avril, Richoux, Embouazza, & Nivoli, 2008; Loumidis & Wells, 1998; Ogden, Veale, & Summers, 1997; Pierce, 1994; Pierce, Daleng, & McGowan, 1993; Pierce, Rohaly, & Fritchley, 1997; Symons Downs, Hausenblas, & Nigg, 2004
Obligatory exercise	Brehm & Steffen, 1998; Elbourne & Chen, 2007; Hall, Kerr, Kozub, & Finnie, 2007; Matheson & Crawford-Wright, 2000; Rodgers, Hall, Blanchard, & Munroe, 2001; Steffen, & Brehm, 1999; Thome & Espelage, 2007.
Obsessive exercise	Boone, T. (1990).

9.16 Appendix P

Testimony of an Exercise Addict on the Internet (Tara Fuller March 24, 2014)

Retrieved January 15, 2015 from:
http://greatist.com/fitness/exercise-addiction-learning-self-care

My Addiction to Exercise Permanently Damaged My Body. But It Also Taught Me

"Exercise has always been an outlet for me. Whether heading to yoga after a long day at the office or jogging outdoors to unplug from my hyper-connected life, physical activity has always been my go-to method of winding down and recentering. But while the benefits of exercise—staying in shape, de-stressing—are preached by many scientists and health professionals, it's a "prescription" that can be easily abused. Which is exactly what happened to me. It started at a young age, when countless coaches taught me the well-known phrase: "Walk it off." Twisted ankle during dance rehearsal? No biggie. Swollen knees from stumbling on a fast break? Worse things have happened. While it seemed like I was simply listening to my leaders, working through the pain was actually my first taste of wanting control—and thinking I had it. I quickly got addicted to the feeling of pushing my body past limits, and it became an emotional outlet. Whenever I was mad or upset, I knew I could take it out on the basketball court by stealing the ball whenever I had a chance and fouling just a tad too hard. When I was sad, it was the same. Whether I was dancing, running, or playing sports, being active took my mind to a different place. No matter the issue, I went home after workouts feeling like the sweat had washed my problems away. Of course, these emotional gains came at a physical price, which I brushed off. Bruises, aches, and pains were temporary, I thought. But I was wrong. The upside? I learned a hell of a lot about self-care in the process, and am finally treating my body the ways it needs, and deserves. **Overwhelmed:** A year ago, I found myself in a tough place: My relationship was on the rocks, I was applying for a new job while trying to complete a project for my current employer that I wasn't equipped to handle, and family life was tumultuous. And, in a true testament to the adage "when it rains, it pours," it was all happening at once. Though I don't often let life get me too down, I was feeling beaten and emotionally exhausted. And on top of that, I didn't feel like I had anyone to talk to. This isn't to say I wasn't surrounded by incredible friends—I was—it was more that being open has never been a skill of mine. Instead of confronting my issues head on, I turned to the one thing I knew would make me feel better, and the one thing I thought I could control: exercise. **Taking It Too Far:** With the New Year right around the corner, I hit the ground running—literally. I signed up for *three half marathons*, quit my job and accepted a new position at my first real startup, and severed ties with the man I thought I would marry. I thought filling my schedule with training runs and 14-hour workdays would push everything else from my mind. But unfortunately for me (and anyone else who suffers from internal problem hoarding), it quickly became apparent that burying emotions isn't the most effective way of dealing with them. Despite running 30 to 40 miles a week and flying across the country for various startup conferences, the pain I was experiencing began bubbling to the surface. Instead of feeling an endorphin rush post-run, I was unable to turn my mind away from feelings of heartbreak, frustration, and sadness. My knees and ankles swelled after every run, I was plagued with headaches, and it seemed like a dull ache had permanently taken up residence in my body. Instead of taking these pains as a sign that I needed to confront my issues, I started exercising more and pushing my body harder. My history of sports-related injuries (we're talking a dislocated kneecap, torn muscles in my ankle, and a stress fracture in my foot, to name just a few) should've been ample warning as to what would happen next. But I charged on, adding two miles to tempo runs "just because," and opting for advanced moves in yoga instead of relaxing in child's pose when my body called out for a break. By the time the DC Rock n' Roll Half Marathon arrived in March, my body was already so tired and torn I could barely push through seven-mile training runs. I was averaging four hours of sleep a night, had been on the road for three weeks without a break, and was teetering on the edge of an emotional breakdown. The copious amount of Advil I was taking to subdue the pain in my joints was not equipped to address any of those problems. I'd also gained weight (likely due to my lack of sleep and insatiable appetite from two-a-day workouts), and was so frustrated with myself that I didn't even want to look in the mirror. Though my body was stronger in many ways, I was also at my weakest. And as someone who prides herself on the fact that she rarely cries, I was close to tears almost every day. But instead of just crying, I ran: Every race was a struggle. In DC I ran the first eight miles way too fast and spent the last three miles cursing and jogging at an elderly walker's pace. During the Brooklyn Half Marathon, I ran like I had a peg leg, trying to ignore the burning sensations in my lower back and right thigh. I spent the next two days working from my couch, as just walking to the kitchen in my studio apartment felt like an almost insurmountable chore. **The Breaking Point:** By the third race, my body was a mess. I stopped running three weeks prior because every time my right foot struck the ground I'd experience such searing pain it made me nauseous. I also wasn't eating enough because I wanted to lose weight before a wedding (not the healthiest mindset, I know). And I was running said race in San Francisco, a location that brought back a flood of memories I wasn't ready to deal with. The city practically haunted me. Every restaurant reminded me of the last time I was there, in someone's arms discussing a future I'd never been more excited about. Every street reminded me of the last time I'd turned that corner, hand-in-hand with someone I wanted forever by my side. I spent a week battling these emotions in silence, reminding myself that it would be over soon and I could go home. **And then race day arrived:** I masked my discomfort with smiles and laughs the morning of, but at mile eight I began to crack. The pain was so brutal I started to see spots, but I refused to let myself stop. I pushed through to the end, losing my ability to walk as I crossed the finish line. My brother sought medical attention, but I wasn't done trying to convince people I was OK, insisting I only needed Advil, an Irish coffee, and a decadent brunch. When I returned to New York, I thought things would look up: There were no races in sight, I was home in my safe space, and a vacation to Nicaragua was in my near future. I patiently waited for my body to recover on its own, foolishly thinking it would. But I couldn't ignore the stabbing pains in my leg and lower back—and I shouldn't have, considering my easy commute—not to mention simply sitting down—had become almost unbearable. I finally went to a doctor, and learned what I was dreading the most: I wouldn't be able to exercise for the next three to six months. I had developed a curve in my spine due to my lower back compensating for previous knee and feet injuries, and as a result my sciatic nerve was being perpetually pinched. My doctor also informed me my body would never be the same, and recommended that I stop running—indefinitely. Coping with Loss: Because of my stubbornness and inability to listen to my body, it's possible I'll never get to achieve one of the most coveted items on my bucket list: completing a marathon. It's also more than possible that the damage I've done to my body is irreversible—and I'm only 26. Instead of being grateful for my ability to run every day, I took it for granted. I acted as if I was in charge, and turned a deaf ear to the screams that were my body begging me to stop. I may not have been abusing drugs or alcohol, but I was abusing exercise, and the results were just as crippling. So what have I learned? That I seriously need to work on myself—both mentally and physically. So why did I write this? To hopefully convince everyone else that pushing your body past its limits isn't worth it. And to stop before it's too late. THE TAKEAWAY: Exercise isn't a solution. It may give endorphins and be a great way to burn off steam, but it shouldn't be a punishment, escape, or Band-Aid. Instead, it should help fuel my goals and be a compliment to whatever I'm trying to achieve. For me, coming to this understanding is about changing perspective. I used to use exercise as an easy way out. I believed that if I ran enough, I would eventually get the body I always wanted, which would help me meet the next great guy, and ultimately make me happier. But guess what? I didn't get any of those things, and I strayed further from happiness than I ever had. I may still be single, and I may not be 100 percent satisfied with my body, but I am happier. And if there's anything I learned from this, it's that you need to make yourself a priority. Your happiness depends on you, and there's rarely an easy answer for how to achieve it. So take the harder road, face your fears, and listen to your body—and your heart. I assure you, it's a lot more fun than three half marathons with an injured spine."

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9.17 Appendix R

The Exercise Addiction Inventory (EAI)

Please indicate the extent to which you agree or disagree with the statements below in relation to your exercise behaviour.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Exercise is the most important thing in my life.	1	2	3	4	5
Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do.	1	2	3	4	5
I use exercise as a way of changing my mood (e.g., to get a buzz, to escape, etc.).	1	2	3	4	5
Over time I have increased the amount of exercise I do in a day.	1	2	3	4	5
If I have to miss an exercise session I feel moody and irritable.	1	2	3	4	5
If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before.	1	2	3	4	5

Developed by Terry, Szabo & Griffiths (2004)