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Physical activity through an affective lens: Examining the consistency and stability of adolescents' exercise-related affective responses

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UNIVERSITY OF CALIFORNIA,  
IRVINE

Physical activity through an affective lens: Examining the consistency and stability of  
adolescents' exercise-related affective responses

DISSERTATION

submitted in partial satisfaction of the requirements  
for the degree of

DOCTOR OF PHILOSOPHY

in Psychology and Social Behavior

by

Svetlana Bershadsky

Dissertation Committee:  
Associate Researcher Margaret Schneider, Co-Chair  
Senior Lecturer JoAnn Prause, Co-Chair  
Lecturer Joanne Zinger

2014



## **DEDICATION**

To

my mom and dad

Your love and encouragement have meant the world to me

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## ACKNOWLEDGMENTS

I'd like to start by thanking whoever invented yoga pants  
For ensuring this dissertation was written in comfort and not in the nude  
And always keeping me just a few moments away  
From feeling energized, refreshed, and renewed

Humor momentarily aside, I'd be lying if I told you  
That the road to this dissertation hasn't been a long, challenging climb  
Yet as I reflect on how it's strengthened and molded me  
Am I filled with gratitude? Yep, all of the time

I must admit, though, that my PhD is not in rhyming  
And although this has been lots of fun  
Prose likely isn't the best medium to thank the wonderful people in my life  
For all that they've done

So now I'll express my thanks and appreciation  
In a heartfelt way  
And hope you'll see that by planting your flowers in my garden  
You've helped my life become one big, love-filled bouquet

Thank you first and foremost to my advisor and academic mom, Margaret Schneider, for supporting and patiently guiding me to explore my passions, for encouraging me to be myself and develop my strengths, for providing insightful and constructive feedback throughout, and for stimulating me to think in new ways about research and also about myself. By modeling values that are the essence of personal success—strength, compassion, and balance— you've inspired me to grow intellectually and personally. You are an incredible example of what it means to lead and guide others with love and I am very grateful to have learned from you. Goethe once said, "Treat people as if they were what they ought to be and you help them become what they are capable of becoming." You have always treated me as if I could excel at anything. And today I know I can, and I do.

A heartfelt gratitude to my committee members for guiding, supporting, and believing in me. To Pietro Galassetti, thank you for your helpful insights. To JoAnn Prause, thank you for offering statistical guidance with abundant patience and for providing feedback on my drafts in the most supportive of ways. Your warmth, sincere encouragement, and ability to explain statistical concepts with such simplicity have been invaluable. To Joanne Zinger, thank you for your infectious enthusiasm, for your consistent confidence in my abilities, and for helping me maintain perspective throughout my graduate years. You have been an amazing mentor and have shown me what it means to teach from the heart.

I am deeply appreciative for having been part of an incredibly supportive research team. To Wendy Beattie, our fierce study coordinator, thank you for every thoughtful word and every bit

of support. I always loved hearing you smile over the phone. To Priel Schmalbach, I really enjoyed our writing and brainstorming seshes, and our personal chats about yoga and life. To the both of you– I admire and thank you for your dedication to our study and to having a meaningful impact on the world.

To my colleagues and friends Mariya Sumaroka, Dana Garfin, Lindsay Cameron, Kristen Meyer, and Brittany Liu, thank you for sharing in my moments of pure bliss and sense of accomplishment, pure courage and vulnerability, and pure genius (or maybe just ridiculousness depending on how you look at it). The words of encouragement, the joyful (and sometimes raucous) laughter, and the beautiful spirit of camaraderie that we shared made this journey all the more meaning- and wonder-ful.

To Inna Garber, my best friend since sixth grade, I am so grateful to you for always listening with a loving heart, for exploring growing, and just being silly with me, for sharing countless heartfelt conversations and bursts of laughter, for accepting me in all ways, and most of all, for teaching me to love others and myself without conditions or judgment. Thank you, from the bottom of my heart, for always being there for me, my *sista* from another *mista*.

To Kate Ladyzhensky, you have been like a wonderfully wise and warm-spirited older sister to me. Your calm voice of reason and fearless heart have, by powerful example, inspired me to become more conscious of and draw on my own inner strength. Thank you for keeping it real– and loving– all these years, for giving sincere and insightful advice, and for nudging me to walk in my own strength and in my own way. I cherish our friendship so much, *Katernater*.

To Laura Zaltsman, I am grateful for and inspired by your gentle kindness, loving heart, and sweet and thoughtful way. Thank you for sharing your spiritual journey with me and kickstarting mine. Our deep conversations reflecting on our ever-evolving understanding of the world, spirituality, and integrating it all into how we understand and live our lives, have been a breath of fresh air for me. I'm so grateful for the many ways my life has been enriched by your continued presence in it.

To Michael Briante, a very big thank you for cheering me on through the most challenging stretch of this journey, and for helping me stay grounded and moving forward with a spirit of optimism. Your easy going, caring nature and sense of humor were wonderful to be around, and for this I am extremely grateful.

To Andrew Fitzgerald– by appreciating my humanness and challenging me to own my vulnerabilities, you've empowered me to soften the edges of my mind to open my heart, and to live my life from the inside out. Being our silly selves with each other, getting nerdy about all sorts of things, spontaneously dancing wherever music was playing, and soaking in the beauty of mother nature together has illuminated my soul. Thank you from the depths of my heart for your friendship and affection during the last year of this journey.

Many thanks to my Yoga and Pilates teachers and friends. To Linda Trumpfheller, your thoughtfulness and genuine support over the years have touched my heart. To Sebrina Tomas, thank you for extending your lighthearted energy to me, for encouraging me to bridge and share

my love of physical activity and teaching, and for helping me to become more aware of my posture. To Jeannie McCormack, a big thank you for your warm spirit, for bringing sunshine into my world when I needed it most, and for guiding me to cultivate a strong and balanced body and mind through my breath.

To my Shambhala meditation teachers and my friends at the Center for Living Peace, thank you for reminding me of the stillness and serenity that lie between my thoughts, and for inspiring me to reconnect to my true, authentic self.

Finally, thank you to my family, my greatest supporters. To my parents, thank you for always believing in me and encouraging me to pursue my dreams. To my Dad, Anatoly, I am oh so thankful to you for instilling in me a love of learning and inspiring in me a determination to achieve my goals. To my mom, Izabella, it is from your caring spirit and heart of gold that I learned life's most important lesson— what it feels like to love and be loved unconditionally. It is because of the pure love and sweet joy that emanate and reflect from you, my lifelong friend, that I can recognize and spread my own. To my brother, Oleg, thank you for always having my back and motivating me to better myself. Your sense of humor has brought me lots of joy over the years, big bro, and has reminded me to live life with a playful spirit. To my babushka and dedushka, thank you for your wholehearted love and support, and for showing me that real strength comes from within. And to my furry cutie patootie, Shiloh, thank you for reminding me to pause and absorb life's simple beauties. The world never looked so beautiful to me as it does now. Each and every one of you has given me lots to be grateful for. I love you very much.

“In friendship or in love, the two side by side raise hands together to find what one cannot reach alone.”

– Khalil Gibran

## CURRICULUM VITAE

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University of California, Irvine  
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### EDUCATION

---

- 2014      **Ph.D., Psychology and Social Behavior.** University of California, Irvine.  
Major: Health Psychology, Minor: Quantitative Psychology  
Thesis: *Physical activity through an affective lens: Examining the consistency and stability of adolescents' exercise-related affective responses*  
Committee: Margaret Schneider, Ph.D., JoAnn Prause, Ph.D., Joanne Zinger, Ph.D., and Pietro Galassetti, M.D., Ph.D.
- 2009      **M.A., Social Ecology.** University of California, Irvine.  
Thesis: *The Impact of Yoga on Cortisol Levels, Cardiovascular Measures, and Mood in Pregnancy*  
Committee: Ilona S. Yim, Ph.D., Sally Dickerson, Ph.D., and JoAnn Prause, Ph.D.
- 2007      **B.A., Psychology, cum laude.** Stony Brook University.  
Major: Psychology, Minor: Health & Wellness

### HONORS AND AWARDS

---

- 2013      **Social Ecology Dean's Dissertation Writing Fellowship;** University of California, Irvine
- 2012      **Newkirk Center for Science and Society Graduate Student Fellowship;** University of California, Irvine
- 2011      **Outstanding Mentor Award,** given for outstanding mentorship of undergraduate students by a graduate student; School of Social Ecology; University of California, Irvine
- 2011      **Svetlana Bershadsky Graduate Community Award named in my honor;** University of California, Irvine
- 2011      **Association for Psychological Science (APS) Travel Assistance Award,** given to fund attendance at the APS 23rd annual convention, Washington, DC.
- 2010      **Pedagogical Fellowship;** Teaching, Learning & Technology Center; University of California, Irvine

- 2010      **American Psychosomatic Society (APS) Young Scholar Award**
- 2009      **Alison Clarke-Stewart Award for the Best 2nd Year Project in the '08/'09 academic year**; University of California, Irvine
- 2007      **Undergraduate Recognition Award for Expanded Learning**; Stony Brook University
- 2007      **Outstanding Leadership & Service Award**; Stony Brook University

## **RESEARCH INTERESTS**

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Health promotion	Psychosocial influences on health behavior
Physical activity promotion in youth	Mindfulness-based stress management
Mind-body strategies for health and well-being	

## **TEACHING INTERESTS**

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Introductory Psychology	Exercise Psychology
Research Methods, Statistics	Positive Psychology
Health Psychology	Psychology of Stress

## **RESEARCH**

---

- 2011-pres.      **Graduate Student Researcher**, Physical Activity and Health Promotion Laboratory, University of California, Irvine  
Principal Investigator: Dr. Margaret Schneider  
Execute research study investigating the effects of a school-based intervention aimed to promote physical activity in adolescents, train and supervise research assistants in performing process evaluation of the intervention, code accelerometry data, conduct statistical analyses
- 2007-2011      **Graduate Student Researcher**, Biopsychology and Health Laboratory, University of California, Irvine  
Principal Investigator: Dr. Ilona Yim  
Designed and served as project coordinator for multiple research studies investigating the relationship of stress during pregnancy with maternal and fetal health outcomes, collected data and conducted statistical analyses, coordinated daily lab activities, administered clinical assessments, supervised and trained undergraduate research assistants

- 2006-2007     **Undergraduate Research Assistant**, Stony Brook University  
*Prenatal Maternal Health Laboratory*, Supervisor: Dr. Marci Lobel  
*Attachment Relationships Laboratory*, Supervisor: Dr. Everett Waters  
*Family Research Translational Group*, Supervisor: Dr. Richard Heyman  
 Recruited participants, conducted literature searches, administered surveys about women’s health risk to research participants, entered data, assisted in study design and the development of a coding system for parenting assessment
- 2006-2007     **Research Assistant**, CUNY Research Foundation, NY, NY  
*Interpersonal Processes Laboratory*, Supervisor: Dr. Kristin Sommer  
 Transcribed videotapes and coded data for a research project examining the impact of rejection on performance motivation
- 2006           **Research Assistant**, Baruch College  
*Industrial-Organizational Psychology Laboratory*, Supervisor: Dr. Loren Naidoo  
 Administered surveys and computer tasks to participants, assisted with data analysis

## **TEACHING AND MENTORING**

---

- 2007-pres.     **Graduate Teaching Assistant**, Department of Psychology and Social Behavior, University of California, Irvine  
 Create and lead weekly discussion sections and review sessions; prepare and deliver lectures; provide input on course design; draft, grade, and provide feedback on student exams & papers.  
 Courses: Introduction to Psychology (Summer 2009 & 2013), Psychology Fundamentals (Fall & Winter 2010), Naturalistic Field Research (Fall 2009 & Winter 2014), Statistical Analysis (Summer 2012, Winter 2013), Health Psychology (Summer & Winter 2008), Human Stress (Spring 2008 & 2010, Winter 2011), Positive Psychology (Spring 2013), Social Epidemiology (Fall 2012), Social Psychology (Spring 2009), Introduction to Biopsychology (Fall 2008), Cognitive Behavioral Therapy (Winter 2009), Infant Development (Summer 2010, Spring 2011)
- 2012-2013     **Graduate student mentor**, Department of Psychology and Social Behavior, University of California, Irvine  
 Provided advice and assistance to junior graduate student.
- 2011-2012     **Associate Faculty**, Department of Psychology, Saddleback Community College  
 Instructed undergraduate Research Methods in Psychology course.
- 2010- 2011     **Pedagogical Fellow**, Teaching Assistant Professional Development Program (TAPDP), University of California, Irvine  
 Designed and led workshops in the training of new graduate teaching assistants, the goal of which is to introduce TAs to their roles and responsibilities, improve

their ability to perform TA duties effectively, and familiarize them with principles of pedagogy and associated skills.

- 2008- 2010    **Tutor**, Ivy West  
Provided one-on-one, in home test preparation for the SAT Math and ACT Math and Science exams.
- 2008-2009    **Tutor**, Compass Tutors  
Provided one-on-one tutoring to students in the following subjects: SAT Math, ACT Math & Verbal, Reading & Writing.
- 2007-2009    **Mentor**, Vista del Campo Undergraduate Housing Mentor/Mentee Program, University of California, Irvine  
Provided undergraduate students with resources and support necessary for them to be successful in college and facilitated informed decision-making regarding post-college options.
- 2007            **Teaching Assistant/Behavioral Analyst Aid**, Association for Metroarea Autistic Children  
Implemented positive behavioral support strategies, conducted behavioral assessments, assisted in designing individual curricula.
- 2005-2006    **Undergraduate Teaching Assistant**, Psychology Department, Stony Brook University  
*Courses:* Psychology of Women's Health; Health Psychology; Social Psychology  
Assisted students during office hours, evaluated course content, created and taught a discussion group on stress management and self-esteem, designed enrichment seminars.

## **UNDERGRADUATE RESEARCH SUPERVISION**

---

*University of California, Irvine*

- 2011-2013    **Undergraduate Research Opportunities Program (UROP)**  
**Inter-Disciplinary Summer Undergraduate Research Experience (ID-SURE)**  
Supervised and secured support for original student research proposals, provide one-on-one mentoring (Amber Morley, Anika Akhter).
- 2009-2010    **Undergraduate Campuswide Honors Program**  
Supervised student honors project, provided one-on-one mentoring (Michelle Tsai).

## MANUSCRIPTS

---

**Bershadsky, S.,** Trumppheller, L., Beck Kimble, H., Pipaloff, D. & Yim, I.S. (2014). The Effect of Prenatal Hatha Yoga on Affect, Cortisol, and Depressive Symptoms. *Complementary Therapies in Clinical Practice*, 20, 106-113.

**Bershadsky, S. & Schneider, M.** The Consistency of the Affective Response to Acute Exercise. *Manuscript Under Review*.

**Bershadsky, S.,** Zinger, J., & Skoluda, N. The Effects of Mind-Body Interventions on Psychological and Physiological Indices of Stress: A Meta-analysis of randomized controlled trials. *Manuscript in Preparation*.

## UNIVERSITY/PROFESSIONAL SERVICE

---

- 2013            **Stress Reduction Instructor**, Dissertation Writing Boot Camp, Graduate Resource Center, University of California, Irvine
- 2013            **Ad hoc reviewer**, Sage Open Access
- 2013            **Volunteer**, Southern California Forum for Diversity in Graduate Education, University of California, Irvine
- 2012-2013     **Co-Facilitator**, Dissertation Writing Group, Graduate Resource Center, University of California, Irvine
- 2011-2013     **Co-Chair**, Palo Verde Residents Council, University of California, Irvine
- 2010            **Ad hoc reviewer**, The American Psychosomatic Society Annual Meeting
- 2010            **Volunteer**, Student of Color Conference, University of California, Santa Barbara
- 2009-2011     **Chair**, Anteater Recreation Center Board, University of California, Irvine
- 2008-2011     **Chair**, Associated Graduate Students Social Committee, University of California, Irvine
- 2008-2011     **Council Member**, Associated Graduate Students, University of California, Irvine
- 2008-2009     **Vice-Chair**, Anteater Recreation Center Board, University of California, Irvine
- 2006-2007     **Membership Coordinator**, Psi Chi Psychology Honor Society
- 2006-2007     **Volunteer**, Avon Walk for Breast Cancer, NY, NY



- 2006-2007     **Intern**, Women’s Health Initiative and SELECT (Selenium and Vitamin E Cancer Trial) Study Center, Stony Brook, NY
- 2006-2007     **Administrative Intern**, Economic Stability Project, Sanctuary for Families, NY, NY

## CONFERENCE PRESENTATIONS

---

**Bershadsky, S.**, Schmalbach, P., & Schneider, M. (2014, May). *Associations between adolescents’ affect and perceived exertion during moderate-intensity exercise*. Poster presented at the annual meeting of the International Society for Behavioral Nutrition and Physical Activity. San Diego, CA.

Schmalbach, P., **Bershadsky, S.**, & Schneider, M. (2014, May). *Patterns of moderate-to-vigorous physical activity (MVPA) among middle-school students by gender and ethnicity*. Presented at the Annual Meeting of the International Society for Behavioral Nutrition and Physical Activity. San Diego, CA.

Schmalbach, P. (Co-chair), **Bershadsky, S.** (Co-chair), Dunton, G.F., King, A.C., Norman, G.J., & Patrick, K. (2014, April). *Physical Activity Through the Lens of a Smartphone*. Symposium conducted at the Annual Meeting of the Society of Behavioral Medicine. Philadelphia, PA.

**Bershadsky, S.**, Schmalbach, P., & Schneider, M. (2014, April). *The affective response to exercise: a stable trait or a dynamic state?* Presented at the Annual Meeting of the Society of Behavioral Medicine. Philadelphia, PA.

Schmalbach, P., **Bershadsky, S.**, & Schneider, M. (2014, April). *The relationship between perceived competence for physical activity and self-selected exercise intensity in a laboratory task*. Presented at the Annual Meeting of the Society of Behavioral Medicine. Philadelphia, PA.

**Bershadsky, S.**, Schneider, M., & Bruecker, S. (2013, June). *School-Based Physical Activity Promotion: The Marshall PE Program as an Exemplar*. Presented at the 7<sup>th</sup> Biennial Childhood Obesity Conference. Long Beach, CA.

**Bershadsky, S.** & Schneider, M. (2013, March). *Affective response to exercise and physical activity among adolescents: Moderation by consistency and stability of the affective response to acute exercise*. Presented at the Annual Meeting of the Society of Behavioral Medicine. San Francisco, CA and the Clinical Translational Research Day Poster Session, University of California, Irvine.

**Bershadsky, S.** & Yim, I.S. (2013, March). *A quasi-experimental study of the impact of prenatal yoga on affect, cortisol levels, and postpartum depressive symptoms*. Presented at the Annual Meeting of the Society of Behavioral Medicine. San Francisco, CA.

Unger, C., **Bershadsky, S.**, Busse, D., & Yim, I.S. (2012, April). *Cardiovascular responses to a guided relaxation: The role of trait mindfulness*. Presented at the Annual Meeting of the Society of Behavioral Medicine, New Orleans, LA.

**Bershadsky, S.**, Yim, I.S., & Campos, B. (2011, May). *Predictors of salivary cortisol during pregnancy: The role of maternal anxiety, depressive symptoms, and neuroticism*. Presented at the Association for Psychological Science Convention, Washington, DC.

**Bershadsky, S.**, Yim, I.S., & Yim, H. (2010, March). *The impact of Hatha Yoga on cortisol levels in pregnancy*. Presented at the American Psychosomatic Society Conference, Portland, OR.

**Bershadsky, S.**, Hamilton, J.G., & Lobel, M. (2007, April). *Young women's perceptions of risk for chronic diseases: The mediating role of health behaviors*. Presented at the Undergraduate Research & Creativity Activities (URECA) program, Stony Brook, NY.

#### INVITED LECTURES/PANELS

---

- 2014      **Invited Speaker**, “We know exercise is good for us, so why don't we all do it? Understanding the psychological influences on physical activity behavior.” PsychTalks Speaker Series, Psychology Department, Saddleback College
- 2013      **Invited Panelist**, “Psychology Degrees and Careers.” Psychology Department, California State University, Fullerton
- 2012      **Invited Panelist**, “Maximizing Mentorship & Advising.” Graduate Resource Center, University of California, Irvine
- 2011      **Invited Lecturer**, “Introduction to Biopsychology.” Department of Psychology and Social Behavior, University of California, Irvine
- 2010      **Invited Panelist**, Guest Panel for Psychology & Social Behavior Undergraduate, Graduate Student, and Faculty Meet & Greet, “Graduate Student Panel.” University of California, Irvine
- 2010      **Invited Panelist**, Guest Panel for Social Ecology Mentor/Mentee Spring Retreat, “Graduate Student Panel.” University of California, Irvine
- 2010      **Invited Lecturer**, “Prenatal and early life stressors.” Department of Psychology and Social Behavior, University of California, Irvine
- 2009      **Invited Panelist**, Guest Panel for UCI Transfer House Meeting, “Getting Involved in Research at UCI.” University of California, Irvine

- 2009 **Invited Panelist**, “Experienced TA Panel.” School of Social Ecology, University of California, Irvine
- 2009 **Invited Lecturer**, “Stress, Its Origins & Its Consequences.” Department of Psychology and Social Behavior, University of California, Irvine
- 2007 **Invited Lecturer**, “Personality and Stress Appraisals.” Department of Psychology and Social Behavior, University of California, Irvine

## **PROFESSIONAL DEVELOPMENT**

---

- 2013 **Communicating Science Training Workshop**, Newkirk Center for Science and Society, University of California, Irvine
- 2013 **Introduction to Hybrid/Blended Learning Workshop**, Teaching, Learning & Technology Center, University of California, Irvine
- 2012 **“Stats n Snacks” Series of Statistical Analysis Workshops**, University of California, Irvine
- 2011 **Effective Responses to Student Writing Workshop**, Office of the Campus Writing Coordinator, University of California, Irvine
- 2011 **Teaching History of Psychology E-Workshop**, Society for the Teaching of Psychology
- 2010-2011 **Advanced Pedagogy and Academic Job Preparation Year-Long Service Learning Course**, Teaching, Learning & Technology Center, University of California, Irvine
- 2010 **Teaching On- Line– Being Prepared for Academe in the 21st Century**, Career Center and Graduate Resource Center, University of California, Irvine
- 2010 **PsycINFO Advanced Student Workshop**, APA PsycNET, American Psychological Association
- 2010 **"Student Evaluations: Benefit or Bane?" Teaching Colloquy**, Teaching, Learning & Technology Center, University of California, Irvine
- 2009 **Classroom Speaking Skills Workshop**, Teaching, Learning & Technology Center, University of California, Irvine

## **PROFESSIONAL AFFILIATIONS**

---

American Psychological Association (APA) (Division 2: Society for the Teaching of Psychology; Division 38: Health Psychology)  
American Public Health Association (Physical Activity Special Interest Group)  
Society of Behavioral Medicine  
American College of Sports Medicine  
Association for Psychological Science

## **SPECIALIZED SKILLS**

---

Accelerometry data analysis  
Salivary cortisol data collection and analysis  
Academic software – Electronic Educational Environment (EEE), Blackboard  
Web-based survey and research data management – Research Electronic Data Capture (RedCAP)

## **LANGUAGES**

---

Conversational Russian and Spanish

## **ABSTRACT OF THE DISSERTATION**

Physical activity through an affective lens: Examining the consistency and stability of adolescents' exercise-related affective responses

By

Svetlana Bershadsky

Doctor of Philosophy in Psychology and Social Behavior

University of California, Irvine, 2014

Associate Researcher Margaret Schneider, Co-Chair

Senior Lecturer JoAnn Prause, Co-Chair

Physical inactivity is a major public health concern that has not been adequately addressed by social-cognitive behavioral theories and models. Recent research has identified affective responses to acute exercise as a promising but often overlooked factor related to individuals' physical activity behavior. Affective responses have been associated with physical activity cross-sectionally and prospectively. Associations of exercise-related affective responses with physiological and behavioral markers of approach motivation suggest that affective responses to exercise may represent an affective style or underlying predisposition to enjoy physical activity that distinguishes regular exercisers from non-exercisers; however, this hypothesis has not been directly explored. The present dissertation reports on two studies that examined whether acute affective responses to exercise reflect an affective style. Chapter 2 describes a study that examined the consistency of adolescents' affective responses across exercise intensity and setting, and the stability of adolescents' affective responses to exercise over time. Operating under the assumption that there are individual differences in the extent to which acute responses reflect global traits, this study further examined whether individual differences in the degree of

affective response consistency play a role in predicting future physical activity behavior. The results suggest that affective responses to acute exercise are consistent across exercise intensity. A substantial proportion of participants failed to complete exercise tasks in a free-living setting, and the study therefore was not a strong test of the hypotheses involving free-living exercise. The results did not provide evidence of affective response consistency across exercise setting or of affective response stability over time, likely owing to the number of missing cases. Findings regarding the role of consistency in the affective response- PA relationship were inconclusive. Chapter 3 describes a study that examined the stability of affective responses over time to a standardized clinic-based exercise task. The results suggest that, when examined across tasks of the same intensity and in the same setting, affective responses are stable. The findings provide support for the notion that affective responses to acute exercise can be conceptualized as a relatively stable, trait-like characteristic that may help to identify adolescents at increased risk for a sedentary lifestyle.

# CHAPTER 1

## General Overview

## Statement of the Problem

In the 1800's, Edward Stanley, Earl of Derby was quoted as saying "those who think they have not time for bodily exercise will sooner or later have to find time for illness." Although his assertion preceded empirical investigations, it turned out to be correct. Physical inactivity is associated with increased risk of chronic morbidity and associated mortality, including nearly a 30% increase in cancer-related mortality, up to a 100% increase in cardiovascular-related mortality, and up to a 50% increase in all-cause mortality (Hu et al., 2004; Myers et al., 2004; Vatten, Nilsen, Romundstad, Drøyvold, & Holmen, 2006). In conjunction with poor diet, physical inactivity is considered the second leading risk factor for death nationwide (Mokdad, Marks, Stroup, & Gerberding, 2004) and is cited as the fourth leading risk factor for death worldwide by the World Health Organization (WHO; 2012). According to recent estimations, physical inactivity accounts for 9% of all worldwide premature deaths (Lee et al., 2012).

Physical inactivity is also a risk factor for conditions which themselves serve as risk factors for a variety of diseases. For instance, physical inactivity can potentiate weight gain and the development of obesity (Hill, Drougas, & Peters, 1994), which characterizes nearly 20% of the nation's children and adolescents over the age of 5 and over 30% of the nation's population over the age of 20 (WHO, 2008), and is itself a major risk factor for the development of cardiovascular disease, stroke, gastrointestinal disorders, and certain types of cancer (Daniels, 2006). Likewise, of the risk factors for hypertension (Bouchard & Després, 1995) and Type 2 diabetes mellitus (Rana, Li, Manson, & Hu, 2007), physical inactivity is at the forefront.

Despite the consequences associated with physical inactivity, nearly 43% of males and 51% of females over the age of 15 are physically inactive nationwide (WHO; 2010) and over 80% are insufficiently active. Similarly, according to the Centers for Disease Control and



Prevention (CDC), approximately 14% of adolescents are inactive and over 80% are insufficiently active when considering the Healthy People 2020 youth aerobic physical activity guidelines (one hour per day of moderate to vigorous-intensity aerobic physical activity, incorporating vigorous-intensity activity, muscle-strengthening, and bone-strengthening at least three days per week) (CDC, 2009; USDHHS, 2011).

Whereas physical inactivity is associated with poor health outcomes, physical activity can reduce the risk for morbidity and mortality and enhance well-being. Physical activity may attenuate genetic susceptibility to obesity (Li et al., 2010) and reduce systolic and diastolic blood pressure (Fagard & Tipton, 1994). It has also been associated with reduced risk of a variety of major diseases, including breast and colon cancers (Lee, 1995), Type II Diabetes (Bouchard & Després, 1995; Helmrich, Ragland, Leung, & Paffenbarger, 1991), cardiovascular disease (Francis, 1996; Tanasescu et al., 2002), coronary heart disease (Tanasescu et al., 2002), and osteoporosis (Borer, 2005). Furthermore, physical activity has been associated with management of established conditions and up to a 50% reduction in risk for all-cause mortality (Hakim et al., 1998; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Warburton, Nicol, & Bredin, 2006). According to recent estimations, with just a 1/4 increase in physical activity, over one million deaths could be prevented annually (Lee et al., 2012).

Yet another distinct advantage of physical activity is its influence on mental health. Physical activity has been shown to have moderate anxiety-reducing effects (Wipfli, Rethorst, & Landers, 2008) and positive effects on short-term physiological stress reactivity (Taylor, 2000). In addition, research suggests that physical activity can positively influence facets of psychological well-being in healthy individuals (Conn, 2010; Fox, 2000) and those with a mental disorder diagnosis (Biddle, 1999; Blumenthal et al., 2007; Deslandes et al., 2009). A recent

meta-analysis of 28 randomized controlled investigations of exercise in clinically depressed individuals found that, relative to comparison groups, individuals in exercise interventions demonstrated a substantial decrease in depression (Mead et al., 2009). Although the authors note methodological weaknesses present in the included investigations, their findings and those of other single, methodologically sound investigations highlight the importance of exercise as one way to improve the mental health of clinically depressed individuals (for review see Blumenthal & Ong, 2009).

It is important to note that physical activity tends to decline notably during the late childhood years and early adolescence (Biddle, Atkin, Cavill, & Foster, 2011; Dumith, Gigante, Domingues, & Kohl, 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008), and continues to do so across the lifespan (Troiano et al., 2008). Unique to adolescence is the malleability of behavioral patterns, given that it is during this stage of development that individuals are still resolving what their long-term lifestyle will entail and that behaviors established in adolescence are likely to persist into adult life. Adolescent physical inactivity has been positively associated with adult inactivity (Hallal, Victora, Azevedo, & Wells, 2006; Kjønniksen, Anderssen, & Wold, 2009), reinforcing adolescence as the period most influential for individual long-term health (Hedberg, Bracken, & Stashwick, 1999). Physical activity promotion in children and adolescents accordingly has been identified as a public health goal by the U.S. Department of Health and Human Services (USDHHS, 2004, 2008).

Motivated by a goal of finding ways to ameliorate the health consequences of physical inactivity, researchers have strived for decades to explain why some individuals engage in physical activity while others do not. A variety of behavioral theories and models have been developed and explored to attempt to understand and influence physical activity behavior. As

reviewed below, these theories have had modest utility in promoting physical activity participation. The present study extends this line of research to incorporate affective influences on physical activity behavior.

### **Social-Cognitive Underpinnings of Physical Activity Behavior**

In attempting to understand the factors impacting behavior, researchers have often relied on social-cognitive explanations. Early theories emphasized the role of beliefs, or thoughts about the attributes of an object or situation (Fishbein, 1965), and used an expectancy-value approach (Eccles, 1983) to help predict behavior. According to this approach, (1) expected consequences/outcomes and (2) value of the outcomes to the individual, are the foundation of motivation (i.e., an individual's determination or yearning to engage in or avoid a particular behavior) and therefore behavior (Wigfield & Eccles, 2000). In the prediction of physical activity adoption or maintenance, expectancy value theory can be conceptualized as (1) individuals' beliefs about their ability or inability, and expectations of success, in adopting or maintaining physical activity, and (2) the importance they place on physical activity and related outcomes such as physical fitness (i.e., attainment value).

Prior to describing the leading behavioral theories that developed from the expectancy-value tradition and their application to physical activity behavior, it is important to define physical activity. Physical activity is defined as “*any* bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen, Powell, & Christenson, 1985). Exercise, a subcomponent of physical activity, is defined as “physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective” (Caspersen et al., 1985). In the context of children and adolescents, exercise also includes sports participation, which is planned,

structured, and repetitive and may or may not have physical fitness as an objective (Caspersen et al., 1985). A majority of adolescent movement in developed countries falls under the category of exercise, as adolescents seldom engage in physically active work and/or employ active modes of transport (i.e., bicycling or walking to school). In the current proposal, for purposes of consistency, where the appropriate term is not specified by research findings or deemed appropriate by thematic context, the term ‘physical activity’ will be used.

**Health Belief Model (HBM).** An early belief-based theory developed to explain behavior was the Health Belief Model (Rosenstock, Strecher, & Becker, 1988), which focuses on the human drive to avoid illness. It posits that perceived benefits of and barriers to a behavior influence the decision to engage in that behavior. The HBM additionally notes that these expectations may in part be altered by the presence of certain sociodemographic and contextual factors. Given its central tenet of illness-avoidance, the HBM has been successful when applied to the cessation of health-compromising behaviors (Nahas, Goldfine, & Collins, 2003) but less so when applied to behaviors that are largely identified as health-enhancing (Biddle & Ashford, 1988). According to Biddle and Nigg (2000), the limited ability of the HBM to predict physical activity and exercise may be due to the theory’s avoidance orientation. While it is true that some older individuals pursue regular physical activity or exercise for its disease risk-reduction qualities, many adolescents and adults do so for its wellness-promoting qualities (e.g., healthy body weight, appearance, self-confidence, opportunities for socialization, and overall emotional well-being) (Ebbeck, Gibbons, & Loken-Dahle, 1995; Ketteridge & Boshoff, 2008).

**Protection Motivation Theory (PMT).** Like the HBM, Protection Motivation Theory (Rogers, 1983) takes an expectancy-value approach to predicting behavior. Originally developed to explain the influence of fear appeals or health threats on behavior change, PMT focuses on

cognitive appraisal processes that underlie individuals' health behavior intentions (i.e., conscious plans to perform a health behavior). According to PMT, protective behavior intentions (i.e., protection motivation) are influenced by two cognitive appraisal processes (Conner & Norman, 1996). The first mechanism, threat appraisals, is conceptualized as an individual's perceived severity of a health threat and perceived probability of or vulnerability to a health threat. The second mechanism, coping appraisals, is conceptualized as an individual's self-efficacy (i.e., belief in one's own ability to undertake and continue the desired behavior) and perceived response efficacy to a perceived threat (i.e., belief that the desired outcome will result from a response). In essence, the processes incorporated in PMT correspond to the factors described in the Health Belief Model as contributing to behavior; however, PMT also includes the independent contribution of self-efficacy. According to a meta-analysis of studies applying PMT to a variety of behaviors, both cognitive appraisal mechanisms of PMT predict health behavior intentions, with coping appraisals demonstrating far greater predictive capability than threat appraisals (Floyd, Prentice-Dunn, & Rogers, 2000). A comparison of studies employing cross-sectional and longitudinal designs indicated that the model successfully predicts concurrent health behavior but is less successful in predicting future health behavior (Milne, Sheeran, & Orbell, 2000). Existing studies applying PMT to physical activity have shown that health threats may alter behavioral intentions but are unlikely to alter behavior itself (Floyd et al., 2000; Milne, Orbell, & Sheeran, 2002), whereas coping appraisals are more predictive of physical activity intention and behavior (Plotnikoff & Trinh, 2010).

**Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB).** The Theory of Reasoned Action (Ajzen & Fishbein, 1980) is centered on the behavioral impact of attitudes. By definition, an attitude is a psychological tendency to evaluate a particular object or

situation favorably or unfavorably (Eagly & Chaiken, 1993). Attitude consists of affective, cognitive and behavioral components (Rosenberg & Hovland, 1960). In short, the affective component of attitude captures feelings toward a behavior, the cognitive component captures beliefs regarding attributes of a behavior, and the behavioral component captures actions or intentions to act (Eagly & Chaiken, 1993). Given that the TRA was developed to explain a single-time behavior (i.e., voting), Ajzen and Fishbein (1980) theorized that behavioral intention, or a conscious plan to perform a future behavior, is the most critical factor in determining behavior. According to the TRA, behavioral intention is determined both by attitude toward a behavior and also by the subjective norm associated with the behavior and motivation to comply with that norm. Subjective norm refers to beliefs of how others view the behavior (e.g., whether important individuals dis/approve of it). Generally, the role of attitudes in predicting behavior has been confirmed; the evidence for the influence of normative beliefs is less convincing (Hausenblas, Carron, & Mack, 1997). Overall, the predictive utility of the TRA for intention and behavior in the context of largely volitional behaviors, or those over which an individual has substantial control, has been noted (Sheppard, Hartwick, & Warshaw, 1988). However, the TRA has been criticized for failing to account for behaviors that depend on particular opportunities and/or resources (e.g., repetitive behaviors) and thus may not be under full volitional control (Liska, 1984).

To account for the above-noted shortcoming of the TRA, the Theory of Planned Behavior (TPB) was developed as a modification of the TRA, and proposed that behavior is determined both by intention and perceived behavioral control (PBC) (Ajzen & Driver, 1991; Ajzen & Madden, 1986). Often likened to self-efficacy, PBC also denotes an individual's perception of their own ability to perform a certain behavior. However, while self-efficacy is exclusively

concerned with individuals' perceptions about their own ability to perform a behavior, PBC is concerned with perceptions of existing factors, ranging from internal control beliefs (e.g., one's own ability and knowledge) to external control beliefs (e.g., presence of resources and support from others), which may facilitate or impede a particular behavior. Accordingly, PBC has been said to comprise subcomponents of both self-efficacy and control beliefs, which have been shown to be conceptually distinct in confirmatory factor analyses (Pertl et al., 2010). In including PBC, the TPB highlights the idea that behavioral motivation (intention) may not be the most critical determining factor for behaviors over which people do not have complete volitional control. Rather, Ajzen and collaborators suggest that PBC has both indirect and direct effects on behavior. As a result of its consideration of behaviors which depend on external factors and may therefore not be under full volitional control, the Theory of Planned Behavior has proven to be a better predictor of behavior and behavioral intention than the Theory of Reasoned Action (Netemeyer, Burton, & Johnston, 1991).

Because physical activity is a repetitive behavior and is thus vulnerable to a variety of potential barriers (e.g., availability of time, access to and convenience of facilities, weather, fatigue), it is not entirely under volitional control. Application of the TPB to physical activity behavior has supported the theory's utility in partly explaining physical activity intentions and behavior (Hagger, Chatzisarantis, & Biddle, 2002). Because barriers may preclude physical activity participation despite the presence of intention, the perceived behavioral control (PBC) construct of the Theory of Planned Behavior itself has received support in the prediction of physical activity intention and behavior (Armitage, 2005; Hagger et al., 2002; Symons Downs & Hausenblas, 2005), and a recent review supported the role of PBC in physical activity behavior change in older children and adolescents (Craggs, Corder, van Sluijs, & Griffin, 2011).

It is clear then that relative to an individual who perceives their physical activity behavior to be largely influenced by individuals and/or factors outside of themselves, an individual who perceives that they have control over potential activity-related challenges will be more likely to engage in physical activity. It should be noted, however, that the evidence for the influence of exercise intention on behavior is inconclusive. Whereas some meta-analyses have reported intention to be a predictor of exercise behavior (Hausenblas et al., 1997; Symons Downs & Hausenblas, 2005), several more recent studies have found that physical activity intentions do not consistently translate into physical activity behavior (Tavares, Plotnikoff, & Loucaides, 2009; Vallance, Plotnikoff, Karvinen, Mackey, & Courneya, 2010). Measurement proximity of initial intention and behavior is suggested to be one explanation for this disagreement. As weeks and/or months from the initial intention increase, so too may the chance of encountering situations likely to weaken the intention-behavior link. Accordingly, when intention and behavior are separated by a short time interval, intention is a strong determinant of behavior but the relationship is attenuated as the time interval increases (Lox, Petruzzello, & Martin Ginis, 2006).

**Self-Efficacy/Social Cognitive Theory (SCT).** Self-perceptions of behavioral competence (i.e., perceived proficiency) have been deemed critical to motivation across a number of social-cognitive theories. At the core of Bandura's early behavioral model was perceived self-efficacy, conceptualized as an individual's situation-specific perceptions of personal ability and likelihood of successfully performing a behavior (Bandura, Adams, & Beyer, 1977; Bandura, 1997). To clarify, Bandura notes that perceived self-efficacy is not a direct reflection of the skills one has but of "the judgments of what one can do with whatever skills one possesses" (Bandura, 1986). Self-efficacy has been said to be a product of (a)



perceived success of previous similar or identical behavior, (b) vicarious experiences or modeling by someone similar to the individual, (c) social persuasion by others aimed to increase an individual's self-efficacy, and (d) physiological (e.g., heart rate) or affective (e.g., positive or negative feelings) states, with prior performance exerting the strongest influence and physiological or affective states exerting the weakest influence.

The construct of self-efficacy became the foundation of Social Cognitive Theory (SCT) (Bandura, 1986) which, like the Theory of Planned Behavior, emphasizes the influence of both cognitive and external factors on exercise behavior, noting the situation-specific nature of perceptions of personal ability and likelihood of successfully performing exercise (Bandura, 1997). SCT centers on the idea that behavior, personal factors, and environmental factors continually influence one another (i.e., reciprocal determinism; Bandura, 1978, 1986), albeit the influence is not necessarily concurrent nor of similar strength (Wood & Bandura, 1989). The central personal factors of SCT are self-efficacy (defined above) and outcome expectancies or perceived potential short- or long-term consequences of a behavior. Behavioral factors are behavior-specific knowledge and skills necessary to perform a behavior (e.g., self-regulation, action goals or plans), and environmental factors are those that are external to the person, including social (e.g., family, friends, peers) and physical (e.g., room size, temperature, availability of healthy foods) environments. Together, these factors influence an individual's mental representation or perception of the situation, which may then influence their behavior.

Because self-efficacy influences other social-cognitive determinants of behavior (e.g., outcome expectancy; Bandura, 2004; Ramirez, Kulinna, & Cothran, 2012), it has been the focal construct of SCT-based research. Self-efficacy for physical activity has been substantiated as a predictor of physical activity intention and behavior (Lloyd & Little, 2010; McAuley &

Blissmer, 2000; Nahas et al., 2003; Umeh, 2003) and also its adoption and maintenance (Sallis, Hovell, & Hofstetter, 1992; Strachan, Woodgate, Brawley, & Tse, 2005). Self-efficacy may also be important in explaining gender differences in and trajectories of physical activity. Self-efficacy for physical activity has been shown to be lower and more strongly associated with physical activity in girls than in boys (Spence et al., 2010). Additionally, self-efficacy for physical activity has been negatively associated with declines in physical activity in adolescents (for review see Craggs et al., 2011).

Studies examining the role of outcome expectancies along with self-efficacy in predicting physical activity intention and behavior have been mixed; whereas some studies have found that outcome expectancies predict physical activity independently of self-efficacy (Gao, Xiang, Lee, & Harrison, 2008), others have found minimal or no added impact of outcome expectancies (Williams, Anderson, & Winett, 2005). It is interesting to note, however, that although self-efficacy has been well studied in SCT-based physical activity research, outcome expectancy has been examined much less frequently.

**Self-Determination Theory (SDT).** The role of personal, behavioral, and environmental factors is also incorporated within Self-Determination Theory (Deci & Ryan, 1985). Originally employed in the academic achievement domain, SDT posits that intrinsic motivation (determination coming from within) compels behavior more so than does extrinsic motivation (determination derived from its associated external rewards or pressure). The reasoning behind the strong influence of intrinsic motivation lies in SDT's proposition that individuals are driven by three innate psychosocial needs. These include a need to be autonomous (i.e., to perceive personal behavior as volitional vs. externally controlled) and competent (i.e., to perceive behavior as performed effectively), and to feel relatedness towards others. As such, an individual

will seek out situations and/or behaviors that enhance perceived autonomy, competence, and/or relatedness (Deci & Ryan, 1987). Moreover, meeting these psychological needs is associated with daily positive affect and overall well-being (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000).

In the last decade, SDT has received particular attention in the physical activity domain. As with various other behaviors, exercise can be undertaken for its own enjoyment, interest, or satisfaction (i.e., intrinsically motivated) or it may be undertaken for purposes of weight loss, fitness, or improvement in appearance and/or health (i.e., extrinsically motivated). Several studies have examined the factors underlying intrinsic or self-determined motivation in relation to physical activity and have shown that perceived autonomy and competence are positively associated with intentions to engage in physical activity and also physical activity behavior (Chatzisarantis, Hagger, & Smith, 2007; Shen, McCaughy, & Martin, 2008) and maintenance (Ryan, Williams, & Patrick, 2009). In contrast, the role of relatedness has been less conclusive (Gillison, Standage, & Skevington, 2011; Standage, Gillison, Ntoumanis, & Treasure, 2012), possibly because unlike autonomy and competence, relatedness is not required to evoke intrinsic motivation (Bandura, 1989). Overall, intrinsic motivation for exercise has been positively associated with leisure-time exercise behavior (Gillison, Standage, & Skevington, 2006), exercise maintenance (Oman & McAuley, 1993) and adoption (Gillison et al., 2011), and has been shown to predict adherence to an exercise program (Ryan, Frederick, Leps, Rubio, & Sheldon, 1997).

**The Transtheoretical Model (TTM).** The transtheoretical model (Prochaska & DiClemente, 1983; Prochaska, Norcross, Fowler, Follick, & Abrams, 1992), also known as the Stages of Change model, is predominantly considered a decision-making theory. It considers behavior change to be of a gradual nature and to occur as a progression through a series of

stages. The stages (i.e., precontemplation, contemplation, preparation, action, and maintenance) are qualitatively different and temporally reflect individuals' readiness to change (Prochaska et al., 1992). Processes theorized to facilitate progression through the stages include those that are affective (e.g., emotional arousal), cognitive (e.g., self-efficacy or perception of the pros and cons of behavior change), and behavioral in nature (Marcus et al., 1992). Although originally developed in the context of smoking cessation, the TTM has since been applied to a range of health behavior changes, including cessation of health-compromising behavior and adoption of health-promoting behavior (Burkholder & Evers, 2002); however, the TTM has not gone without criticism. The TTM has drawn criticism due to its arbitrary criterion of six months as the time after which individuals move into the maintenance stage (Kraft, Sutton, & Reynolds, 1999) and its disregard for the non-linear progression of behavior change, characterized by skipped stages and/or return to earlier stages, that many individuals experience. Additionally, a conceptual criticism is that given its multidimensional and complex nature, human functioning cannot easily be categorized into a handful of discrete stages as proposed by the TTM (Bandura, 1997).

Evidence for the utility of the TTM in predicting physical activity behavior change has been mixed; while some studies have found support for a transtheoretical model of physical activity behavior change (Hellsten et al., 2008), others have shown the utility of the TTM in predicting physical activity behavior change to be weak (Callaghan, Khalil, & Morres, 2010) or non-existent (Dishman et al., 2009). Importantly, the TTM has been valuable in distinguishing between individuals in different stages (Marshall & Biddle, 2001) and in predicting the direction of adolescents' transition through the stages of physical activity behavior change. It has not, however, predicted which stage an individual will move to and when (Prapavessis, Maddison, & Brading, 2004). Accordingly, the mechanisms behind individuals' progression through the stages

(i.e., their readiness to exercise regularly) remain largely unexplained. Of importance, self-efficacy has been deemed important within the TTM, particularly for progression through the latter stages of change. An investigation of the utility of the TTM in predicting adolescent exercise behavior provided evidence that self-efficacy increased as adolescents progressed through the stages of exercise behavior change (Nigg & Courneya, 1998).

**Contextual models.** Behavioral theories have consistently described behavior as a function of cognitive processes centered on self-reflection, whether in the form of self-efficacy in Social Cognitive Theory, perceived behavioral control in the Theory of Planned Behavior, or competence and autonomy in Self-Determination Theory. As detailed above, constructs indicative of self-reflection have been at the forefront of predicting behavior. As such, that behavior is in part a function of self-referent thought is widely recognized. However, models and theories based predominantly on individual-level social-cognitive constructs have accounted for limited variance in physical activity behavior (Hagger et al., 2002; Owen, Leslie, Salmon, & Fotheringham, 2000; Petosa, Hertz, Cardina, & Suminski, 2005). As highlighted by Spence and Lee (2003), “correlational research testing theories and models that focus on the individual explain, at best, 20-40% of the variance in physical activity.” Consequently, contextual health behavior models that increase the scope of influence from the level of the individual to the interactions between the individual and their environment (Bronfenbrenner, 1977; McLeroy, Bibeau, Steckler, & Glanz, 1988; Stokols, Grzywacz, McMahan, & Phillips, 2003; Stokols, 1992) have been applied to physical activity behavior. For instance, social-ecological models view the environment as individuals’ physical and sociocultural surroundings (Stokols, 1992) that can serve to either facilitate or hinder motivation, intention, and behavior. Be that as it may, environments do not act by themselves; rather, they interact with individual cognitive factors to

determine concurrent and future behavior. While one individual may recognize and ascribe meaning to an environmental stimulus, another individual may not.

Social-ecological models, as applied to physical activity behavior, have highlighted the importance of the environmental context of physical activity. In particular, research generated by these models suggests that social attributes of the environment such as parental, friend, and teacher support, and physical attributes of the environment such as neighborhood safety, access to and availability of equipment and recreational facilities tend to be involved in determining youth physical activity (Biddle et al., 2011; Zhang, Solmon, Gao, & Kosma, 2011).

The multitude of research that has examined social-cognitive and contextual health behavior models and theories in the context of physical activity has demonstrated the most support for SDT and TPB. Of the constructs included in the different models and theories, self-efficacy and social support have been most strongly and consistently associated with physical activity (Biddle et al., 2011; Plotnikoff, Costigan, Karunamuni, & Lubans, 2013; Trost, Owen, Bauman, Sallis, & Brown, 2002).

### **From Social-Cognitive Theories to Interventions**

As reviewed above, cross-sectional and prospective investigations have provided correlational evidence that each social-cognitive model and theory has some explanatory value for physical activity behavior (Hagger et al., 2002; Hellsten et al., 2008; Plotnikoff et al., 2013; Ryan et al., 2009). The critical question then is whether this explanatory value translates into behavior change. Thus, a review of intervention studies employing existing social-cognitive models and theories follows. The characteristics of these studies are detailed in Table 1.1. Because school PE programs offer an ideal channel by which to promote physical activity, schools have commonly served as the site of interventions. Accordingly, the following is a

review of the major school-based, randomized controlled trials (RCTs) that have strived to influence child and adolescent physical activity.

Several large-scale RCTs have been grounded exclusively in Social Cognitive Theory. New Moves (Neumark-Sztainer, Story, Hannan, & Rex, 2003), a high school-based intervention grounded in Social Cognitive Theory, did not find a significant influence of the intervention on physical activity. Planet Health, a middle school-based intervention grounded in Social Cognitive Theory (Gortmaker et al., 1999) and notable for its target population of both boys and girls, also did not find statistically significant differences in physical activity between schools in the intervention and control conditions. More recently, the HEALTHY study was a middle school-based RCT with a theoretical basis in the social-cognitive tradition, and considered of high methodological quality because of its large sample size, the composition of the sample (both boys and girls), and its duration of two and a half years. The HEALTHY study also failed to find a difference in change in moderate-to-vigorous physical activity between adolescents attending intervention and control schools (Jago et al., 2011). Another middle school-based RCT, ‘Incorporating More Physical Activity and Calcium in Teens’ (IMPACT), was grounded in both Social Cognitive Theory and the transtheoretical model. IMPACT had a significant effect on girls’ participation in vigorous physical activity (Jones, Hoelscher, Kelder, Hergenroeder, & Sharma, 2008); however, this effect was modest and equivalent to only a six-minute daily increase in vigorous physical activity. Lastly, the Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) intervention, a year-long RCT based on Social Cognitive Theory that targeted girls in middle schools in socioeconomically disadvantaged areas and used a direct measure of PA, had no effect on girls’ physical activity behavior (Dewar et al., 2013). Overall, then, the body of

evidence does not support Social Cognitive Theory for informing interventions to promote physical activity among children and adolescents in a school-based setting.

Other large-scale RCTs have employed a social-ecological framework, thereby incorporating broader community, environmental and policy components (see Table 1.1). For instance, a recent year-long elementary school-based physical activity intervention (“Kinder-Sportstudie”; KISS) grounded predominantly in the Social-Ecological model of behavior change and notable for its direct measure of physical activity and inclusion of both boys and girls, found a significantly greater increase in moderate-to-vigorous physical activity, equivalent to 11 minutes per day, in the intervention schools compared to the control schools (Kriemler et al., 2010).

Whereas the KISS intervention was based predominantly in a social-ecological framework, numerous other large-scale randomized controlled trials have used a multicomponent approach, incorporating social-cognitive constructs within a social-ecological framework (see Table 1.1). The Lifestyle Education for Activity Program (LEAP), a high school-based intervention based on the Social-Ecological model and Social Cognitive Theory and unique for its long-term follow-up period, was found to have a significant effect of on girls’ participation in vigorous physical activity (Pate et al., 2005); however, this effect pertained to fewer than half of the girls for whom it was intended and was of a modest magnitude. Nearly three years after the end of the active intervention, girls attending schools that maintained the core components of the intervention were 6% more likely to participate in at least 30 minutes of daily vigorous physical activity (Pate et al., 2007). The Child and Adolescent Trial for Cardiovascular Health (CATCH), an elementary school-based intervention that offered the methodological strengths of a large sample size, a duration of two and a half years, and a target population of both boys and girls,



was similarly grounded in Social Cognitive Theory and the Social-Ecological model (Luepker et al., 1996). Compared to children in control schools, children in intervention schools reported significantly greater participation in vigorous physical activity, a difference equivalent to approximately 11 minutes per day. A follow-up study of approximately 70% of original participants demonstrated that the difference in vigorous physical activity was maintained over the next three years, although it decreased by almost five minutes over that three-year time span (Nader et al., 1999). Also noteworthy because of its direct measure of physical activity, long-term follow-up, and broad scope, the Trial of Activity for Adolescent Girls (TAAG; Webber et al., 2008) incorporated operant conditioning and Social Cognitive Theory constructs within a broader ecological focus in its design of a middle school-based intervention. TAAG did not result in a significant difference in moderate-to-vigorous physical activity between intervention and control schools after two years of implementation; after three years, a modest increase of almost two minutes per day in moderate-to-vigorous physical activity was found.

As summarized in Table 1.1, it is evident that despite correlational and observational evidence of the contribution of social-cognitive factors to the prediction of physical activity behavior, large-scale, multi-site randomized clinical trials that incorporate these constructs have seldom brought about meaningful physical activity behavior change. A recent review of school-based controlled interventions (Demetriou & Höner, 2012) offered criticism of intervention studies to date, emphasizing that researchers have largely failed to provide reasons for an intervention's lack of success or to delineate the component(s) or underlying mechanisms of an intervention responsible for change. In fact, in this review of school-based interventions, only 3 of 53 studies examined psychological characteristics as potential mediators. Likewise, existing interventions have commonly reported group averages; rarely have they addressed individual

baseline physical activity levels and psychological characteristics or specified *for whom* (i.e., moderators of) intervention efforts may have been more or less effective.

In sum, a review of the literature has revealed that although ample resources (i.e., people, time, and money) have been devoted to the evaluation of large-scale efforts to increase physical activity, these efforts seldom have been effective in bringing about behavior change. When effective, interventions have resulted in only modest increases in physical activity behavior at best, with many individuals still unable to meet the Youth Physical Activity Guidelines' recommendation of one hour per day of either moderate or vigorous-intensity physical activity (USDHHS, 2011), and the reasons and mechanisms for behavior change remain speculative. Furthermore, few large-scale interventions have reported on their long-term effectiveness, and the maintenance of any physical activity behavior change is therefore unknown. Considering evidence of the persistent recalcitrance of physical inactivity in the face of current theory-based interventions, it is clear that existing models and theories of behavior are insufficient and much remains to be discovered about the psychological underpinnings of individuals' continued engagement in this modifiable protective behavior.

Table 1.1

*Randomized Controlled Trials of School-Based Physical Activity Promotion in Adolescents*

Study		Participants			Intervention		Findings	
Author, year	Objectives	<i>N</i> (schools, students)	Age at baseline (mean ± SD)	Gender (%female)	Theoretical model	Duration	PA outcome measure	Intervention effects
Neumark-Sztainer et al., 2003	New Moves intervention to improve PA and eating behavior	6, 190	15.4 ± 1.1	100.0	SCT	4 months	Modified version of the Leisure Time Exercise Questionnaire	No influence of the intervention on PA
Jones et al., 2008	'Incorporating More Physical Activity and Calcium in Teens' (IMPACT) program to increase PA	11, 606	11.6 ± 0.4	100.0	SCT + Trans-theoretical model	1 ½ years	The Self-Administered Physical Activity Checklist (SAPAC)	Girls in the intervention schools reported 6 mins per day more vigorous PA
Gortmaker et al., 1999	Planet Health program to reduce obesity	10, 1,295	11.7 ± 0.7	48.0	SCT + Behavioral Choice theory	1 ½ years	The Youth Activity Questionnaire	No influence of the intervention on PA
Jago et al., 2011	HEALTHY intervention to increase PA and improve diet	42, 4,063	11.3 ± 0.6	52.4	SCT	2 ½ years	The Self-Administered Physical Activity Checklist (SAPAC)	No influence of the intervention on PA
Dewar et al., 2013	Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) program to promote healthy eating and PA	12, 357	13.2 ± 0.5	100.0	SCT	1 year	Accelerometry	No influence of the intervention on PA

Kriemler et al., 2010	“Kinder-Sportstudie” (KISS) intervention to increase PA	15 <sup>a</sup> , 498	6.9 ± 0.3, 11.1 ± 0.5 <sup>b</sup>	50.0	SCT + Social-Ecological model	9 months	Accelerometry	Girls and boys in the intervention schools engaged in 11 mins per day more MVPA
Pate et al., 2005	Lifestyle Education for Activity Program (LEAP) to increase PA	24, 1,604	13.6 ± 0.6	100.0	SCT + Social-Ecological model	1 year	The 3-Day Physical Activity Recall (3DPAR)	Girls in the intervention schools engaged in modestly greater amounts of vigorous PA
Luepker et al., 1996	The Child and Adolescent Trial for Cardiovascular Health (CATCH) to improve diet and PA	96, 4,019	8.8 ± __	48.2	SCT + Social-Ecological model	2 ½ years	The Self-administered Physical Activity Checklist (SAPAC) <sup>c</sup>	Girls and boys in the intervention schools reported 11 minutes per day more vigorous PA
Webber et al., 2008	Trial of Activity for Adolescent Girls (TAAG) to increase PA	36, 431	12.0 ± __	100.0	SCT + Social Learning theory + Social-Ecological model	1 ½ years	Accelerometry	No influence of the intervention on PA

<sup>a</sup> The KISS intervention randomized 28 classes within 15 schools to intervention or control conditions.

<sup>b</sup> The KISS intervention sample consisted of 50% first graders and 50% fifth graders. Mean age = first graders, fifth graders

<sup>c</sup> The SAPAC was administered only at follow-up.

\* PA= physical activity; SCT= Social Cognitive theory

\* A majority of interventions were compared to a PE as usual control condition. New Moves provided schools in the control condition with written information on PA and eating behavior. TAAG provided schools in the control condition with a delayed intervention.

\* Most interventions recruited only girls given lower levels and greater declines of physical activity observed in girls during childhood and adolescence (Biddle, Whitehead, O'Donovan, & Nevill, 2005; Sallis, Prochaska, & Taylor, 2000).

## **Affective Underpinnings of Behavior**

As highlighted by the above review of the literature, social cognitive constructs have been at the forefront of existing theories aimed at understanding behavior, and associated interventions aimed at changing behavior (Mayne, 1999). In contrast, the role of affect—an individual's general assessment of how they feel (e.g., pleasure/displeasure) that does not require conscious thought (i.e., cognition) (Diener & Emmons, 1984; Frijda, 1993)—has been minimized or entirely discounted (van der Pligt, Zeelenberg, van Dijk, de Vries, & Richard, 1997). The affect-behavior association has its basis in Hedonic Theory (Carels, Berger, & Darby, 2006; Kahneman, 1999), which states that individuals are driven by a desire to enhance pleasure and avoid or minimize pain. As such, feelings of pleasure associated with a particular behavior may reinforce that behavior while feelings of displeasure may instead inhibit the behavior, as individuals form an affective attitude or evaluation of its overall pleasantness or unpleasantness. Positive affect experienced in a situation and subsequent time spent in that situation have been positively associated, and negative affect experienced in a situation and subsequent time spent in that situation have been negatively associated (Emmons & Diener, 1986).

Some researchers have acknowledged the lack of attention to affect in most behavioral theories (Kwan & Bryan, 2010a; Parfitt, Rose, & Burgess, 2006; Schneider, Dunn, & Cooper, 2009; Welch, Hulley, Ferguson, & Beauchamp, 2007; West, 2005; Williams et al., 2008). As described in the preceding review of social-cognitive theories and models, SDT (Deci & Ryan, 1985) was the first social-cognitive theory to give a prominent role to an affective dimension of behavior (i.e., intrinsic motivation). More recently, Conner and Sparks (2005) suggested a revised TPB consisting of perceived behavioral control, norms, and both affective (i.e., beliefs of pleasantness or unpleasantness) and instrumental (i.e., beliefs of costs and benefits) components

of attitude. When included in investigations of the TPB, the affective component of attitude has been shown to predict intention across a variety of health behaviors (Ajzen & Timko, 1986; Godin, 1987). While it is true that affective attitudes commonly influence behavior indirectly through their relationship with the cognitive appraisals preceding them, evidence of a direct influence of affective attitude on intention, even without cognitive mediation (Allen Catellier & Yang, 2013; French et al., 2005; Lawton, Conner, & McEachan, 2009; Trafimow et al., 2004), has accumulated. Moreover, it has become clear that for some behaviors, affective attitude tends to have greater predictive power for intention and behavior than does cognitive attitude (Lowe, Eves, & Carroll, 2002; Trafimow et al., 2004). Together, these findings have substantiated the role of affective attitude in behavioral intention and have compelled reconsideration of existing models and theories of behavior.

Of particular interest in the context of health promotion is whether and how affect contributes to the process by which behavioral intentions, often used as a proxy for behavior, actually translate into behavior. A relationship between intentions and behavior has been confirmed by meta-analyses of correlational studies (Armitage & Conner, 2001), however experimental evidence is not consistent. Although intention to engage in a behavior is often considered a proximal determinant of actual behavior, a meta-analysis of experimental studies (Webb & Sheeran, 2006) reported that interventions that successfully altered intentions had a small-to-moderate influence on behavior. In examining constructs within social-cognitive theories that may be responsible for the heterogeneous findings among studies, the authors noted that there is likely a non-conscious factor that influences whether intention will be matched by behavior. Findings of affective associations (which as noted earlier can be formed without prior cognitive processing of an event) with intention (Keer, Putte, & Neijens, 2010; Kraft, Rise,

Sutton, & Røysamb, 2011; Trafimow et al., 2004), intention stability over time (Kwan & Bryan, 2010b), and behavior itself (Lawton et al., 2009) have led a number of researchers to propose that neglect of affect in interventions, and the social cognitive models they are based on, may in part explain the observed “intention-behavior gap” (Kwan & Bryan, 2010b; Lawton et al., 2009).

### **Affective Underpinnings of Physical Activity**

**Affect.** In studies that have incorporated affect in relation to physical activity, affect has been defined and measured in a number of different ways. The below review will be inclusive of the range of affect-based constructs used to date.

Affect can contribute to physical activity intention and behavior independently of cognitive construals. Investigations of physical activity intention have isolated the influence of the affective component of attitude from that of the instrumental component. In so doing, these investigations have established that the affective component of attitude influences exercise intention (Godin, 1987; Valois, Desharnais, & Godin, 1988) independently of perceived behavioral control and subjective norms (French et al., 2005; Lowe et al., 2002). Research in the physical activity domain also has shown that affective associations with physical activity influence physical activity behavior both through their influence as a mediator of cognitive beliefs (i.e., expected value of engaging in physical activity, perceptions of social norms, perceived control over activity behavior, and perceived benefits of and barriers to physical activity) and independent of these beliefs. For instance, in a study of 433 adults, affective associations influenced physical activity behavior independently in addition to their influence as a mediator of the link between cognitive beliefs and physical activity behavior (Kiviniemi, Voss-Humke, & Seifert, 2007). A recent meta-analytic review by Rhodes, Fiala, and Conner (2009) reported a medium-to-large effect of affect-based constructs on physical activity in correlational

studies, and a majority of the studies reviewed noted an independent effect of affect-based constructs.

Not only does affect contribute independently to physical activity, its influence may be just as, if not more, important than that of cognitive construals in shaping physical activity behavior. In other words, behavior may be a direct result of affective experiences rather than a function of intentional decision-making (Damasio, 1994). Relative to cognitive factors, affect has been shown to exert a greater influence on subjectively reported physical activity (Kiviniemi et al., 2007; Lowe et al., 2002). In the above-mentioned LEAP intervention, increase in pre-to-post-intervention vigorous physical activity was found to be mediated by enjoyment of physical activity (Pate et al., 2005), suggesting a salient role of affect in the behavior change process. In another longitudinal experimental study, albeit of short duration, the contributions of affective and instrumental components of attitude to the prediction of physical activity were tested in 120 adolescents. Findings showed that self-reported physical activity at the end of the two-week intervention was greater for inactive adolescents who were randomized into the affective intervention, consisting of 14 affect-based text messages about physical activity, relative to physical activity of those assigned to the instrumental or combined intervention groups, or to the control group (Sirriyeh, Lawton, & Ward, 2010), providing support for the salient role of affect in physical activity promotion in inactive adolescents. Further, given recent neurobiological findings of more rapid development of affective systems than cognitive control systems (Casey, Jones, & Hare, 2008), affect may play a particularly important role in determining behavior in adolescence. That is, in the absence of a fully developed neurobiological system to regulate affect, the impact of affect is likely to be stronger, providing further support for the centrality of affect to the understanding of physical activity behavior among adolescents.



**Affective Responses.** Because positive and negative affect experienced in a situation is associated with subsequent time spent in that situation (Emmons & Diener, 1986), researchers have turned attention to proximal exercise-related affective responses to acute exercise as a determinant of exercise motivation and adherence. This approach is consistent with an understanding of behavior as a product of the aggregate of individual responses and their consistency across situations (i.e., consistency) and time (i.e., stability) (Zuckerman, 1991).

A growing body of research suggests that acute affective responses may have implications for physical activity intentions and behavior. For example, affective responses of 25 inactive women to a graded exercise test were associated with physical activity, predominantly in the form of planned exercise (Carels et al., 2006). Annesi (2005) found a positive association between proportion of exercise session attendance and proportion of exercise-related pre-to-post positive feeling state changes in 66 healthy, inactive adults starting an exercise program, supporting Van Landuyt and colleagues' (2000) suggestion of affective responses being the first link in the chain joining exercise and exercise adherence. In another study, increased positive affective responses during a 30-minute exercise bout in 127 adults moderated the relationship between exercise intentions and self-reported frequency of voluntary exercise three months later (Kwan & Bryan, 2010a). In other words, as improvements in positive affect increased during exercise, so did the likelihood that exercise behavior would match intentions. In adolescents, an affective response-physical activity association also has been observed, such that adolescents who reported an increase in pleasure while exercising at a moderate intensity engaged in a greater amount of daily moderate-to-vigorous physical activity than those whose pleasure decreased or stayed the same (Schneider, Dunn, et al., 2009). Moreover, a prospective investigation demonstrated that affective responses to a graded exercise test in 31 inactive adults

participating in a physical activity intervention had predictive value for physical activity behavior 6 and 12 months later (Williams et al., 2008). In sum, the available body of evidence suggests that the influence of affective responses to exercise on physical activity has the potential to partially explain the relatively modest utility of interventions based on social cognitive theories. To date, however, there has been inadequate research to characterize the affective response to exercise in terms of its value as a predictor of physical activity behavior.

### **Affective Style as a Determinant of the Affective Response to Exercise**

**Psychophysiology of Affective Style.** Recent attention has turned to the possibility of an affective style; a psychophysiological trait that reflects a tendency for an idiosyncratic pattern of affective responsiveness to stimuli (Davidson, 1998). Affective style is considered to be rooted in the activity of two neurophysiological systems, termed the Behavioral Inhibition and Behavioral Approach systems (BIS/BAS) (Davidson, 1992). In short, the BIS controls behavioral responses to aversive stimuli and its activity is characterized by withdrawal motivation or movement away from aversive stimuli. The BAS, on the other hand, controls goal-directed behavior and is characterized by approach motivation or movement in the direction of a goal (Gray, 1990). Variations in BIS and BAS activation are related to individual differences in sensitivity to cues of punishment or reward (Pickering, 1997) and to a predisposition to respond negatively or positively to emotion-eliciting stimuli (Davidson, 1998), ingrained in the personality traits of introversion and extraversion, respectively (Gray, 1970).

There is evidence that affective style also may be manifested in a characteristic pattern of activity within the frontal cortex of the brain, in particular resting frontal brain asymmetry patterns (Davidson, 1995), such that greater left frontal activation relative to right is associated with the approach system and positive affect. In other words, an individual with greater left

hemispheric activation will have a propensity to experience positive affect whereas an individual with greater right frontal activation will be more likely to experience negative affect (Tomarken, Davidson, Wheeler, & Doss, 1992). Additionally, resting asymmetry patterns in frontal brain regions have been associated with acute affective response to emotion-eliciting stimuli. For instance, greater right frontal activation has been associated with more negative affective responses to negative films (Tomarken, Davidson, & Henriques, 1990; Wheeler, Davidson, & Tomarken, 1993) and greater left frontal activation has been associated with more positive affective responses to positive films (Wheeler et al., 1993). These findings lend support to the notion that asymmetric frontal brain activation reflects a predisposition to respond with a particular affective valence.

Further evidence for the existence of an affective style comes from investigations of whether temporary affect (e.g., affective state, affective response) is consistent across situations (i.e., consistency) and time (i.e., stability) within individuals, a fundamental property of traits like affective style (Epstein, 1979). In an investigation by Diener and Larsen (1984), the within-person consistency and stability of affective states in a wide range of situations were examined by prompting 42 college students two times a day using the experience sampling method (ESM). Findings showed three-week temporal stability, aggregated across identical pairs of situations, to be .79 for positive affect and .81 for negative affect. Similarly, affect was reasonably stable over time within typical situations. Not surprisingly, given the influence context exerts on behavior (Van Mechelen & De Raad, 1999), consistency of positive and negative affect across situations (social, novel, and work) was on average lower than stability, ranging from .58 to .80. That is, individuals' responses were typically more consistent across similar situations at distinct time periods than across varying situations at proximal time periods.

**“Traitedness” of Affective Style.** Of importance, a growing line of research in the field of personality psychology has demonstrated interindividual variability in the degree of expression of a character trait, termed “traitedness” (Baumeister & Tice, 1988). That is, individuals may vary in the extent to which they consistently express a particular trait. For instance, in the aforementioned investigation of cross-situation consistency and temporal stability of positive and negative affect (Diener & Larsen, 1984), variability in degree of consistency was observed, with some individuals demonstrating more habitual, or consistent, responses than others (Diener & Larsen, 1984). This variability in “traitedness” has been shown to be in part a function of the circumstances and situations an individual encounters (Funder, 2006) and also of how sensitive or resistant an individual is to situational changes (Gross & John, 2003), thereby supporting the long ago suggested influence of environmental factors on the expression of a trait in a given situation (Mischel, 1968). That is, to the extent that individuals differ on dispositional characteristics and their exposure and sensitivity to contextual factors, there will be differences in consistency and stability of trait-relevant responses between them.

Furthermore, the propensity to express variability in a character trait has itself been shown to be consistent across situations and stable over time (Fleeson, 2001; Penner, Shiffman, Paty, & Fritzsche, 1994; Satterwhite, Fogle, & Williams, 1999). For instance, an investigation by Eid and Diener (1999) demonstrated that although intraindividual variability in positive affect was associated with individuals’ mean levels of positive affect, it showed sufficient stability over time to be classified as a self-standing trait apart from general positive affect. In other words, the degree of variability in acute affective states itself constituted an individual difference that may be part of broader individual differences in affective style. In line with this conceptualization of traits, the notion of affective style can be interpreted as an individuals’ general disposition to

respond positively or negatively to emotion-eliciting stimuli, of which the difference in expression may be one of degree. In other words, two individuals may be similar with regard to positive affective style but not “traitedness;” the individual who is most “traited” will display more consistently positive affective responses (Bem & Allen, 1974).

**Application to Exercise-related Affective Responses.** In attempting to explain exercise-related changes in affect, several researchers have suggested that applying the concept of an affective style may help explain affective response to exercise (Hatfield & Landers, 1987; Petruzzello & Landers, 1994). This postulation has been reinforced by multiple lines of research in the physical activity domain. First, affective style, commonly assessed via responses to self-report measures of approach/ withdrawal motivation characteristics (Carver & White, 1994), has been related to adolescents’ affective responses to exercise. In a study of 146 healthy adolescents, affective responses before, during, and following a 30-min acute exercise bout were negatively associated with the BIS, indicative of a personality characterized by withdrawal motivation and positively associated with the BAS, indicative of a personality characterized by approach motivation (Schneider & Graham, 2009).

Second, studies of exercise and personality, or a relatively stable set of individual features that serve as the basis for actions and reactions to stimuli and events one encounters, provide additional, indirect evidence for affective style underlying physical activity behavior. In particular, extraversion, a personality type characterized by an inclination toward experiencing positive emotion, preference for stimulation-seeking behaviors (e.g., social interaction and exciting or novel activity) (Eysenck, 1970) and reward-sensitivity (Depue & Collins, 1999), and considered another index of approach motivation (BAS) (Carver, Sutton, & Scheier, 2000; Mitchell et al., 2007), has been shown to be related to physical activity behavior. Numerous

studies have found an association between frequency of and adherence to exercise and extraversion (Courneya & Hellsten, 1998; Rhodes & Smith, 2006). Some investigations, however, have failed to demonstrate a significant association between extraversion and exercise behavior (e.g., Yeung & Hemsley, 1997) or provided evidence for an association in an unexpected direction (Yeung & Hemsley, 1997b). Some researchers have provided insight into this contradictory evidence, noting that existing self-report measures of extraversion emphasize social characteristics of the trait more than its interoceptive indices (Ekkekakis, Hall, & Petruzzello, 2005). One of the core components of extraversion is a preference for stimulation-seeking behaviors that results from extraverts' lower level of basal arousal of the reticular activating system, which leads them to show less sensitivity to and thus more positive affect with high-intensity stimuli (Eysenck, 1967). As such, valid operationalization and assessment of extraversion rests on an emphasis of not only its interoceptive expression (e.g., reward sensitivity) but also its exteroceptive expression (e.g., sociability) (Lucas, Diener, Grob, Suh, & Shao, 2000).

Third, using resting frontal asymmetry patterns as a marker of affective style, research has suggested that individuals with greater left frontal activation relative to right may experience more positive, and less negative, emotion in response to exercise (Hatfield & Landers, 1987; Petruzzello & Landers, 1994). Assessed via electroencephalography (EEG) measures of electrical activity in the brain, greater resting left frontal brain activation has been shown to predict more positive affective responses to acute exercise (Petruzzello, Hall, & Ekkekakis, 2001; Petruzzello & Landers, 1994; Schneider, Graham, Grant, King, & Cooper, 2009), although some studies find this association to be dependent on exercise intensity (Petruzzello & Tate, 1997). Studies of the association between EEG asymmetry and post-exercise affective responses

have reported that frontal EEG asymmetry predicts affective responses at high (operationalized as 70-75 %VO<sub>2max</sub>), but not low (operationalized as 55-60 %VO<sub>2max</sub>) exercise intensities (Ekkekakis & Acevedo, 2006). Studies providing this evidence, however, have been hindered by several methodological weaknesses (related to timing of affective response assessment and poor standardization of exercise intensity) that are common to this research area, and will be described in the following section.

As illustrated above, affective responses may be indicative of an underlying predisposition to enjoy physical activity. Although differences in enjoyment of physical activity between active and inactive adolescents (Cox, Smith, & Williams, 2008) as well as active and inactive adults (Hoffman & Hoffman, 2008) have been observed, these findings have commonly been construed as evidence for regular exercise fostering positive exercise-related affective experiences. Given the above evidence of an affective style- affective response relationship, it must also be considered that the differences between regular exercisers and non-exercisers may reflect an inherent predisposition for positive exercise-related affective experiences in some individuals but not others. In other words, individuals who are predisposed to experience positive affect in response to exercise may be more likely to become regular exercisers.

The idea that individuals have a nonrandom pattern of affective responses deserves research attention with respect to physical activity as it may further theory development in this domain. Prior to making conclusions of an affective style underlying the affective response to exercise, however, research is needed to directly explore whether affective responses to exercise are consistent across situations and stable over time within individuals, keeping in mind variations in the degree of consistency and stability that individuals are likely to express. A recent study assessed affective *states* using ecological momentary assessment (EMA) in 121

children and adolescents and showed that affective states fluctuate within individuals over the course of a day, and found that children and adolescents with more stable positive affect engaged in greater hourly leisure-time MVPA (Dunton et al., 2013). In contrast, although *inter*individual variability in affective responses has been established, to the best of our knowledge there exists no research that evaluates *intra*individual variability of affective responses, or the degree to which affective *responses* to exercise fluctuate within individuals. The present study, using the individual as the unit of analysis, explores this dynamic by examining the consistency and stability of affective responses to exercise within individuals, and evaluates the potential influence of these markers of affective style on the relationship between the affective response to exercise and subsequent physical activity. In so doing, the present study seeks evidence for or against the presence of individual response profiles rooted in a dispositional affective style, and thereby advances the study of the determinants of physical activity behavior. Considering that the efficacy of physical activity interventions is dependent on individual characteristics (Dunton, Schneider, & Cooper, 2007), by employing the understudied construct of affective style, the present study may help explain the limited and mixed success of physical activity promotion efforts. Of particular relevance to the current research is evidence from a recent investigation by Schneider and Cooper (2011) that enjoyment of physical activity at baseline moderated the impact of a physical activity intervention.

In sum, evidence is emerging suggesting that differences in affective responses to exercise may constitute an individual difference in predisposition to enjoy exercise. In evaluating whether such a predisposition, or affective style, exists, it is important to consider several critical dimensions to the exercise experience that are relevant to the design and interpretation of any study of exercise and affect.



## **Methodological Considerations in Exercise-Affect Research**

**The Birth of Exercise Intensity-Affect Research and the Inverted-U Model.** Although exercise is similar in some ways to and has occasionally been associated with other health behaviors (Wankel & Sefton, 1994), it poses unique challenges that are unlikely to arise with other health behaviors. Inherent to exercise are factors that can impact individual affective responses and motivation; for example, its duration and intensity. While the idea of a duration ‘threshold,’ or specific duration of exercise that must be reached in order for affective improvements to occur, has not been demonstrated, a complex relationship between exercise intensity and affective responses, rooted in human physiology, has emerged.

The relationship of affect and exercise intensity was in part brought to light by studies in which participants were given the opportunity to self-select exercise intensity. The early work of Cabanac in the 1980’s first established the notion that affective responses predict self-selection of exercise intensity (Cabanac & Leblanc, 1983). In one study, six males participated in two conditions, one in which the treadmill incline was predetermined while room temperatures varied, and another in which room temperature was predetermined while treadmill incline varied. Findings showed that when low room temperature was imposed, males chose a steeper treadmill incline; when a high treadmill incline was imposed, males chose a lower room temperature. Upon mapping these choices onto affective ratings provided by the males during a first session in which both temperature and incline were predetermined, it became evident that the males had regulated their choices of temperature and incline to produce an ideal affective state (Cabanac & Leblanc, 1983).

Evidence from studies employing ratings of perceived exertion (Gunnar Borg, 1998), an index of exercise intensity reflecting the individual’s evaluation of effort, has corroborated these

findings. In another of Cabanac's studies, when three male participants were given a choice to adjust treadmill speed or incline while one or the other was predetermined, the resulting intensity and RPE of the two conditions were almost identical, and affective ratings obtained every two minutes predicted the males' individual adjustments of speed or incline (Cabanac, 1986). From these studies, Cabanac hypothesized that individuals regulate their exercise choices so as to find a physiological "middle ground" or homeostasis which they gauge through feelings of pleasure or displeasure; a hypothesis that lends support to the Hedonic theory in the exercise context. Subsequent research employing larger and more inclusive samples has confirmed this hypothesis. For example, King and colleagues (1991) observed only a slight difference in RPE in a study of sedentary adults between the ages of 50 and 65 who were randomly assigned to a higher-intensity or lower-intensity exercise training. Upon closer examination, the reason for comparable perceived exertion ratings became evident. The exercise intensity level of individuals in the higher-intensity exercise training stayed close to the bottom of the assigned heart rate range, while the exercise intensity level of individuals in the lower-intensity exercise training stayed close to the upper end of the assigned heart rate range (King et al., 1991).

In line with Cabanac's findings, it was proposed that the relationship between exercise intensity and affective responses can be captured by an inverted-U model (Kirkcaldy & Shephard, 1990). According to the inverted-U model, exercise of low intensity or high intensity is unlikely to produce an improvement in affect and exercise of high intensity may even produce negative affective changes, while exercise of moderate intensity is ideal for improving affect.

**Early Findings and Methodological Weaknesses.** Given the unique challenges associated with the study of exercise intensity and affect, early research in this area was marred

by a number of methodological limitations that interfered with researchers' ability to ascertain the association between exercise intensity and affective responses. Accordingly, included in the discussion of the relationship between exercise intensity and affective responses below are methodological considerations related to assessing the affective response to exercise.

***Timing of Assessment of Affect.*** One limitation of past research is the manner in which affect was assessed. Historically, researchers have assessed affective responses before and after exercise, a choice that was in part based on the assumption that affect changed linearly throughout exercise and in part based on the impracticality of assessing affect during exercise with existing multi-item measures. These pre-post studies have demonstrated that upon the completion of laboratory exercise, affect is consistently positive and often more positive than affect reported before exercise (Acevedo, Rinehardt, & Kraemer, 1994; Parfitt, Eston, & Connolly, 1996), regardless of exercise intensity (Ekkekakis & Petruzzello, 1999). Several studies examining the exercise-affect association in free-living settings in adults have confirmed this notion. For instance, greater positive affective states were observed after vigorous physical activity relative to identical times on days without activity (Gauvin, Rejeski, & Reboussin, 2000), as was improved affect from before to ten minutes after moderate-intensity treadmill running in a laboratory setting and running in a natural environment (Kerr et al., 2006). In sum, studies that assessed affective responses before and after exercise have substantiated the "exercise makes people feel good" notion across exercise intensities and thus have contradicted the inverted-U model's proposition of improvement in affect with lower, but not higher, exercise intensity.

***Calibration of Exercise Intensity.*** Exercise intensity can be calibrated in a variety of ways, and in lab-based studies has been usually indexed to an assessment of cardiopulmonary

fitness, such as percentage of maximal heart rate ( $\%HR_{\max}$ ) and percentage of maximal oxygen uptake ( $\%VO_{2\max}$ ). These measures define a given intensity as a function of the highest exercise intensity that an individual will voluntarily reach during a graded exercise test (i.e., cardiorespiratory fitness or endurance capacity). However, even using these quantitative and physiologically-based methods for defining exercise intensities, researchers have failed to achieve consensus as to what defines “moderate-intensity” or “high-intensity” exercise. Findings of disparate metabolic stress, or homeostasis being challenged for some individuals but not others, despite equivalent relative  $\%HR_{\max}$  across individuals (e.g., Katch, Weltman, Sady, & Freedson, 1978) made comparisons of activity intensity challenging in early studies, and suggested the need for a better criterion for determining the standardization of exercise intensity. Accordingly, it has been proposed that exercise intensity be set in relation to the point at which anaerobic activity begins to supplement aerobic activity, which can be defined via one of two physiological parameters: (1) the lactate threshold (LT), an index of blood lactate above resting levels or the point at which accumulation of lactate is quicker than its clearance (i.e., aerobic-anaerobic transition; (Kindermann, Simon, & Keul, 1979), or (2) the ventilatory threshold (VT), an index of variations in gas exchange associated with the LT, or the point at which the ventilatory equivalent for oxygen ( $O_2$ ) increases while the ventilatory equivalent for carbon dioxide ( $CO_2$ ) remains constant. The LT and VT represent direct and indirect indices of the point at which anaerobic activity begins to supplement aerobic activity, respectively. Given its non-invasive nature, the VT approach has been preferred in physical activity research.

**Recent Findings and Methodological Improvements.** The last decade has evidenced considerable improvement in the timing of affect assessment and calibration of exercise intensity. These improvements and resulting advances in knowledge are described below.

With the advent of refined measures that allow for affective response assessment *during* exercise, more recent studies have exposed the methodological limitations of the pre-post design. In particular, the Feeling Scale (FS; Hardy & Rejeski, 1989) and Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985), both single-item measures, have been used widely to assess affective responses continuously during exercise. The FS and FAS have a theoretical basis in the Circumplex model (Russell, 1980), which represents affective states along two orthogonal dimensions; one dimension represents the valence of affect (i.e., good/bad) and the other dimension represents level of activation (i.e., high/low). The FS captures the affective valence dimension of the Circumplex model while the FAS captures the affective activation dimension. Given their ease of administration and minimal distraction from the exercise task, the FS and FAS offer the advantage of feasibility and accuracy of repeated affective assessment *during* physical activity. Although the FAS has been employed alongside the FS in physical activity research for some time, it has not contributed to the prediction of physical activity behavior. This finding is not surprising considering that physical activity is by its nature activating. That is, activation typically increases with physical activity. As such, researchers have more recently omitted the FAS from investigations of affective responses to physical activity and have directed their attention exclusively to the FS (Dasilva et al., 2011; Kwan, Hooper, Magnan, & Bryan, 2011; Schneider, Dunn, et al., 2009; Stych & Parfitt, 2011; Williams et al., 2008).

Studies that have employed affective assessment *during* exercise have elucidated the reason for early studies' contradiction of the inverted-U model. Affect tends to rebound to an improved state immediately or shortly after completion of exercise (Bixby, Spalding, & Hatfield, 2001; Ekkekakis, Hall, VanLanduyt, & Petruzzello, 2000; Hall, Ekkekakis, & Petruzzello, 2002; Parfitt et al., 2006). Change in affect from before to during exercise, however, may not mirror

the homogeneously positive change in affect reported by the pre-post studies. Studies employing the pre-during design have provided some renewed support for the inverted-U model via evidence of increases in negative affective states and reductions in positive affective states during high-intensity cycle ergometry exercise in the laboratory (Acevedo et al., 1994; Bixby et al., 2001; Hall et al., 2002; Kilpatrick, Kraemer, Bartholomew, Acevedo, & Jarreau, 2007; Parfitt et al., 1996), thereby confirming the idea that assessing affective responses only before and after exercise obscures the affective changes that take place throughout the course of exercise (Ekkekakis, Parfitt, & Petruzzello, 2011).

Studies that have addressed the methodological limitation of standardized calibration of exercise intensity across individuals have further elucidated the relationship between affect and exercise intensity. Comparisons of affective responses to single-intensity exercise bouts set in relation to individual VT have demonstrated distinct responses to exercise prescribed below and above the VT. For instance, while affective responses of 12 middle-aged, inactive males to an above-VT exercise condition worsened over time, they remained consistently positive in the below-VT condition (Parfitt et al., 2006). Likewise, in a study of 30 active young adults, below-VT exercise bouts were accompanied by positive affect, while above-VT exercise bouts were accompanied by negative affect (Ekkekakis, Hall, & Petruzzello, 2008). Studies employing incremental exercise have similarly illustrated this relationship, showing that affect worsens when an individual reaches the point at which exercise intensity exceeds the VT (Bixby et al., 2001; Hall et al., 2002; Kilpatrick et al., 2007).

From an adaptational perspective, it seems logical that affect would begin to worsen around the point at which anaerobic metabolism begins to supplement aerobic metabolism. Generally, the function of affective responses is associated with the approach and withdrawal

motivational systems (Watson, Wiese, Vaidya, & Tellegen, 1999) and affective responses are thus considered evolutionarily adaptive, providing the individual with information about the safety or threat of situations they encounter. With physical activity beyond the VT come physiological changes (e.g., increases in ventilatory drive and recruitment of muscle fibers) that are likely to pose a threat to homeostasis and generate aversive interoceptive cues (e.g., shortness of breath, muscle aches, and fatigue). These physiological changes are accompanied by a worsened affective response, which serves as a signal to the individual to revert to activity at a point below the VT (Cabanac, 1971; Panksepp, 1998).

In sum, it is evident that although a given work rate may constitute moderate intensity for one individual, it may not do so for another individual. Given evidence for worsened affect around the VT, it is important to consider individual-specific metabolic processes when examining affective responses to exercise.

**Individual-level analysis and the Dual-Mode Theory.** Progress of research examining the affect-exercise intensity association was furthered not only by the aforementioned methodological improvements in timing of affective assessment and calibration of exercise intensity, but also by the addition of individual-level analysis. Researchers evaluating affective responses at the level of the individual have made key contributions to the understanding of the affect-exercise intensity association. Despite gaining some supporting evidence, the inverted-U model does not appear to accurately capture the wide range of individuals' responses to exercise. Research has demonstrated variability in affective responses across individuals, pointing to a non-global affective response trajectory. For example, positive responses to exercise of low- and high intensity (e.g., Ekkekakis, Hall, VanLanduyt, & Petruzzello, 2000; Pronk, Crouse, & Rohack, 1995) and negative responses to exercise of moderate intensity (e.g., Van Landuyt et al.,

2000) have been observed in some individuals. Research using individually-determined VT has further illustrated the heterogeneity of affective responses across individuals. For instance, in 20 inactive young women, affective response was not uniform during moderate-intensity exercise close to the VT; rather, there was considerable variability in individuals' affective responses (Welch et al., 2007). In a sample of 124 adolescents, considerable variability in affective responses to exercise set at 80% of individual VT was also demonstrated (Schneider, Dunn, et al., 2009).

Research in which individuals are instructed to choose their own level of exercise intensity (i.e., "self-selected" intensity) also confirms that there is considerable variability among individuals. In Lind and colleagues' investigation of inactive women, self-selected intensity ranged widely from 62% to 160% of VT during a 20-minute treadmill exercise bout (Lind, Joens-Matre, & Ekkekakis, 2005). The wide range of self-selected exercise intensity was confirmed in a recent review. Ekkekakis (2009) noted that the lowest self-selected intensity tends to be well below the minimum intensity endorsed by the ACSM and the highest tends to draw near the maximum endorsed intensity. In view of the variability in affective responses to exercise of the same intensity and self-selection of exercise intensity among individuals, it is clear that the nomothetic inverted-U model is not an adequate representation of the affect-exercise intensity relationship. Individual-level differences in the affective response to exercise have yet to be understood.

From the above review of the literature, it is clear that individual-level differences in the affective response to exercise do exist and have yet to be understood. Taking into consideration (1) the previously-illustrated notion that affective responses to exercise reflect individuals' responses to varied exercise intensities and associated interoceptive cues, and (2) evidence that



affective responses reflect potential underlying cognitive processes (e.g., self-efficacy, ratings of perceived exertion, and related cognitive appraisals) shown to contribute to interindividual differences in affective responses to exercise (e.g., McAuley, Talbot, & Martinez, 1999; Tuson, Sinyor, & Pelletier, 1995), a theory integrating both interoceptive cues and cognitive processes in explaining the affective response to exercise has emerged. Importantly, the Dual-Mode theory (Ekkekakis & Acevedo, 2006; Ekkekakis, 2003) states that interoceptive cues and cognitive appraisal processes are not equally influential across all intensities of exercise. Rather, the relative contribution of interoceptive cues and cognitive processes is proposed to change with exercise intensity.

According to the Dual-Mode theory, when exercise intensity is well below the VT, cognitive factors are moderately important and interoceptive factors are not important because intensity is low and unlikely to disrupt homeostasis; the affective responses that are evoked are homogeneously pleasurable (i.e., increases in positive affect and decreases in negative affect). When exercise intensity is at or approaching the VT, cognitive factors (e.g., self-efficacy, expectations) are posited to be most influential in determining the affective response to exercise; the affective responses that are evoked are therefore varied (i.e., some individuals may show affective change towards pleasure while others may show change towards displeasure). Finally, when exercise intensity is above the VT and thus likely to adversely impact homeostasis, interoceptive factors are routed past the cortex and hippocampus and act directly on the amygdala, thereby influencing affective responses to exercise directly and superseding the influence of cognitive processes; the affective responses that are evoked are homogeneously in the direction of displeasure (i.e., decreases in positive affect and increases in negative affect) (Ekkekakis & Acevedo, 2006).

Support for the Dual-Mode theory comes from studies showing a stronger negative relationship between interoceptive cues and affective responses as exercise intensity increases. In 11 experienced distance runners, physiological markers were not associated with affective responses before or at the VT, but a significant association with physiological markers was observed beyond this point of transition (Acevedo, Kraemer, Haltom, & Tryniecki, 2003). In another study, the strongest positive association between self-efficacy and affective valence corresponded to exercise intensity at or approaching the VT and weaker self-efficacy-affect associations were observed with VT increasing beyond the transition (Ekkekakis, 2003).

Thus, both empirical and theoretical evidence supports the assertion that affective responses to exercise are in part dependent on exercise intensity and that affective responses to exercise are not uniform between individuals. Moreover, the greatest variability can be seen near the VT. Hence, in attempting to identify interindividual differences in affective responses to exercise that may predict future exercise behavior, exercise near this transition may be particularly relevant. Evidence is accumulating to suggest that individual differences in affective responses to exercise near the VT may help explain why some adolescents choose to engage in physical activity while others do not.

Taking into account the above methodological considerations, the current study sought to evaluate whether individuals' affective responses to exercise can be characterized by an affective style, and if so, to determine whether the affective style plays a role in predicting future physical activity behavior, with the prospect of advancing an understanding of why some adolescents choose to engage in physical activity while others do not.

## Specific Aims and Hypotheses

The present dissertation pursued the following specific aims and tested the associated hypotheses using data derived from two separate studies.

**Specific Aim #1:** To examine the consistency of adolescents' affective responses to exercise across setting and intensity and the stability of adolescents' affective responses to exercise over time.

**Hypothesis #1a:** Adolescents' affective responses to moderate-intensity exercise are consistent across two divergent settings. This hypothesis was tested in Study 1 by comparing affective responses across two settings: a supervised clinic-based moderate-intensity exercise task and an unsupervised exercise task performed in a free-living setting.

**Hypothesis #1b:** Adolescents' affective responses to exercise are consistent across two divergent intensities. This hypothesis was tested in Study 1 by comparing affective responses across two clinic-based exercise tasks: a moderate-intensity exercise task and a hard-intensity exercise task.

**Hypothesis #1c:** Adolescents' affective responses to moderate-intensity exercise are stable over time when the setting is consistent. This hypothesis was tested first in Study 1 by comparing responses to an unsupervised free-living exercise task across a one-year time interval, and secondly in Study 2 by comparing responses to a supervised clinic-based task across a four-month interval.

**Specific Aim #2:** To examine whether the affective response to moderate-intensity exercise will predict future exercise behavior, and to determine whether this relationship is moderated by the consistency and/or stability of the acute affective response to exercise.

**Hypothesis #2:** The affective response to a moderate-intensity exercise task will prospectively predict adolescent exercise behavior, such that adolescents with a more positive affective response will be more physically active, and this association will be strengthened when affective response consistency and/or stability is high.

**Hypothesis #2a:** The association between the affective response to exercise and future PA will be strongest among those adolescents who respond in a consistent manner to two moderate-intensity exercise tasks performed in different settings. This hypothesis was tested in Study 1.

**Hypothesis #2b:** The association between the affective response to exercise and future PA will be strongest among those adolescents who respond in a consistent manner to a moderate- and hard-intensity exercise tasks. This hypothesis was tested in Study 1.

**Hypothesis #2c:** The association between the affective response to exercise and future PA will be strongest among those adolescents who respond in a stable manner to two moderate-intensity exercise tasks separated by a time interval. This hypothesis was tested in Study 1.

Chapter 2 presents a test of both hypotheses of Study 1. Chapter 3 presents a test of the hypothesis of Study 2.

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## CHAPTER 2

### Affective Response Consistency and Stability as Moderators in the Relationship between the Affective Response to Acute Exercise and Physical Activity

## Abstract

**Background.** Exercise-related affective responses have been identified as a factor contributing to physical activity behavior. Recent research suggests that affective style may underlie the documented variation in individuals' affective responses to exercise, and may help explain variability in PA participation, yet research evaluating the degree to which the affective response to exercise is reflective of an affective style is scarce. **Purpose.** The present study examined whether acute affective responses to exercise were consistent across exercise intensity and setting and stable over time, and whether individual differences in the degree of consistency of these responses played a role in predicting future PA behavior. **Methods.** Adolescents ( $N = 182$ ) provided affect ratings before and after a 30-minute moderate-intensity unsupervised exercise task at baseline and one year later, and before, during, and after two 30-minute clinic-based exercise tasks (moderate- and high-intensity) at baseline. Adolescents' physical activity levels were measured with accelerometry and self-report at baseline and one-year later. **Results.** Affective responses to acute exercise were consistent across exercise intensity but not across setting, and were fairly unstable over time. Variability in the degree of consistency of affective responses among adolescents was evident; however, tests of moderation of the affective response-PA relationship by affective response consistency were inconclusive. **Conclusions.** These findings provide preliminary evidence that affective responses to exercise may constitute a trait-like characteristic.

Physical inactivity is associated with increased risk of chronic morbidity and associated mortality (Hu et al., 2004; Myers et al., 2004; Vatten et al., 2006)<sup>1</sup>. In conjunction with poor diet, physical inactivity is considered the second leading risk factor for death nationwide (Mokdad et al., 2004) and is cited as the fourth leading risk factor for death worldwide by the World Health Organization (WHO; 2012). According to recent estimations, physical inactivity accounts for 9% of all worldwide premature deaths (Lee et al., 2012). The opposite is true for physical activity; physical activity can reduce the risk of disease (e.g., coronary heart disease, breast and colon cancers) and promote longevity (Warburton et al., 2006; Wen et al., 2011).

Despite the consequences associated with physical inactivity, approximately 1/2 of adolescents over the age of 15 are physically inactive nationwide (World Health Organization; 2010) and over 3/4 are insufficiently active to meet current recommendations. Furthermore, physical activity tends to decline notably during the late childhood years and early adolescence (Biddle et al., 2011; Dumith et al., 2011; Nader et al., 2008) and continues to do so across the lifespan (Troiano et al., 2008). Adolescence is recognized as an influential period for establishing individual long-term health behaviors (Hedberg et al., 1999) as adolescent physical inactivity predicts adult inactivity (Hallal et al., 2006; Kjønnsen et al., 2009). Physical activity promotion

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<sup>1</sup> A full review of the literature relating to the emergence of exercise-related affect as a promising construct to study as a means of understanding adolescents' physical activity behavior has already been presented in the introduction to this dissertation. The following abbreviated introduction highlights the most salient points and establishes a context for the first of the two studies reported in this dissertation.

among children and adolescents therefore has been identified as a public health goal by the U.S. Department of Health and Human Services (USDHHS, 2004, 2008).

In attempting to understand why some individuals engage in physical activity while others do not, researchers have often relied on social-cognitive explanations. Although social-cognitive constructs, in particular self-efficacy and social support, are associated with physical activity behavior (Biddle et al., 2011; Trost, Owen, Bauman, Sallis, & Brown, 2002), they have had minimal utility in explaining physical activity behavior change in intervention studies (Jago et al., 2011; Jones et al., 2008; Nader et al., 1999; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003; Pate et al., 2007). More recently, researchers also have turned their attention to proximal exercise-related affective responses as a contributing factor to physical activity behavior. In one investigation, adults who experienced increases in positive affect during acute exercise were more likely to translate their intentions to exercise into voluntary exercise behavior (Kwan & Bryan, 2010a). In another investigation, adolescents who reported an increase in pleasure while exercising at a moderate intensity engaged in a greater amount of daily moderate-to-vigorous physical activity than those whose pleasure decreased or stayed the same (Schneider, Dunn, et al., 2009). Moreover, a prospective investigation of inactive adults participating in a physical activity intervention demonstrated that affective responses to a graded exercise test had predictive value for physical activity behavior 6 and 12 months later (Williams et al., 2008).

Recent attention has turned to the possibility that affective style, a psychophysiological trait that reflects a tendency for an idiosyncratic pattern of affective responsivity to stimuli (Davidson, 1998), may help explain the affective response to exercise. Among adolescents, the affective response to an acute exercise task has been found to correlate with measures of the Behavioral Inhibition and Behavioral Approach systems (BIS/BAS) (Carver & White, 1994;



Davidson, 1992)—the two neurophysiological systems within which affective style is rooted (Schneider & Graham, 2009). Another marker of affective style is resting frontal cortical asymmetry patterns (Davidson, 1995), such that greater activation of the left frontal cortex relative to right reflects activity in the approach system (BAS), which is associated with positive affect. Using electroencephalography (EEG), this research has shown that greater resting left frontal brain activation predicts more positive affective responses to acute exercise (Petruzzello et al., 2001; Petruzzello & Landers, 1994; Schneider, Graham, et al., 2009). Furthermore, extraversion, a personality type characterized by an inclination toward experiencing positive emotion, preference for stimulation-seeking behaviors (e.g., social interaction and exciting or novel activity) (Eysenck, 1970) and reward-sensitivity (Depue & Collins, 1999), and considered another index of approach motivation (Carver et al., 2000; Mitchell et al., 2007), has been associated with physical activity behavior (Courneya & Hellsten, 1998; Rhodes & Smith, 2006). Especially intriguing is the suggestion that a genetic basis may contribute to the affective response to exercise (Karoly et al., 2012) and exercise participation (Stubbe et al., 2006; Wilkinson et al., 2013). This series of findings suggests that *inter*individual differences in affective responses may be indicative of an underlying predisposition to enjoy physical activity and sheds light on the possibility that differences between exercisers and non-exercisers may reflect an inherent tendency for positive exercise-related affective experiences in some individuals but not others.

Absent from the literature, however, is a direct evaluation of whether individuals show a nonrandom pattern of affective responses across exercise occasions (i.e., consistency) and over time (i.e., stability) (Epstein, 1979). In a recent study in which affective states were assessed using ecological momentary assessment (EMA) throughout the course of a day, children and

adolescents with more stable positive affect engaged in greater hourly leisure-time moderate-to-vigorous physical activity (Dunton et al., 2013). There is, however, no published research that quantifies *intraindividual* variability of affective responses to exercise, or the degree to which exercise-related affective responses fluctuate within individuals.

Studies supporting the Dual-Mode model of the affective response to exercise (Ekkekakis, 2003) suggest that *interindividual* differences in affective responses to exercise are a function of exercise intensity, such that affective responses are homogeneously pleasurable when exercise intensity is well below the ventilatory threshold (VT) (a marker of aerobic exercise capacity), varied when exercise intensity is at or approaching the VT, and largely in the direction of displeasure when exercise intensity is above the VT (Ekkekakis, Parfitt, & Petruzzello, 2011). Evidence for the Dual-Mode model is plentiful, and involves the comparison of group means across different exercise intensities. What remains to be demonstrated in this regard is the extent to which an individual who shows a pleasurable response to an exercise episode of one intensity is also likely to show a pleasurable response to exercise of another intensity and/or of a similar intensity on another occasion.

### **The Present Study**

Using the individual as the unit of analysis, the first aim of the present study was to examine (1) the consistency of adolescents' affective responses across exercise tasks in divergent settings and across exercise of different intensity and (2) the stability of adolescents' affective responses to exercise across time. It was hypothesized that adolescents' affective responses to exercise would be consistent across two divergent tasks (a moderate-intensity and a hard-intensity task) and settings (a supervised task in a clinic-based setting and an unsupervised task

in a free-living setting), and stable over time across unsupervised exercise tasks in free-living settings.

A second purpose of the present study was to evaluate to what extent there is variability in the consistency and stability of adolescents' affective responses to exercise. This question draws from existing literature suggesting that individuals differ in the degree to which they manifest a general disposition (Baumeister & Tice, 1988; Diener & Larsen, 1984), considered a function of the circumstances and situations they encounter (Funder, 2006; Roberts, 2009) and also of how sensitive or resistant they are to situational changes (Gross & John, 2003; Meehl, 1975; Morgan & Pollock, 1977). This evidence led to the hypothesis that there would be interindividual variability in the consistency of adolescents' exercise-related affective responses across tasks and in their stability over time.

A final goal of the present study was to examine the role of exercise-related affective response consistency and/or stability as a potential moderator of the relationship between the affective response and future exercise behavior. It was hypothesized that the affective response to exercise would prospectively predict adolescent exercise behavior, such that adolescents with a more positive affective response would be more physically active. It was further hypothesized that the consistency and stability of adolescents' exercise-related affective responses would moderate the strength of the affect-activity association, such that the association between affective response to exercise and participation in physical activity would be most pronounced for adolescents with a consistent and/or stable affective response to exercise.

A major contribution of the current study is the evaluation of whether individuals' affective response to exercise represents an enduring trait. In addition, the study investigates the role that consistency and stability of affective responses play in shaping physical activity

behavior. Furthermore, because investigations of the affective response-physical activity relationship often concentrate on individuals' responses to a single exercise task (Kwan & Bryan, 2010a; Williams et al., 2008), a secondary contribution of the current study is a methodological one; that is, to evaluate the reliability of a single assessment of the affective response to exercise, which may provide valuable information for researchers investigating the predictive capability of exercise-related affective responses.

## **Method**

### **Participants**

Participants were recruited via flyers posted throughout two public high school campuses and sent to the homes of parents, and verbal announcements made in classrooms in the spring of adolescents' 9<sup>th</sup> grade year. Adolescents were eligible to participate in the study if they: (1) were entering the 10<sup>th</sup> grade at the time of enrollment, (2) did not have health problems that might impede their participation in moderate and vigorous exercise, (3) were right-handed as determined by the Chapman Handedness Inventory (Chapman & Chapman, 1987), (4) did not self-report a history of neurological disorders, stroke, or significant head trauma (i.e., head trauma manifesting in loss of consciousness for more than 24 hours), and (5) did not have prior or current clinical depression, defined as a clinical diagnosis or a score  $\geq 15$  on the Beck Depression Inventory (Beck, Steer, & Brown, 1996). Inclusion criteria (3), (4), and (5) were related to assessment of frontal cortex activation with electroencephalogram (EEG), relevant to a related but distinct aim of the larger study.

### **Procedures**

Eligibility was determined, and written participant assent and parental consent for study participation were obtained at group orientation sessions. Adolescents who met the eligibility

requirements took part in exercise assessments in two different settings. At the university-based General Clinical Research Center (GCRC), adolescents took part in a cardiopulmonary fitness test, a moderate-intensity exercise task, and a hard-intensity exercise task. In a free-living setting, adolescents completed two unsupervised moderate-intensity exercise tasks. For their participation, adolescents were compensated \$25 for each clinic visit and \$10 for completing each unsupervised exercise task. The study was approved by the Institutional Review Board (IRB) of the University of California, Irvine.

During their first visit to the clinic, participants completed questionnaires regarding their sociodemographic background (age at study entry, gender, race/ethnicity) and an experimenter recorded readings of participants' height (cm) and weight (kg) from a calibrated stadiometer and calibrated digital scale, respectively. Next, participants underwent a ramp-type cardiopulmonary fitness test on an electromagnetically braked cycle ergometer (Whipp, Davis, Torres, & Wasserman, 1981). To ensure that participants gave their maximum rather than just adequate effort, they were verbally encouraged to continue giving their best effort as higher workloads were reached. Pulmonary gas exchange (i.e., oxygen uptake, carbon dioxide output, and ventilation), measured breath by breath (Cooper, Weiler-Ravell, Whipp, & Wasserman, 1984), was used to derive participants' VT using the V-slope method (Beaver, Wasserman, & Whipp, 1986) (VIASYS Healthcare Inc., *SensorMedics*, Yorba Linda, CA).

Within one week of the first visit, participants completed a 30-minute unsupervised exercise task. Participants were instructed to "Find a time to do a 30-minute exercise session sometime during the week" and to "exercise at a level that increases [their] heart rate and makes [them] breathe harder (i.e., at least a brisk walk)." Using a log provided by the study (see Appendix A), participants were asked to record the time they started and stopped the exercise,

and indicate how they felt immediately before and after the exercise (on a scale developed for this study). Participants also were instructed to wear a uniaxial accelerometer (ActiGraph model 7164, Pensacola, FL) secured to a belt on their left hip during the exercise task. Provided to participants at the end of their first visit, the Actigraph accelerometer, a tool widely used to obtain valid measurement of individual movement in both field- and laboratory-based studies (Freedson & Miller, 2000; Tryon & Williams, 1996), enabled objective assessment of activity during the unsupervised exercise task.

Approximately one week after the first visit, participants returned to the clinic and underwent a Dual X-ray Absorptiometry (DEXA) scan, a technique that uses a minimal dosage of ionizing radiation to assess percentage of body fat. During this session and a second session one week later, participants took part in either a 30-minute moderate- or hard-intensity exercise task on a cycle ergometer, calibrated to their individual VT and counter-balanced across the two visits to eliminate potential effects of order. Target work rate for the moderate-intensity exercise task was calibrated to the work rate corresponding to 80% of individual VT, a method considered to be a reliable means of ensuring a “moderate-intensity” exercise session owing to its consideration of differences in metabolic processes across individuals (Kindermann et al., 1979). Target work rate for the hard-intensity exercise task was calibrated to the work rate halfway between individual VT and  $VO_{2peak}$ . The two tasks were successful in yielding different heart rate responses and ratings of perceived exertion as previously reported by Schneider and colleagues (2009). During either task, if the participant showed signs of fatigue, defined as an inability to maintain a cycling pace or cadence of  $70 \pm 10$  revolutions per minute (RPM) for one minute, the target work rate was reduced incrementally by 10 W. This procedure guaranteed that all participants would complete all 30 minutes of the exercise task. Participants rated their

momentary feeling state immediately prior to, every ten minutes during, and immediately following each task, and once more after a 10-minute rest period (i.e., mins 0, 10, 20, 30, and 40) by verbally indicating a response to the Feeling Scale from options posted in enlarged type (see Appendix B for moderate- and hard-intensity exercise task protocols).

Approximately one year after the first visit, participants again completed a 30-minute unsupervised exercise task while wearing an accelerometer. Exercise task instructions were identical to those of the first unsupervised task (see Figure 2.1 for the sequence of assessments for supervised and unsupervised exercise tasks).

## **Measures**

**Affective response to clinic-based exercise.** Affective responses corresponding to the clinic-based exercise tasks of moderate and hard intensities were assessed with the unidimensional, single-item Feeling Scale (FS; Hardy & Rejeski, 1989). Participants were asked to rate how they felt at the current moment on an 11-point bipolar scale ranging from -5 (very bad) to +5 (very good) with additional anchors at zero and every odd integer. The FS has demonstrated convergent validity via associations with valence scales of other self-reported measures of affect, namely the Self Assessment Manikin (SAM) and the Affect Grid (Lang, 1980; Van Landuyt et al., 2000), and is a change-sensitive measure of affective valence for adolescents engaging in multi-intensity exercise (Sheppard & Parfitt, 2008).

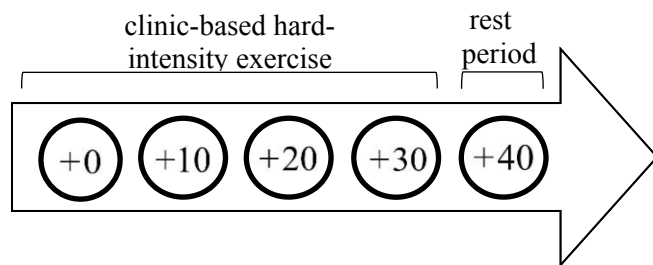
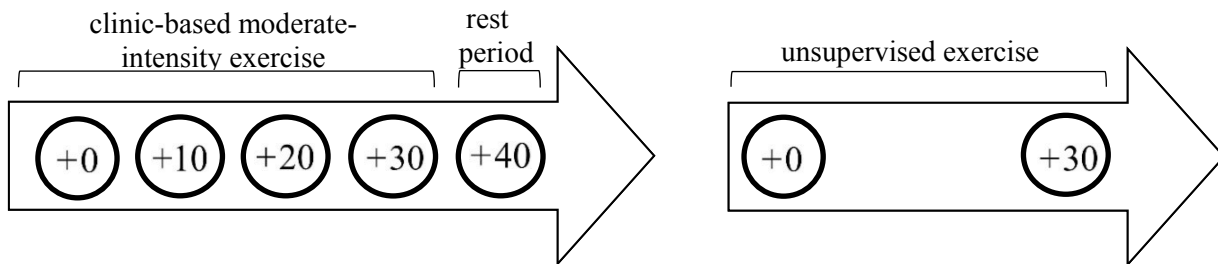
**Affective response to unsupervised exercise.** Affective response corresponding to the unsupervised exercise task was assessed with a modified version of the FS with the same anchors (“very bad” and “very good”) but only five response options (1 to 5) (see Appendix A). This number of response options is within the range of acceptable response options for maintenance

of internal consistency reliability and factorial validity of responses (Lozano, García-Cueto, & Muñiz, 2008; Masters, 1974).

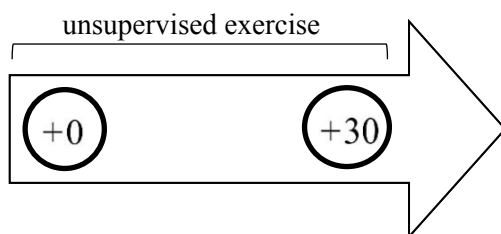


Figure 2.1. Affective response assessment sequence

Baseline



One-year follow-up



**Physical Activity.** Physical activity at baseline and follow-up was assessed via self-report measures, accelerometry, and physiological indices derived from cardiopulmonary fitness testing.

***Self-Report Measures.*** Self-reported physical activity was assessed with the 3-Day Physical Activity Recall (3dPAR), adapted from the Previous Day Physical Activity Recall (PDPAR) (Weston, Petosa, & Pate, 1997) and validated for the assessment of adolescents' moderate-to-vigorous physical activity (MVPA) by (Pate, Ross, Dowda, Trost, & Sirard, 2003) and Motl and collaborators (2004). Participants were provided with a list of 61 categorized activities and asked to recall the activities they engaged in during 30-minute time segments from 7:00 AM to 11:30 PM in the three days prior, excluding participation in Physical Education (PE) class (see Appendix C). Using a compendium of physical activities and assigned metabolic equivalent (MET) values, which serve as an index of workload (Ainsworth et al., 2011), the average number of minutes spent participating in MVPA ( $\geq 3$  METs) per day was calculated.

Self-reported physical activity also was assessed as participation in structured physical activity, using a questionnaire specific to school sports and another questionnaire specific to sports outside of school, both developed during the MSPAN (Middle School Physical Activity and Nutrition) study by Sallis and colleagues (2003). Participants were asked to indicate which sports they had participated in within the last year from a checklist of 14 in-school sports and another checklist of 14 out-of-school sports (see Appendix D). If a sport that the child had participated in was not included in either checklist, the participant could freely indicate their involvement in the sport. Participation in structured physical activity was calculated as the sum of non-overlapping school sports and out-of-school sports the participant indicated being involved in. Compared to questionnaires that ask participants to report physical activity

participation within a defined length of time usually ranging from one day to one week (e.g., the 3dPAR), these in- and out-of-school sports questionnaires, which ask the participant to report on their sports involvement within the last year, tap into habitual activity.

*Accelerometry.* Because children and adolescents may over- or under-report their physical activity due to recall bias or social-desirability, it is recommended that self-reports of physical activity be supplemented with objectively measured free-living physical activity (Sirard & Pate, 2001; Troiano, Petree Gabriel, Welk, Owen, & Sternfeld, 2012). Accelerometers represent the most favored method of objective physical activity assessment in the field of physical activity today. In the current study, physical activity in participants' free-living environment was assessed at baseline and the one-year follow-up with the Computer Science & Applications (CSA) ActiGraph accelerometer model 7164 (Pensacola, FL), a commercially-available, uniaxial ambulatory monitor. This monitor measures acceleration in the vertical plane in units termed "counts." In the current study, Actigraphs<sup>®</sup> were initialized to sample activity counts over a 60-second epoch, thereby providing output in counts per minute, and were used to gauge activity timing, duration, and intensity. Actigraphs<sup>®</sup> are considered an objective and practical measure of physical activity (Mathie, Coster, Lovell, & Celler, 2004). Their validity in measuring individual movement when secured to a belt worn on either hip has been shown (Tryon & Williams, 1996) in both field and laboratory-based studies (Freedson & Miller, 2000). Furthermore, validity has been established in adults (Freedson, Melanson, & Sirard, 1998) as well as in children and adolescents (Dencker & Andersen, 2008; Trost, McIver, & Pate, 2005), in laboratory and free-living environments via relationships between Actigraph<sup>®</sup> output or derivations and indirect calorimetry-derived energy expenditure, oxygen uptake, and direct observation (Trost et al., 2005). Inter-instrument (Welk, Schaben, & Morrow, 2004) and intra-

instrument (Metcalf, Curnow, Evans, Voss, & Wilkin, 2002) reliability of the Actigraph® accelerometer likewise have been shown.

***Physiological Indices.*** Peak oxygen uptake ( $VO_{2peak}$ ), a physiological measurement determined via the aforementioned cardiopulmonary fitness test, was used as an indicator of habitual physical activity. Regular physical activity is associated with improved aerobic capacity of the body and hence higher  $VO_{2max}$  (Kemper, Twisk, Koppes, van Mechelen, & Post, 2001; “United States Department of Health and Human Services (USDHHS). Physical Activity Guidelines for Americans.,” 2008). As such, self-report measures of physical activity are often validated against  $VO_{2max}$  (Chinapaw, Mokkink, van Poppel, van Mechelen, & Terwee, 2010).

**Sociodemographic characteristics.** Sociodemographic background comprised questions about participants’ age at study entry, gender, and race/ethnicity. Participants were asked to freely indicate their age and select their gender. They indicated their race and ethnicity by responding to the question “Are you Hispanic or Latino/a?” (yes/no response format) and secondarily by endorsing one of the following response categories: “American Indian/Alaska Native,” “Asian,” “Black or African American,” “Native Hawaiian or other Pacific Islander,” “White,” “Multiracial” or “other.”

**Physical characteristics.** Baseline indices of fitness included  $VO_{2peak}$  (ml/kg/min), determined via the cardiopulmonary fitness test described above, body fat percentage derived from the DEXA scan, and body mass index (BMI), calculated as the participant’s weight (kg)/height (m)<sup>2</sup>. Corresponding age- and sex-specific BMI percentile was obtained using the Centers for Disease Control and Prevention published standards (National Center for Health Statistics, 2004).

**Psychosocial characteristics.** Psychosocial characteristics that were considered as potential covariates were perceived competence and parental support for physical activity. Perceived competence for exercise, a component of intrinsic motivation conceptually related to self-efficacy, was assessed with five of six questions from the Intrinsic Motivation Inventory (Ryan, 1982) that tap into individuals' perceived exercise competence, based on factor analysis reported by Schneider and Kwan (2013). Example items include "I think I am pretty good at exercising" and "I am satisfied with my performance when I exercise." Seven response options ranging from 1 (not at all true) to 7 (very true) are provided.

Perceived parental support of physical activity was assessed with a 5-item scale developed specifically for use with adolescents (Prochaska, Rodgers, & Sallis, 2002). Participants rated how often during a typical week a member of their household: encouraged them to exercise, participated in physical activity or played a sport with them, provided transportation for them to locations for the purpose of physical activity or sport, watched them participate in physical activities or sports, or told him/her that they were doing well in physical activities or sports. Responses options were provided on a Likert-type scale from 1 (none) to 5 (every day).

### **Data analysis**

**Affective Response Data Reduction.** To enable comparison of affective responses between clinic-based and free-living exercise settings, FS ratings in response to clinic-based exercise, which were provided on a response scale of -5 to 5, were rescaled to fall within the range of 1 to 5 (i.e., -5 or -4 = 1; -3 or -2 = 2; -1, 0, or 1 = 3; 2 or 3 = 4; 4 or 5 = 5) such that they were on the same scale as those from the unsupervised exercise task. For comparisons of

affective responses between the two clinic-based exercise tasks, original, non-rescaled FS values were used.

To compute affective responses to the different exercise tasks, simple mathematical operations were employed. Affective responses *after* exercise were defined as change in affect from beginning to end of exercise. In the case of unsupervised exercise, the measure of affective response was computed by subtracting the pre-exercise FS rating (min 0) from the single post-exercise FS rating. In the clinic, however, multiple post-exercise ratings of affect were available, and affective responses were computed by subtracting the pre-exercise FS rating from the average of the FS rating immediately and 10 minutes after the end of the exercise task (mins 30 and 40). This approach takes into account the probability that study participants recorded their post-exercise affect in the unsupervised setting at least a few minutes after terminating the activity. Affective responses *during* moderate- and hard-intensity clinic-based exercise tasks were characterized as the change in affect from before to during exercise, and were computed via difference scores between the pre-exercise FS rating (min 0) and the average of FS ratings 10 and 20 minutes after the start of the exercise task. Furthermore, with respect to the clinic-based exercise tasks, an indicator of *cumulative* affective responsivity was computed via area under the curve relative to ground ( $AUC_g$ ) including FS ratings before, during, and after the exercise tasks (mins 0, 10, 20, 30, and 40).  $AUC_g$  considers the distance of measurements from zero and therefore distinguishes, for example, between individuals whose affect decreased and became negative and individuals whose affect decreased yet remained positive. Given equal time intervals between measurements,  $AUC_g$  is computed by summing the average of successive measurements (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). Finally, taking into account the potential moderating influence of baseline affect on change in affect (Blanchard,

Rodgers, Courneya, & Spence, 2002), standardized residualized affective responses (pre-to-post, during, and area under the curve) were computed by regressing each affective response measure on pre-exercise affect via regression analysis. This approach accounts for possible regression to the mean that may influence the consistency of affective responses and helps adjust for the baseline value of affective response.

**Classification of Affective Response Consistency.** To investigate its potential moderating role, the consistency of adolescents' affective responses to exercise was classified into one of three categories based on affective ratings. Because affective style refers to individual differences in valence-specific patterns of affective responding (i.e., approach or withdrawal), classifications did not consider baseline affect (Davidson, 2000). In other words, adolescents were classified according to whether they felt “good” or “bad” in response to exercise, not whether they felt “better” or “worse” compared to before exercise. Classifications were as follows: 1) strongly consistent (i.e., felt “good,” “bad,” or neutral in response to both exercise occasions), 2) moderately consistent (i.e., felt “good”/ “bad” in response to one exercise occasion and felt neutral in response to another exercise occasion), or 3) inconsistent (i.e., felt “good” in response to one exercise occasion and felt “bad” in response to another exercise occasion). Although originally intended as a method of classifying the consistency of the affective response across unsupervised and clinic-based exercise tasks and the stability of affective responses across baseline and follow-up unsupervised exercise tasks, investigations of the unsupervised task led us to conclude that this variable was unreliable because participants either did not complete the task or did not comply with exercise intensity/duration instructions. Consequently, data yielded by the unsupervised task were used to examine consistency and stability of affective responses but were not included in the moderation analyses.

### **Comparison of completers and non-completers of unsupervised exercise tasks.**

Sociodemographic characteristics (i.e., gender, race/ethnicity), baseline physical (i.e., BMI percentile, body fat percentage,  $VO_{2peak}$ ) and psychosocial (i.e., perceived competence, parental support) characteristics, and affective responses to clinic-based exercise tasks of completers and non-completers of unsupervised exercise tasks were compared using  $\chi^2$  tests for categorical variables and independent samples t-tests for continuous variables.

**Manipulation check and intensity of unsupervised exercise.** To determine the integrity of unsupervised exercise (i.e., to verify that participants engaged in exercise of at least moderate intensity for at least 30 minutes as instructed), the date and time of the exercise task self-reported by the participant were compared to the Actigraph activity data using ActiLife Lifestyle Monitoring System software (version 6.1; ActiGraph, Pensacola, FL). To be classified as having successfully completed the unsupervised exercise task, participants were required to complete  $\geq$  30 minutes of predominantly moderate- to vigorous-intensity exercise within  $\pm$  60 minutes of their self-reported activity start time. To determine whether participants met these criteria, we drew on (1) the commonly accepted definition of a bout of activity as continuous activity above a selected threshold for at least 10 minutes, of which  $\leq$  2 minutes may be below the threshold (Troiano et al., 2008), and (2) the child-specific ‘Children (Freedson/Janz)’ cut points which define light physical activity as 101 -499 counts per minute (cpm), moderate-intensity physical activity as 500-3999 cpm, and vigorous-intensity physical activity as  $\geq$  4000 cpm (Freedson, Pober, & Janz, 2005). Accelerometer cut points or cpm thresholds used to define light, moderate, and vigorous PA are commonly derived via regression equations that estimate energy expenditure from accelerometer counts. Due to variability in type (locomotor, non-locomotor) and setting (laboratory, free-living) of PA, and in the age range and gender distribution of the



samples, numerous sets of cut point thresholds have been generated and implemented. Between 2005 and 2010, researchers investigating youth PA used a dozen different accelerometer cut point ranges to define PA intensity (Cain, Sallis, Conway, Van Dyck, & Calhoun, 2013) and at present, the so-called “cut point conundrum” (Troost, 2007) remains unresolved. For present purposes, to determine which participants were compliant with the unsupervised exercise task, a more liberal child-specific criterion was employed. Thus, to be considered valid, participants’ Actigraph records were required to show activity above 100 cpm for a minimum of 30 minutes, of which  $\leq 6$  minutes were permitted to be below 100 cpm, and the proportion of time spent engaging in moderate-to-vigorous-intensity activity was required to be equal to ( $\pm 5\%$ ) or exceed the proportion of time spent engaging in light-intensity activity.

Using the child-specific cut points, the intensity of successfully completed unsupervised exercise was quantified as the average percentage of time adolescents spent in light-, moderate-, and high-intensity activity separately for baseline and follow-up tasks.

**Accelerometer Data Reduction.** To quantify the time spent in moderate-to-vigorous activity across the multiple days of accelerometer assessment, minute-by-minute activity counts from accelerometers were categorized according to established cut points for adults (light physical activity: 101 - 1951 counts per minute (cpm); moderate-intensity physical activity: 1952 - 5724 cpm; high-intensity physical activity:  $\geq 5725$  cpm) (Freedson et al., 1998). Average daily MVPA was computed for participants who provided at least four valid days of data, one of which was a weekend day. A valid day was defined as one having at least eight valid hours, and a valid hour contained fewer than 30 consecutive zero counts or minutes of non-wear time.

**Hypothesis tests.** Intra-class correlation coefficients (ICCs) were used as an index of intraindividual consistency and stability. Unlike the Pearson correlation, which reflects linear

association and can be high when absolute agreement is low (Lin, 1989; Nickerson, 1997), the ICC measures agreement (Van Dongen, Maislin, & Dinges, 2004). ICCs type (3,1), recommended by Shrout and Fleiss (1979) for measuring consistency of multiple ratings, were computed using a two-way mixed-effects model that treated participants as a fixed effect and exercise occasions as a random effect. ICCs were interpreted using standards for poor ( $< 0.4$ ), good ( $\geq .4$  but  $< 0.75$ ), and excellent agreement ( $\geq 0.75$ ) proposed by Fleiss (1986).

Prior to testing for moderation, Pearson correlations were used to examine bivariate relationships of sociodemographic characteristics (gender, race/ethnicity) and baseline physical (BMI percentile, body fat percentage) and psychosocial (perceived competence, parental support) characteristics with PA at follow-up. Characteristics significantly associated with PA at follow-up were retained as main effects in regression analyses (described below) to help explain variation in follow-up PA and to adjust for potential confounding of the association between the affective response to exercise and follow-up PA. The moderating role of covariates on the association between the affective response, affective response consistency, and future PA was not evaluated because the sample size was not adequate to allow for simultaneous inclusion of three-way interactions and all lower-order terms (main effects and two-way interactions).

Two models for each outcome were fit using Ordinary Least Squares (OLS). The first model included study covariates and the main effects of the interaction terms. In the second model, hypothesized interactions were included. Using this strategy, separate regressions were estimated for each measure of PA (mean daily number of minutes spent in moderate PA, vigorous PA, and MVPA as assessed by accelerometry, mean daily number of minutes spent in moderate PA, vigorous PA, and MVPA as self-reported in the 3dPAR, total number of in-school and out-of-school sports, and  $VO_{2peak}$ ). All continuous predictor variables were centered by

subtracting the respective sample mean from each participant's value (Aiken & West, 1991). A categorical variable with three groups representing consistency of affective responses was created. Consistency of the response between exercise occasions was coded using two indicator variables to represent adolescents with 1) moderately consistent affective responses, and 2) inconsistent affective responses. Adolescents with strongly consistent affective responses were used as the reference category, to which the other groups were compared. In the first model, the following variables were entered: baseline affect measurement from the moderate-intensity clinic-based exercise task; the affective response to that exercise task; the two indicator variables representing the consistency of the response between the two occasions; baseline PA; and covariates (identified as those constructs that were significantly associated with future PA). To evaluate whether consistency of the affective response moderated the association between the affective response to exercise and future PA, product term interactions between the affective response and the two indicator variables representing consistency of the response were entered in Model 2. Terms reaching the  $p < .05$  level of significance were considered statistically significant, and significant interaction terms were interpreted using interaction plots and tests of simple slopes. Effect sizes are described using Beta coefficients, which provide standardized effect size estimates.

To ensure the validity of inferential tests, residuals from the regression models were screened to determine whether the assumptions of normality and homoscedasticity were met. Cases with a standardized residual greater than 3.3 or less than -3.3 were considered outlying and were omitted from analyses (Tabachnick & Fidell, 2007). The number of outlying cases was small, and depending on the analysis, ranged from zero to two. To verify that multicollinearity was not present, variance inflation factors were checked to ensure they did not exceed the

threshold of 10. As mentioned above, due to the unreliable nature of the unsupervised exercise task, the consistency of affective responses across baseline clinic-based and unsupervised exercise tasks and the stability of affect ratings across baseline and follow-up unsupervised exercise tasks were not examined as potential moderators of the affective response- PA relationship.

## **Results**

### **Descriptive**

**Participant characteristics.** Baseline characteristics of the 182 study participants are detailed in Table 2.1. The sample was approximately evenly divided between males and females, and slightly more than half were non-Latino whites. Of the 182 participants, 161 had data that satisfied the Actigraph inclusion criteria at baseline (3 did not wear the Actigraph, 12 had insufficient total valid days, and 6 had sufficient total valid days but no valid weekend days). Of these 161 participants, 118 had data that satisfied the inclusion criteria at follow-up (25 did not wear the Actigraph, 16 had insufficient total valid days, and 2 had sufficient total valid days but no valid weekend days).

**Comparison of completers and non-completers of unsupervised exercise tasks.** One hundred and seventeen adolescents failed to complete the baseline unsupervised exercise task successfully and were omitted from analyses of unsupervised exercise because they (a) did not self-report completion of the baseline unsupervised exercise task ( $n = 41$ ), (b) were missing Actigraph data for the self-reported exercise task day ( $n = 10$ ), (c) were missing Actigraph data for the self-reported activity duration because they removed the monitor due to swimming ( $n = 15$ ), (d) did not meet the criteria for displaying a discrete bout of  $\geq 30$  minutes on the Actigraph within  $\pm 60$  minutes of the self-reported activity start time ( $n = 40$ ), or (e) spent more of the self-

reported activity duration engaging in light-intensity activity than moderate-to-vigorous-intensity activity ( $n = 11$ ). Seventy-four adolescents successfully completed the baseline unsupervised task (39% completion rate) and were included in analyses evaluating the consistency of affective responses across the unsupervised and clinic-based exercise tasks at baseline. Of the 74 adolescents who successfully completed the baseline unsupervised exercise task, 37 (50%) also successfully completed the follow-up unsupervised exercise task and were thus included in analyses evaluating the stability of affective responses to two unsupervised exercise tasks in free-living settings across a one-year time interval.

Completers and non-completers of the baseline unsupervised exercise task did not differ with regard to sociodemographic characteristics, baseline physical and psychosocial characteristics, and affective responses to clinic-based exercise tasks; however, compared to non-completers of the follow-up unsupervised exercise task ( $M = 64.66$ ,  $SD = 26.92$ ), completers ( $M = 55.12$ ,  $SD = 27.12$ ) had a significantly lower BMI percentile at baseline ( $p = .02$ ). Sociodemographic characteristics of completers of both baseline and follow-up unsupervised exercise tasks are presented in Table 2.1 under the column labeled “Follow-up.”

Table 2.1.

*Participant Characteristics at Baseline and Follow-up*

		Baseline ( <i>n</i> = 182)		Follow-up ( <i>n</i> = 37) <sup>a</sup>	
		<i>n</i>	%	<i>n</i>	%
Gender	Male	99	54	19	51
	Female	83	46	18	49
Race/ethnicity <sup>b</sup>	Non-white Latino	32	19	7	20
	Non-latino White	93	55	16	46
	Asian/Pacific Islander	20	12	6	17
	Other	23	14	6	17
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age		14.78	.47	14.68	.47
VO <sub>2</sub> peak (L/min)		2.46	.63	2.34	.53
VO <sub>2</sub> peak (mL/kg/min)		39.63	8.76	39.25	7.79
BMI percentile		60.04	27.10	50.51	29.44
Body mass percentage		23.02	8.93	22.02	8.86

<sup>a</sup> Reflects participants who successfully completed both baseline and follow-up unsupervised exercise tasks.

<sup>b</sup> 14 participants did not provide race/ethnicity information.

**Intensity of unsupervised exercise.** Completers of the baseline unsupervised exercise task spent an average of 28.66% ( $SD = 13.00$ ) of the time engaging in light-intensity activity, 50.39% ( $SD = 18.32$ ) in moderate-intensity activity, and 20.95% ( $SD = 19.82$ ) in vigorous-intensity activity. The proportions were virtually identical at the follow-up time point; completers of the follow-up unsupervised exercise task spent an average of 27.11% ( $SD = 11.52$ ) of the time engaging in light-intensity activity, 52.44% ( $SD = 19.65$ ) in moderate-intensity activity, and 20.46% ( $SD = 21.66$ ) in vigorous-intensity activity. During both the baseline and follow-up tasks, adolescents engaged predominantly in moderate-intensity activity.

**Affective responses.** Table 2.2 provides the breakdown of adolescents who felt “good,” “bad,” or neutral during and after clinic-based exercise tasks.

**Categorization of affective response consistency.** During moderate- and hard-intensity exercise tasks, 59.9% of adolescents were categorized as having strongly consistent, 12.6% as having moderately consistent, and 27.5% as having inconsistent affective responses. Adolescents were more likely to show strongly consistent affective responses after moderate- and hard-intensity exercise tasks; 82.4% were categorized as exhibiting strongly consistent affective responses, while only 7.1% showed moderately consistent and 10.4% showed inconsistent affective responses.

Table 2.2.

*Absolute Affective Responses by Exercise Occasion (n = 182)*

Affective response	“Good”		Neutral		“Bad”	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Moderate-intensity exercise						
During	152	(83.5)	13	(7.1)	17	(9.3)
After	169	(92.9)	5	(2.7)	8	(4.4)
Hard-intensity exercise						
During	95	(52.2)	14	(7.7)	73	(40.1)
After	144	(79.1)	10	(5.5)	28	(15.4)



## Consistency

To examine the degree of intraindividual affective response consistency, ICCs were computed between adolescents' (1) pre-to-post affective responses to the baseline moderate-intensity clinic-based exercise task and unsupervised exercise task in a free-living setting, (2) pre-to-post affective responses to baseline moderate- and hard-intensity clinic-based exercise tasks, (3) affective responses during baseline moderate- and hard-intensity clinic-based exercise tasks, and (4) cumulative affective responses to the moderate- and hard-intensity clinic-based tasks (i.e., including the affective response both during and after exercise). Table 2.3 shows ICC estimates for the consistency of residualized pre-to-post, during, and cumulative affective responses, and associated 95% confidence intervals.

ICC analyses revealed that the consistency of adolescents' affective responses across the two moderate-intensity exercise tasks (one clinic-based and the other unsupervised) was poor (ICC = .240). However, there was good consistency across adolescents' affective responses to the moderate- and hard-intensity clinic-based tasks. Comparison of affective responses *during* (ICC = .470) and *after* (ICC = .563) the two clinic-based tasks fell within the “good” range, and comparison of *cumulative* affective responsivity (i.e., using  $AUC_g$ ) to the two clinic-based tasks yielded a moderately high ICC value of .711.

These results indicate that there was considerable intra-individual variation in affective responses after exercise across clinic-based and free-living settings. In contrast, affective responses during and after exercise in a standardized clinic-based setting were more consistent. Cumulative affective responses to exercise in standardized clinic-based settings, representing ratings of affect before, during, and after exercise, demonstrated the highest consistency.

Table 2.3. *Intraclass Correlation Coefficients Representing Consistency and Stability of Affective Responses to Exercise*

Exercise Occasion 1	Exercise Occasion 2	Affective Response Operationalization <sup>a</sup>	<i>n</i>	ICC residualized $\Delta$ scores (95% CI)
Moderate-intensity, clinic-based (baseline)	Unsupervised (baseline)	Pre-to-post $\Delta$ scores	67	.240* (.001-.452)
Moderate-intensity, clinic-based (baseline)	Hard-intensity, clinic-based (baseline)	Pre-to-post $\Delta$ scores (min 0 $\rightarrow$ avg mins 30 and 40)	182	.563*** (.455-.655)
		During $\Delta$ scores (min 0 $\rightarrow$ avg mins 10 and 20)	182	.470*** (.349-.576)
		AUC <sub>g</sub> (mins 0, 10, 20, 30, and 40)	180	.711*** (.631-.776)
Unsupervised (baseline)	Unsupervised (follow-up)	Pre-to-post $\Delta$ scores	36 <sup>b</sup>	.233 (-.099-.518)

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

<sup>a</sup> With the exception of AUC<sub>g</sub>, all affect ratings were residualized to adjust for baseline affect.

<sup>b</sup> One participant who met criteria for completing both unsupervised tasks did not self-report affect after the baseline task.

## **Stability**

To evaluate whether affective responses were stable over time, an ICC was computed between pre-to-post affective responses to baseline and follow-up unsupervised exercise tasks in free-living settings. Analyses revealed that affective responses showed poor stability across a one-year time interval (ICC = .233, Table 2.3).

## **Affective response consistency as a moderator of the affective response-PA relationship**

Bivariate correlations of gender, BMI percentile, body fat percentage, perceived competence, and parental support with follow-up PA levels are shown in Table 2.4. Along with baseline affect and PA, variables with significant bivariate associations with the outcomes were included as main effects in the regression models.

Table 2.4.

*Pearson Correlations Among Potential Covariates and Follow-up PA*

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 Female	–																
2 Non-white Latino	.20 <sup>c</sup>	–															
3 Non-latino White	-.25 <sup>b</sup>	-.45 <sup>c</sup>	–														
4 Asian/Pacific Islander	.15	-.12	-.52 <sup>c</sup>	–													
5 “Other” race/ethnicity	.06	-.12	-.52 <sup>c</sup>	-.14	–												
6 BMI percentile	.17 <sup>a</sup>	.07	-.08	.00	.06	–											
7 Body fat percentage	.66 <sup>c</sup>	.19 <sup>a</sup>	-.22 <sup>b</sup>	.09	.09	.64 <sup>c</sup>	–										
8 Competence	-.28 <sup>c</sup>	.01	.07	-.14	.02	-.21 <sup>a</sup>	-.42 <sup>c</sup>	–									
9 Parental support	.00	.13	.07	-.05	-.15	.05	.05	.52 <sup>c</sup>	–								
10 Actigraph MVPA	-.28 <sup>b</sup>	-.03	.08	-.02	-.07	.03	-.26 <sup>b</sup>	.10	.04	–							
11 Actigraph moderate PA	-.28 <sup>b</sup>	-.06	.09	.01	-.09	.06	-.21 <sup>a</sup>	.04	.03	.95 <sup>c</sup>	–						
12 Actigraph vigorous PA	-.15	.05	.02	-.09	.02	-.07	-.26 <sup>b</sup>	.19 <sup>a</sup>	.04	.63 <sup>c</sup>	.37 <sup>c</sup>	–					
13 Self-reported MVPA	-.08	-.07	.13	-.18 <sup>c</sup>	.04	.06	-.11	.28 <sup>c</sup>	.29 <sup>c</sup>	.29 <sup>b</sup>	-.20 <sup>b</sup>	.13	–				
14 Self-reported moderate PA	.06	-.09	.08	-.13	.08	.15	.07	.06	.15 <sup>a</sup>	.05	.10	-.11 <sup>c</sup>	.79 <sup>c</sup>	–			
15 Self-reported vigorous PA	-.21 <sup>b</sup>	.00	.11	-.11	-.05	-.12	-.27 <sup>c</sup>	.36 <sup>c</sup>	.24 <sup>b</sup>	.42 <sup>c</sup>	.36 <sup>c</sup>	.37 <sup>c</sup>	.50 <sup>c</sup>	-.15	–		
16 Physical fitness	-.69 <sup>c</sup>	-.11	.20 <sup>c</sup>	-.20 <sup>c</sup>	.00	.10	-.56 <sup>c</sup>	.40 <sup>c</sup>	.14	.42 <sup>c</sup>	.35 <sup>c</sup>	.41 <sup>c</sup>	.24 <sup>b</sup>	.03	.35	–	
17 Sports participation	.03	.01	-.07	.08	.01	.03	-.08 <sup>c</sup>	.36 <sup>c</sup>	.37 <sup>c</sup>	.14	.11	.18	.07	-.02	.15	.12	–

Note. Sample size varies from 106 to 182.

<sup>a</sup>  $p < .05$ ; <sup>b</sup>  $p < .01$ ; <sup>c</sup>  $p < .001$

**Affective response during exercise.** The results of moderated regression analyses are summarized in Table 2.5. Detailed regression results for each measure of PA are presented in Appendix E.

After adjusting for covariates and baseline affect and PA, the affective response during clinic-based moderate-intensity exercise was negatively associated with sports participation ( $\beta = -.226, p = .010$ ), but not other measures of PA, at follow-up. Contrary to expectations, this association was in the negative direction. A main effect of consistency was also observed. Adolescents with inconsistent affective responses during exercise showed less self-reported moderate ( $\beta = -.167, p = .021$ ) and greater self-reported vigorous ( $\beta = .187, p = .007$ ) PA at follow-up than adolescents with strongly consistent responses. Table 2.6 shows adolescents' average PA at follow-up according to consistency of their affective responses (strongly consistent, moderately consistent, or inconsistent).

Affective response consistency moderated the association between affective response during exercise and self-reported MVPA and vigorous PA. The affective response during exercise was more strongly associated with self-reported MVPA ( $\beta = .202, p = .007$ ) and vigorous PA ( $\beta = .196, p = .010$ ) at follow-up for adolescents with inconsistent relative to strongly consistent affective responses during exercise (see Figures 2.2a and 2.2b). Consistency explained an additional 3.2% of the variance in self-reported MVPA above the 30.4% variance explained by Model 1,  $R^2\Delta = .032, F \Delta (2,161) = 3.87, p = .023$ . Consistency explained an additional 2.9% of the variance in self-reported vigorous PA above the 29.9% variance explained by Model 1,  $R^2\Delta = .029, F \Delta (2,161) = 3.51, p = .032$  (see Appendix E). Affective response consistency did not moderate the relationship between affective response during exercise and the

other PA measures (self-reported moderate PA, both intensities of accelerometer-determined PA, fitness, and sports participation).

These findings indicate that adolescents with inconsistent affective responses during moderate- and hard-intensity exercise tasks engaged in more self-reported vigorous PA compared to adolescents with strongly consistent affective responses to the two tasks. For this group of adolescents, the affective response during moderate-intensity exercise was also more strongly associated with self-reported MVPA and vigorous PA at follow-up.

Table 2.5.

*Summary of Regression Analyses Predicting Physical Activity Behavior*

Predictor	Outcome							
	Actigraph			Self-Reported			Fitness	Sports
	MVPA	Mod PA	Vig PA	MVPA	Mod PA	Vig PA		
Covariate								
Race/Ethnicity								
Gender								
BMI percentile								
Body fat pctg								
Competence								✓ <sup>a</sup>
Parental support				✓				
Main Effect								
FS during exercise								✓
FS after exercise	✓	✓			✓			✓
Inconsistent FS during exercise					✓	✓		
Moderately consistent FS during exercise								
Inconsistent FS after exercise								
Moderately consistent FS after exercise	✓							
Interaction Effect								
FS during exercise X Inconsistent FS				✓		✓		
FS during exercise X Moderately consistent FS								
FS after exercise X Inconsistent FS								
FS after exercise X Moderately consistent FS								

Note. FS = Affective Response

<sup>a</sup>Competence was significantly associated with sports participation only in model of the affective response after exercise

Figure 2.2a. Affective response consistency as a moderator of the relationship between the affective response during exercise and self-reported MVPA

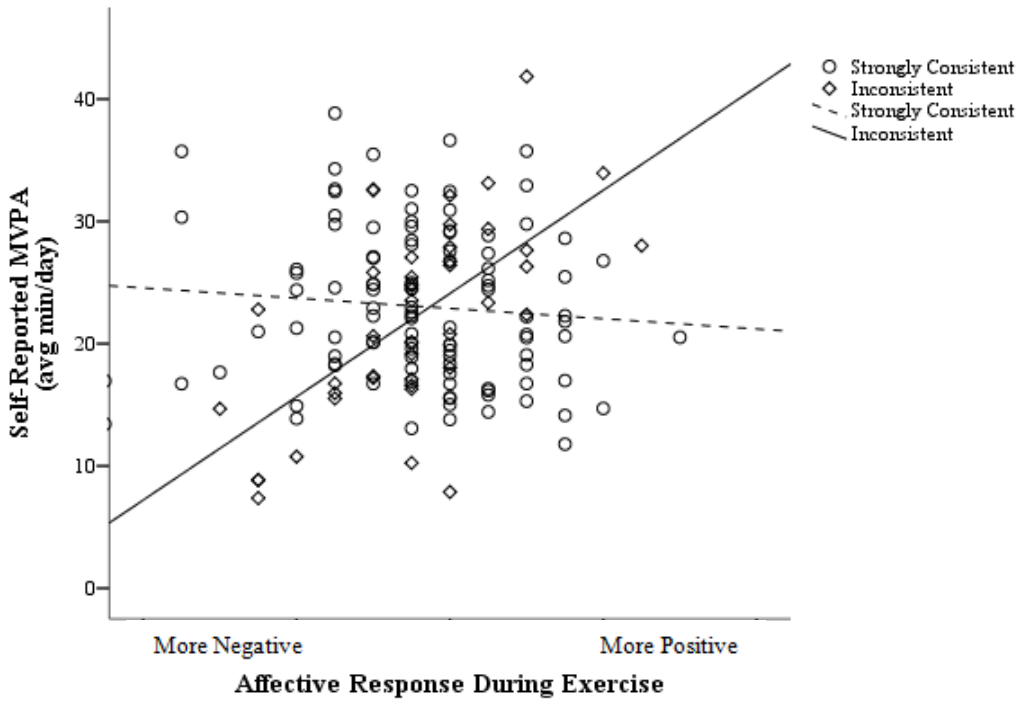
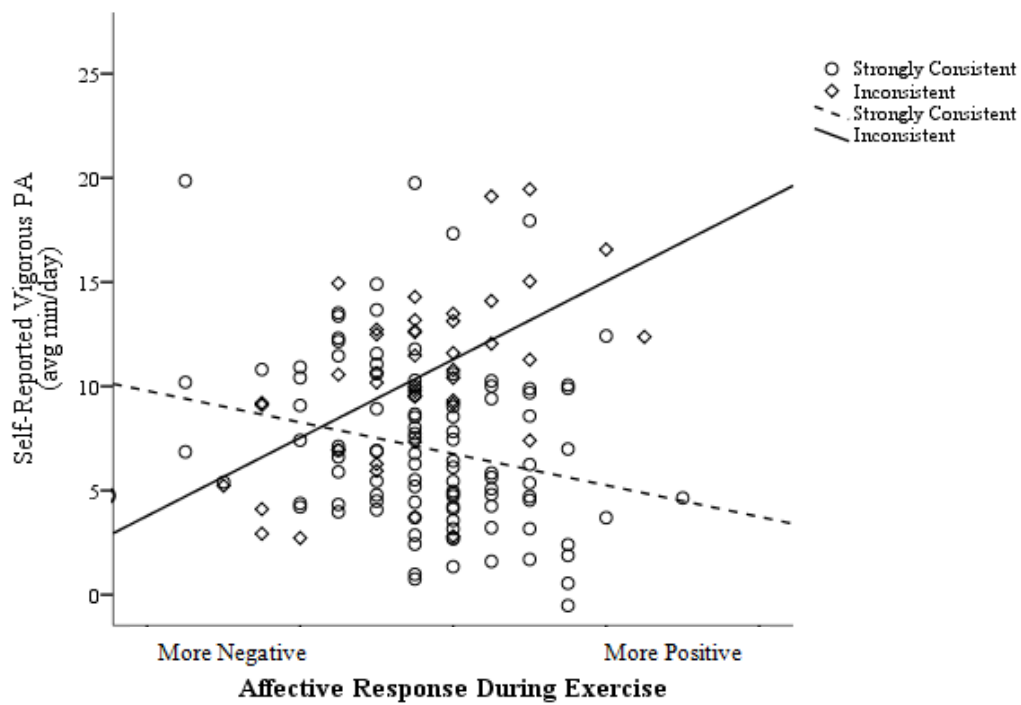


Figure 2.2b. Affective response consistency as a moderator of the relationship between the affective response during exercise and self-reported vigorous PA





**Affective response after exercise.** No consistent pattern of results was observed for the affective response after exercise (see Table 2.5). After adjusting for covariates and baseline affect and PA, four significant associations between the affective response after exercise and follow-up PA emerged, and showed inconsistent directions of association. Negative associations were observed between the affective response after exercise and accelerometer-determined MVPA ( $\beta = -.211, p = .026$ ) and moderate PA ( $\beta = -.195, p = .045$ ), and sports participation ( $\beta = -.240, p = .014$ ), whereas a positive association was observed between the affective response after exercise and self-reported moderate PA ( $\beta = .183, p = .040$ ). A main effect of consistency of affective responses was observed, such that adolescents with moderately consistent affective responses after exercise showed less accelerometer-determined MVPA at follow-up than adolescents with strongly consistent responses ( $\beta = -.176, p = .044$ ). Interactions between the affective response after exercise and affective response consistency were not significant.

These findings indicate that the affective response after moderate-intensity exercise was negatively associated with sports participation and accelerometer-determined MVPA and moderate PA, and positively associated with future self-reported moderate PA.

### **Post hoc analysis**

To aid in the interpretation of the findings, a post hoc analysis was performed to identify the valence of affective ratings for individuals categorized as having strongly consistent, moderately consistent, or inconsistent affective responses.

Among the 109 adolescents with strongly consistent affective responses during exercise, the vast majority (85.3%) had a positive affective response to both moderate- and hard-intensity tasks. Relatively few (12.8%) responded negatively to both tasks, and only 1.8% had neutral ratings on both exercise occasions. Thus, the adolescents with strongly consistent affective

responses during the exercise tasks were, for the most part, those who felt “good” during both tasks, with a minority of adolescents feeling “bad” during both tasks. It is interesting to note, however, that out of the entire sample all but two of the adolescents who felt “bad” during moderate-intensity exercise also felt “bad” during the hard-intensity exercise and were classified as strongly consistent responders.

In contrast, those who displayed moderately consistent affective responses during exercise ( $n = 23$ ) were about evenly split between those who felt “good” during moderate-intensity exercise and felt neutral during hard exercise (47.8%) and those who felt neutral during moderate-intensity exercise and “bad” during hard-intensity exercise (47.8%). Within this group of moderately consistent responders during exercise, virtually all (95.6%) felt “good” or neutral and only one felt “bad” during moderate-intensity exercise. The 50 adolescents classified as having inconsistent affective responses during exercise were almost uniformly (96%) comprised of those who felt “good” during moderate-intensity exercise and “bad” during hard-intensity exercise.

Examination of the distribution of affective responses after exercise across the two tasks revealed a similar pattern to that described for the responses during exercise, except that the responses were generally shifted toward a more positive affective response, consistent with the typical affective rebound observed upon termination of acute exercise. Accordingly, more adolescents were categorized as having strongly consistent responses after exercise ( $n = 150$ ), most of whom (94.7%) felt “good” after both tasks, while a minority (4.7%) felt “bad” after both tasks. Of the remaining 30 adolescents who did not have a strongly consistent response after exercise, 13 were classified as moderately consistent, with most (69.2%) feeling “good” after

moderate-intensity exercise and neutral after hard-intensity exercise and relatively few (23.1%) feeling neutral after moderate-intensity exercise and “bad” after hard-intensity exercise.

Finally, only 17 adolescents displayed inconsistent responses after exercise, of whom 94.1% felt “good” after moderate-intensity and “bad” after hard-intensity exercise. Thus, as with the responses during exercise, adolescents who felt “bad” after moderate-intensity exercise almost uniformly felt “bad” after hard-intensity exercise.

To further aid in the interpretation of findings, because the group of adolescents with strongly consistent affective responses during exercise consisted predominantly of those who felt “good” during both moderate- and hard-intensity tasks but also of those who felt “bad” during both tasks, a post hoc analysis was performed to determine physical activity levels of the subgroups of strongly consistent responders. Overall, descriptive analyses showed that relative to adolescents who felt “bad” during both tasks (12.8% of the group), adolescents who felt “good” during both tasks (85.3% of the group) self-reported more MVPA [ $t(102) = 2.07, p = .041$ ] and moderate PA [ $t(100) = 2.45, p = .016$ ]; accelerometer-determined PA levels did not echo this pattern of activity. Mean estimates of each PA outcome measure for the subgroups of strongly consistent responders are detailed in Table 2.7.

Table 2.6.

*Physical Activity at Follow-up by Consistency Categorization, M (SD)*

	During Exercise			After Exercise		
	Strongly Consistent (n = 72)	Moderately Consistent (n = 14)	Inconsistent (n = 29)	Strongly Consistent (n = 95)	Moderately Consistent (n = 7)	Inconsistent (n = 13)
<b>Accelerometry<sup>a</sup></b>						
Moderate PA	31.01(16.09)	28.02(9.95)	30.57(18.84)	30.92(16.23)	25.94(11.27)	30.46(18.69)
Vigorous PA	3.52(5.06)	1.88(1.62)	3.79(7.51)	3.50(5.79)	2.25(2.20)	3.19(4.32)
MVPA	34.40(18.71)	33.41(17.05)	36.79(25.75)	35.54(20.75)	28.19(11.45)*	33.65(21.77)
	Strongly Consistent (n = 106)	Moderately Consistent (n = 22)	Inconsistent (n = 43)	Strongly Consistent (n = 143)	Moderately Consistent (n = 10)	Inconsistent (n = 18)
<b>Self-reported<sup>a</sup></b>						
Moderate PA	15.28(9.95)	10.86(7.97)	11.67(9.34)*	14.04(9.89)	11.30(8.93)	13.22(8.79)
Vigorous PA	7.06(7.00)	6.09(5.65)	10.37(8.97)*	7.64(7.33)	10.60(9.73)	7.17(7.76)
MVPA	23.05(11.36)	16.95(9.51)	22.05(14.21)	22.22(11.87)	21.90(17.35)	20.39(10.39)
Fitness	2.60(.65)	2.39(.85)	2.56(.72)	2.56(.69)	2.57(.48)	2.55(.82)
	Strongly Consistent (n = 70)	Moderately Consistent (n = 18)	Inconsistent (n = 30)	Strongly Consistent (n = 96)	Moderately Consistent (n = 6)	Inconsistent (n = 16)
Sports <sup>b</sup>	2.17(1.84)	1.83(1.98)	1.73(1.14)	2.08(1.69)	2.83(2.86)	1.25(1.06)

Note. Accelerometry and self-reported PA are expressed as daily averages

<sup>a</sup> Ns vary  $\pm 2$  among moderate PA, vigorous PA, and MVPA due to exclusion of outliers

<sup>b</sup> 62 participants did not complete sports participation measures at follow-up

\* PA levels significantly different from 'strongly consistent' group at  $p = .05$

Table 2.7.

*Physical Activity at Follow-up for Adolescents with Strongly Consistent Affective Responses During Exercise, M (SD)*

	Accelerometry			Self-reported			Fitness	Sports
	Moderate PA	Vigorous PA	MVPA	Moderate PA*	Vigorous PA	MVPA*		
Felt "good" during both tasks	30.27 (15.88)	3.73 (5.39)	33.84 (18.98)	16.33 (9.96)	7.01 (7.06)	24.14 (11.22)	2.59 (.65)	2.36 (1.91)
Felt "bad" during both tasks	37.72 (16.26)	2.11 (1.90)	39.83 (15.70)	9.23 (8.08)	8.08 (7.02)	17.31 (10.63)	2.62 (.61)	1.11 (1.05)

\* Indicates a significant difference among groups

## Discussion

The aims of the present study were 1) to evaluate the *intraindividual* consistency and stability of the affective response to exercise, 2) to determine whether there is *interindividual* variability in the consistency of affective responses to exercise, 3) to examine the prospective association of the affective response to exercise with PA behavior, and 4) to ascertain whether consistency of affective responses moderates the affective response-PA association. The results provide support for consistency of the affective response to acute exercise across exercise intensity but not across setting, and provide weak support for stability of the affective response to unsupervised exercise over time. Furthermore, the results were in agreement with the hypothesis of variability in the consistency of adolescents' affective responses across exercise tasks. The hypothesis that the affective response to exercise would predict adolescents' future exercise behavior was partially supported, but not in the manner expected. Finally, tests of moderation of the association by affective response consistency yielded mixed results.

Analyses of *intraindividual* affective response consistency that revolved around the clinic-based exercise tasks were in agreement with the hypothesis and showed good consistency of adolescents' affective responses during and after two clinic-based exercise tasks and very good consistency of cumulative responses. This finding adds to the psychophysiological evidence that suggests that affective responses to exercise reflect an affective style (Petruzzello et al., 2001; Petruzzello & Landers, 1994; Schneider, Graham, et al., 2009; Schneider & Graham, 2009). Among the estimates of consistency of affective responses to the two clinic-based exercise tasks, the highest estimate was that for the area under the curve response. This finding signifies that much is to be gained in terms of reliability of the construct by examining the cumulative affective response rather than simply pre-to-post or even during exercise affective

changes and provides preliminary support for the notion that affective responses to acute exercise constitute an individual trait-like characteristic.

The analyses of *intraindividual* affective response consistency and stability that revolved around the unsupervised exercise tasks mostly failed to support the hypotheses. In terms of comparisons of the affective response across the baseline unsupervised exercise task and the baseline clinic-based moderate-intensity exercise task, there was very poor consistency. Moreover, the comparison of the two unsupervised tasks, separated by the passage of a year, failed to provide evidence for stability of the affective response over time. The low correspondence of affective responses across clinic-based and free-living settings and across time in two free-living settings may indicate that consistency/stability of the affective response is indeed low across different settings and across long periods of time. This would also indicate that affective responses to exercise obtained in the laboratory may be inaccurate representations of affective responses to exercise in the real world. An alternative possibility, however, is that methodological issues may have contributed to these findings.

First, a limited sample was available for analyses involving the free-living exercise task. A low proportion of adolescents successfully completed the baseline unsupervised exercise task and even fewer completed both the baseline and follow-up unsupervised exercise tasks. The low compliance with study instructions emerged after imposing stringent inclusion criteria on the data. The internal validity of these findings is consequently compromised and generalizability limited. Findings of poor consistency of affective responses across clinic-based and free-living exercise settings therefore should be interpreted in light of these constraints. Similarly, findings of poor stability should be interpreted cautiously given the wide confidence intervals and limited number of adolescents who met the inclusion criteria for completing both the baseline and

follow-up unsupervised exercise tasks. According to a power analysis using the method suggested by Bonett (2002), a sample size of 61 is required to obtain an ICC of .4 (representing fairly good stability) with two repeated measures, using an  $\alpha$  of .05 and a 95% confidence interval width of .2. Thus, the poor stability of affective responses in a free-living exercise setting over time may be attributed to the study's limited statistical power to detect agreement. Additionally, adolescents who did not complete the follow-up unsupervised exercise task had higher body mass index than those who did complete the task. This difference may limit the generalizability of affective response stability findings as well as the applied utility of these findings in identifying youth at greatest risk for a sedentary lifestyle. The small proportion of adolescents who successfully completed the unsupervised exercise tasks further points to methodological limitations of this approach to assessing the affective response to exercise. Collection of free-living measurements of affective responses to exercise may require supervision and/or a more controlled setting as done by Dasilva and colleagues (2011) and may be more feasible with the use of newer monitoring technologies.

Second, unlike affective responses to clinic-based exercise tasks, affective responses to unsupervised exercise in free-living settings may reflect retrospective recall biases. Adolescents were asked to indicate how they felt at the end of the unsupervised exercise task in their free-living environment by responding to an item in a paper log; this method does not guarantee that participants did, in fact, complete the item immediately after exercise, and consequently responses were vulnerable to retrospective recall bias as has been observed in past studies of exercise-related affect (Anderson & Brice, 2011). Third, it is also possible that the poor consistency of affective responses between clinic-based exercise tasks and exercise tasks in free-living settings reflects the variability in response formats of measures used to assess affective

responses on these occasions. Agreement estimates are influenced by between-individual variance; the larger the variability between individuals, the larger the estimate. As such, the estimate of agreement between affective responses to moderate- and hard-intensity clinic-based exercise tasks, by virtue of the 11-point response scale used (thus resulting in increased response variance between participants), is likely to be greater than that of estimates of agreement between affective responses to unsupervised exercise, which used a 5-point response scale. However, when estimates of agreement were computed between residualized affective responses to moderate- and hard-intensity clinic-based tasks rescaled to a 5-point scale, values were similar to those obtained using non-rescaled values.

Another potential limitation of exercise completed in free-living settings is that it may have yielded data that are unreliable owing to the range in exercise setting and type of exercise. As documented in previous research, given the influence context exerts on behavior (Van Mechelen & De Raad, 1999), within-person consistency of affective states across a wide range of situations tends to be lower than stability of affective states across comparable situations at distinct time periods (Diener & Larsen, 1984). Thus, the consistency of adolescents' affective responses across clinic-based and free-living exercise settings may have been impacted by features of the differing settings in which exercise took place. Similarly, the stability of affective responses across two exercise tasks in a free-living setting may have been influenced by variability in features of the task. Consistent with this explanation, self-report of the type and setting of unsupervised exercise varied among participants. For instance, some participants engaged in aerobic exercise (e.g., walking, running) whereas others engaged in resistance exercise (e.g., weight lifting), some engaged in individual exercise (e.g., riding a bicycle) while others engaged in exercise in a social context (e.g., basketball, soccer), and some engaged in



exercise in an indoor gym while others engaged in outdoor exercise. Interestingly, intra-individual variability in the type and setting of activity participants engaged in when completing baseline and follow-up exercise tasks in free-living settings was also observed. In contrast to evaluations of affective response consistency and stability based on the unsupervised exercise sessions, the moderate-to-high consistency of affective responses to two clinic-based exercise tasks is encouraging, given that the exercise tasks were of the same type (i.e., cycle ergometer) and took place in the same setting (i.e., clinic-based).

Furthermore, the intensity and subjective experience of unsupervised exercise differed from those of clinic-based exercise. Although inclusion criteria for the unsupervised task data ensured that all adolescents spent a greater proportion of exercise time in moderate-to-hard relative to light-intensity activity and adolescents on average engaged predominantly in moderate-intensity activity during both baseline and follow-up tasks, individual participant data was nevertheless suggestive of considerable variability in adolescents' preferred unsupervised exercise intensity. Further, when visually examining the direction of affective change from baseline in clinic-based and free-living settings, it was evident that compared to affective responses to exercise in clinic-based settings, adolescents were more likely to show no change and less likely to show a decline in their affective response to exercise in free-living settings. Because adolescents were in control of their exercise type and intensity in free-living settings, they may have chosen to engage in activities that they enjoy, thereby ensuring a positive experience. Relatedly, the variability in affective responses to unsupervised exercise may have been limited due to self-selection in completion of the tasks and it is unclear how this potential source of bias, and the overall small sample size, could have influenced the results.

The second aim was to determine whether there is *inter*individual variability in the consistency of affective responses to exercise. The findings support the hypothesis of variability in the consistency of adolescents' affective responses across clinic-based moderate- and hard-intensity exercise tasks and are consistent with reports of variability in degree of cross-situation consistency of positive and negative affect among individuals (e.g., Diener & Larsen, 1984). A majority of adolescents showed strongly consistent affective responses during and after moderate- and hard-intensity exercise tasks; however, some adolescents showed moderately consistent or inconsistent responses. This variability in consistency of adolescents' affective responses to exercise may speak to interindividual differences in sensitivity to reward (Meehl, 1975), a correlate of exercise behavior (Knab & Lightfoot, 2010). It may also be that the variation in affective response consistency among adolescents stems from differences in associative (i.e., attention to internal bodily cues) relative to dissociative (i.e., attention to external environmental cues) attentional style (Morgan & Pollock, 1977), a cognitive factor that shapes affective responses to low-to-moderate-intensity exercise (Lind, Welch, & Ekkekakis, 2009). Consistent with numerous studies documenting affective benefits upon completing exercise (Acevedo et al., 1994; Parfitt et al., 1996) irrespective of its intensity (Ekkekakis & Petruzzello, 1999), the findings showed that the range of variability in consistency of responses was greater during than after the tasks.

Lastly, this study set out to test the hypothesis that the affective response to a moderate-intensity exercise task would predict adolescents' future exercise behavior and that this association would be most pronounced among those adolescents whose affective responses across tasks were strongly consistent. The findings in relation to the affective response-PA relationship were largely in the unexpected direction. Unlike Schneider and colleagues (2009)

who found a cross-sectional positive association of the affective response during moderate-intensity exercise with accelerometer-determined MVPA and moderate PA in this sample, this study did not find a prospective association between the affective response during exercise and accelerometer-determined PA. The only measure of PA associated with the affective response during clinic-based moderate-intensity exercise was sports participation and this was in the negative direction. The affective response after exercise also was associated negatively with sports participation, as well as with accelerometer-determined MVPA and moderate PA. Only one association was in the expected direction and that was between the affective response after exercise and self-reported moderate PA. It may be that the unexpected negative associations reflect the nature of the measures used. Accelerometry includes both volitional, purposeful activity and non-volitional activity pursued out of necessity rather than choice. Similarly, youth sports participation, commonly influenced by parents (Fredricks & Eccles, 2005), likely reflects both volitional and non-volitional activity. Self-report measures of PA, on the other hand, although subject to social desirability and recall bias, may to a greater extent reflect an individual's volitional activity. The 3dPAR measure was administered during the summer months in this study and therefore largely captures out-of-school activity, considered a more accurate reflection of volitional PA (Baranowski & De Moor, 2000). That a positive association of the affective response during moderate-intensity exercise with accelerometer-determined PA was found cross-sectionally but not prospectively in this sample suggests that the association may not be causal but rather attributable to unexamined factors that influence both affective responses and PA and mediate their relationship over time. Another possibility is that exercise-related affective responses influence PA levels in the short-term but may minimally, or not at all, shape PA in the long-term. Given that the affective response to just a single exercise task was

used to prospectively predict PA one year later, the positive association observed between the affective response and self-reported moderate PA is all the more striking. Because previous research in adults has demonstrated a prospective positive association between affective responses and PA behavior (Williams et al., 2008), further prospective studies designed to examine the affective response-PA relationship are warranted.

With regard to the moderating role of affective response consistency, the findings are inconclusive. Due to the unreliable nature of the unsupervised exercise tasks, it was not possible to evaluate the moderating role of affective response consistency across clinic-based and unsupervised exercise tasks and of affective response stability across two unsupervised tasks over time. Consistency of affective responses during moderate- and hard-intensity clinic-based exercise tasks did emerge as a moderator of the affective response- PA relationship for two measures of PA. Interestingly, however, the moderation did not operate in the hypothesized manner. Results showed that the affective response during moderate-intensity exercise was more strongly associated with PA at follow-up for adolescents with *inconsistent* affective responses during moderate- and hard-intensity exercise tasks. A closer look revealed that inconsistent responders were primarily those who felt “good” during moderate-intensity and “bad” during hard-intensity exercise. In contrast, the group of strongly consistent responders consisted primarily of adolescents who felt “good” during both moderate-and hard-intensity exercise tasks but also of those who felt “bad” during both tasks. Because one would expect that feeling “bad” during both exercise tasks would be associated with less PA, it is likely that this method of classifying affective response consistency, whereby adolescents with positive affective valence ratings and those with negative affective valence ratings in response to both tasks were combined into a single group, introduced noise into the analysis. Such heterogeneity in the make-up of the

strongly consistent group may have obscured, or greatly minimized, potential differences in PA between groups of responders and thus influenced the presence and/or nature of the moderating relationship.

Although the present study is the first to characterize affective responses to exercise in terms of their consistency and stability, not only across well-controlled clinic-based exercise settings but also across ecologically valid free-living exercise settings, several limitations of the current study should be recognized in interpreting the results. One limitation of the study is the sample size. As mentioned above, the sample size available for evaluating consistency and stability of affective responses to exercise in free-living settings was inadequate. Although the overall sample size with regard to clinic-based exercise was sufficient, it was substantially reduced for analyses of accelerometer-determined PA because of insufficient and/or incomplete data. Furthermore, the sample size of various groups according to affective response consistency, in particular the moderately consistent responders during exercise, and both moderately consistent and inconsistent responders after exercise, was relatively small. The small sample size of these groups may have reduced power to detect moderated relationships. An additional limitation is related to the clinic-based moderate-and hard-intensity exercise tasks utilized in this study. As proposed by the Dual-Mode model of exercise and affect (Ekkekakis, 2003), at the group level, affective responses to exercise intensity at or approaching the VT (moderate intensity in the present study) and intensity above the VT (hard intensity in the present study) tend to vary in valence and in range. Thus, because different intensity exercise tasks are not the ideal means of truly assessing consistency and stability of affective responses to exercise, these findings should be viewed as preliminary.

Future studies should address the aforementioned limitations of the current study by examining affective responses across a greater number of exercise occasions of the same intensity and across an identical clinic-based setting and a controlled free-living setting to enhance reliability of affective response measures and rule out factors that may influence estimates of affective response consistency and stability. Studies should be designed to examine affective responses to exercise in free-living settings in real time (e.g., with cellular technology) to improve the ecological validity of exercise tasks and minimize the likelihood of retrospective recall bias. Furthermore, given the increased consistency awarded when examining affective responses periodically during an exercise task, future studies should assess affect at shorter intervals during exercise. This will afford the advantage of obtaining a more reliable estimate of total affective responsivity and detecting subtle changes in affect throughout the course of exercise.

One question that remains to be addressed is whether the affective response to exercise, assuming that it represents a trait-like individual predisposition, can be altered over time. To address this remaining question, future studies should experimentally investigate whether exercise-related affective responses can change through repeated training interventions. Future research may also wish to investigate the influence of genetic factors on affective responses to exercise by examining concordance of affective responses to exercise in monozygotic and dizygotic twins reared together and reared apart. Moreover, future research should be designed to investigate the implications of consistency and stability of affective responses for physical activity behavior in further detail.

In summary, this study provides evidence that affective responses to exercise may constitute a trait-like characteristic and adds to the growing body of knowledge regarding

psychophysiological factors underlying exercise behavior. If replicated in future experimental studies with larger samples, these findings would lend support to the notion that affective responses to exercise constitute an individual predisposition. This finding has practical implications for the development and design of interventions that strive to help children and adolescents become active and stay active into adulthood. By identifying adolescents at risk for a sedentary lifestyle, early intervention efforts can be designed to target this risk factor and thus help set these youth on a trajectory of increased physical activity and optimal health. Findings also have implications for parents, clinicians, and educators who play a central role in shaping adolescents' perceptions and behaviors. These individuals can encourage and provide opportunities for youth who are reluctant to exercise to engage in activities that are affectively pleasing and thus help them form positive impressions of physical activity.

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## CHAPTER 3

Stability of Affective Response to Exercise among Adolescents

*Manuscript submitted to Journal of Sport and Exercise Psychology for consideration*

## Abstract

**Background.** Exercise-related affective responses have been identified as a factor contributing to physical activity behavior. Recent research suggests that the affective response to exercise may represent a stable trait-like characteristic; however, the intra-individual variability of affective responses to exercise has not been systematically evaluated.

**Purpose.** This study tested the hypothesis that adolescents' affective responses to a standardized exercise task would be stable over time.

**Methods.** At baseline and after a four-month follow-up period, adolescents ( $N = 73$ ; 50% male) provided affect ratings before, during, and after a 30-minute clinic-based moderate-intensity exercise task.

**Results.** Acute affective responses during exercise, after exercise, and total affective response showed good within-person stability over time (ICCs = .58, .54, .61,  $ps < .001$ ).

**Conclusions.** These findings provide evidence that affective responses to exercise may constitute a trait-like characteristic. Area under the curve inclusive of affective response during and after the task may be the most reliable measure for characterizing the response.

## Introduction

Regular physical activity (PA) improves physical health and psychological well-being, yet many individuals fail to engage in an active lifestyle. Given evidence that only one in eight U.S. youth meet the Healthy People 2020 target for both aerobic and muscle-strengthening activities (Centers for Disease Control and Prevention, 2012) and that PA participation rates decline as adolescents mature (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008), PA promotion among youth is critically important.

Social-cognitive theories, widely used to try to understand PA behavior to date, have identified a number of factors that contribute to youth PA behavior, including perceived self-efficacy and parental support (Biddle, 2011; Plotnikoff, Costigan, Karunamuni, & Lubans, 2013); however, a considerable amount of the variance in youth PA is not accounted for by social-cognitive theories (Plotnikoff et al., 2013), and the efficacy of interventions derived from social-cognitive theories in changing PA behavior has been limited (Dobbins, Husson, DeCorby, & LaRocca, 2013). Recently, increasing attention has turned toward the role of affect as a factor influencing PA behavior. In particular, a number of studies have employed Self-Determination Theory (Deci & Ryan, 1985) to promote consideration of intrinsic motivation (i.e., participating in an activity for the pleasure of it) as an important factor in PA participation (Fortier, Duda, Guerin, & Teixeira, 2012). As evidence for the contribution of exercise-associated affect to PA behavior is accumulating, a question has arisen as to whether the affective response to exercise reflects an underlying predisposition/trait or whether it is situational and subject to random fluctuation.

Based on a single assessment, there is evidence for considerable intra-individual variability in how people respond affectively to exercise, particularly at moderate exercise



intensities (Ekkekakis, Parfitt, & Petruzzello, 2011). Some individuals show improvements in affect during exercise while others show no affective change or even a decline in affect, and the magnitude of affective change also differs among individuals. Moreover, positive affective responses to exercise have been shown to predict exercise intentions (Kiviniemi, Voss-Humke, & Seifert, 2007) and to attenuate the PA intention-behavior gap (i.e., commonly observed discordance between intentions and behavior). That is, PA behavior is more likely to match intention among individuals who have demonstrated a positive exercise-related affective response (Kwan & Bryan, 2010a). This relationship in part may be explained by a greater persistence of exercise motivation among those with a more positive affective response to exercise (Kwan & Bryan, 2010b). Furthermore, a growing body of research suggests that affective responses to acute exercise are associated with PA (Schneider, Dunn, & Cooper, 2009) and may exert an influence on PA behavior (Williams, 2008). A recent meta-analysis confirmed a relationship between affective judgments and PA among youth (Nasuti & Rhodes, 2013). The effect size for the association of affective judgment with PA was found to be larger than the effect size reported for other established correlates of PA in youth, such as parental support (Pugliese & Tinsley, 2007). Although these studies provide indirect evidence for the affective response to exercise as a stable characteristic, they are all based on a single assessment of affective response and so fall short of providing direct evidence of the stability of the affective response to exercise.

Additional support for the stability of exercise-associated affect comes from a growing body of research suggesting that variability in individuals' affective responses to exercise may be related to motivational tendencies. Using both measures of brain activity in the left and right frontal cortex and also pen-and-pencil measures of behavioral motivations (i.e., the BIS/BAS

questionnaire), individuals can be characterized according to their sensitivity to reward (i.e., approach motivation) and punishment (i.e., avoidance motivation) (Carver & White, 1994; Davidson, 1992). Individual differences in approach and avoidance motivation have been associated in turn with differences in the affective response to acute exercise in adolescents (Schneider & Graham, 2009; Schneider, Graham, Grant, King, & Cooper, 2009). Additionally, there is evidence that extraversion, a personality trait related to approach and avoidance motivation (Carver, Sutton, & Scheier, 2000), is associated with PA (Lochbaum, 2013; Rhodes & Smith, 2006). Finally, and perhaps most convincingly, a genetic contribution to exercise behavior (Stubbe et al., 2006; van der Aa, De Geus, van Beijsterveldt, Boomsma, & Bartels, 2010), psychological attitudes towards exercise (Huppertz et al., 2014), and responses to exercise (Karoly et al., 2012) has been indicated, suggesting that differences in affective responses among individuals may reflect an underlying and stable disposition.

The premise that a stable affective disposition may underlie the documented inter-individual variability in affective responses to exercise implies that exercise-related affective responses of each individual are stable over time. To date, however, the literature does not provide evidence that individuals will manifest a consistent affective response to acute exercise at different points in time. The purpose of the current study was to evaluate the stability of affective responses to acute exercise over time.

## **Method**

### **Procedures**

**Participant recruitment.** Participants were recruited through flyers sent to the homes of students in the 6<sup>th</sup> grade of a public school. During an orientation session prior to the first assessment, participants provided written assent and parents provided written consent for study

participation, and screening questionnaires to determine whether participants met the study inclusion criteria were administered. Participants were eligible to participate in the study if they: (1) were in the 6<sup>th</sup> grade at time of enrollment, (2) were not a member of an individual or team competitive sport, (3) did not have health problems that may impede their participation in regular physical activity, (4) were right-handed, (5) did not self-report a history of neurological disorders, stroke, or significant head trauma (i.e., head trauma manifesting in loss of consciousness for more than 24 hours), and (6) did not have moderate-to-severe depression, defined as scoring above the range of mild depression on a standardized depression inventory.

**Assessment schedule.** Participation in the present study consisted of data collection at baseline and after a four-month follow-up period. At each assessment period, participants completed a measurement of height and weight, a cardiopulmonary fitness test and a moderate-intensity exercise task. During the week in between the two assessments, participants wore an activity monitoring device to assess free-living activity levels. Data from the fitness tests were used to calibrate the work rate for the moderate-intensity exercise tasks. During the four-month interval between baseline and follow-up assessments, participants took part in an intervention study testing a strategy for increasing physical activity. All assessments took place during regularly-scheduled PE periods in a classroom laboratory designated for this purpose at the school site. Adolescents were compensated \$25 for each assessment. The study was approved by the Institutional Review Board (IRB) of the University of California, Irvine as well as the Long Beach Unified School District (LBUSD).

**Cardiorespiratory fitness assessment.** Participants completed a ramp-type cardiopulmonary fitness test on an electromagnetically braked cycle ergometer (Whipp, Davis, Torres, & Wasserman, 1981). Participants were instructed to pedal at 60-80 revolutions per

minute (RPM). The test began with a two-minute warm-up at 0 W before work rate was increased by a slope of 10 W/min. Each participant was encouraged to give maximal effort until he or she could no longer maintain the specified RPM. An exercise technician calculated the peak oxygen consumption ( $VO_{2peak}$ ) for each participant by averaging the  $VO_2$  breath-by-breath values during the last 20 seconds of exercise.

**Moderate-intensity exercise task.** Following a two-minute warm-up at 15 W, the work rate was calibrated to an intensity of 50% of the oxygen uptake reserve ( $VO_{2R}$ ; computed as  $VO_{2peak} - VO_{2rest}$ ). Participants were instructed to pedal at 60-80 RPM. If the participant showed signs of fatigue, defined as an inability to maintain the specified cycling pace, or HR exceeding 170 beats per minute (BPM) for over one minute, work rate was reduced by 10 W to ensure that all participants completed the task in its entirety. Prior to beginning the task, participants rated their affective valence using the Feeling Scale (Hardy & Rejeski, 1989). Thirty seconds post-warm-up and toward the end of each 3-minute segment of the 30-minute task and a six-minute cool-down period, participants provided ratings of affect and perceived exertion (see Appendix F for the moderate-intensity exercise task protocol).

## Measures

**Physical activity.** At baseline and follow up, participants' physical activity levels were assessed objectively over a one-week period with Actigraph accelerometry-derived "counts" representing acceleration in the vertical plane (Computer Science & Applications ActiGraph accelerometer model 7164, Pensacola, FL). Participants were instructed to wear the Actigraph® accelerometer on the left hip for seven consecutive days, except while sleeping, swimming, or bathing. Data from the Actigraph® were analyzed using the Actilife software with the Freedson cutoff (Freedson, Melanson, & Sirard, 1998) to yield the average number of minutes per day that

participants engaged in moderate-to-vigorous physical activity (MVPA). Valid days included a minimum of eight valid hours, and a minimum of four valid days (including at least one weekend day) of data was required.

Physical activity levels also were assessed by a modified version of the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985; Haas & Nigg, 2009) (see Appendix G). Participants were asked to report the number of days and minutes per day (in 10 minute increments from 0 through 60+) they spent engaging in strenuous, moderate, and mild physical activity during their free time outside of school in a typical week. Examples of strenuous (e.g., running), moderate (e.g., fast walking), and mild (e.g., easy walking) physical activity were provided. Responses were used to compute the average minutes per day participants engaged in moderate and/or vigorous physical activity (MVPA).

**Affective valence.** The single-item Feeling Scale (FS) (Hardy & Rejeski, 1989) was used to assess affective valence prior to, during, and after exercise. Participants verbally rated how they felt at the current moment on an 11-point scale ranging from -5 (very bad) to +5 (very good) with additional anchors provided at zero and every odd integer. The FS has demonstrated convergent validity via associations with valence scales of other self-reported affect measures (Lang, 1980; Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000).

**Perceived exertion.** The single-item Rating of Perceived Exertion scale (RPE; Borg, 1982) was used as a manipulation check to ensure that participants perceived themselves to be working at a comparable intensity during the two exercise tasks. Participants verbally rated how hard they were working at the current moment on a 15-point scale ranging from 6 (very, very light) to 20 (very, very hard). The RPE has been validated against heart rate, blood lactate, %  $\text{VO}_2\text{max}$ , and a variety of other physiological indicators of intensity, with reported validity

coefficients ranging from .57 to .72 in a meta-analysis (Chen, Fan, & Moe, 2002). Associations with FS ratings show that increases in RPE are distinct from decreases in exercise-related affective responses (Acevedo, Kraemer, Haltom, & Tryniecki, 2003).

**Body Mass Index (BMI).** Students were weighed using a calibrated digital scale (Seca 869, Chino, CA) and height was measured using a stadiometer (PE-AIM-101, Perspective Enterprises, Portage, MI). BMI percentile was computed according to the normative values provided by the Centers for Disease Control and Prevention (see <http://apps.nccd.cdc.gov/dnpabmi/>).

### **Data analyses**

Independent samples t-tests were used to examine gender differences in baseline cardiovascular fitness, PA, and BMI. To permit comparison to prior studies examining affective responses during and after exercise separately (e.g., McAuley, Duncan, & Tammen, 1987; Schneider & Kwan, 2013; Schneider, Dunn, et al., 2009; Stych & Parfitt, 2011), affective responses *during* exercise tasks were calculated as the average of FS ratings at mins 3, 6, 9, 12, 15, 18, 21, 24, and 27, and affective responses *after* exercise were calculated as the average of FS ratings at mins 30, 33, and 36. As a measure of the overall affective experience in response to the acute exercise task, total affective response also was calculated as the area under the curve with respect to ground ( $AUC_g$ ) of FS ratings between mins 0 and 36. The formula for computing  $AUC_g$ , as described by Pruessner et al. (2003), assumes equal time between assessments and allows for distinction between, for example, a participant whose affect remained flat and positive throughout the task and a participant whose affect remained flat and negative throughout the

$$AUC_G = \sum_{i=1}^{n-1} \frac{m_{(i+1)} + m_i}{2}$$

task. Specifically, the formula used was: where  $n$  = the total number of assessments and  $m$  = value of each assessment. Standardized residual change scores of each aggregate affect variable were computed using linear regression analysis to adjust for baseline (min 0) ratings to ensure that stability estimates did not reflect regression to the mean. Intra-class correlation coefficients (ICCs) were then computed as described below using the residuals from baseline and follow-up assessments.

Stability of within-individual affective responses was evaluated with two-way mixed-effects, single measurement ICCs between adolescents' (1) affective responses during the two exercise tasks, (2) affective responses after the two exercise tasks, and (3) cumulative affective responses to the two tasks. ICCs were classified according to Fleiss' (1986) standards for poor (< 0.40), good (.4 < 0.75), and excellent ( $\geq 0.75$ ) agreement.

To verify that intensity was comparable across the two moderate-intensity exercise tasks, the ICC of RPE was estimated using the  $AUC_g$  formula for the 12 assessments of RPE (mins 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36). RPE values were computed following procedures outlined for FS; however, values were not residualized since baseline RPE was set at a constant of 6 for all participants. All analyses were performed using the IBM Statistical Package for Social Sciences (SPSS) version 21 (SPSS Inc., Chicago, IL).

## Results

**Participant characteristics.** Baseline characteristics of the study participants are detailed in Table 3.1. Although 74 adolescents completed baseline testing, one participant dropped out of the study before the follow-up, so data are presented for the 73 individuals with complete data.

The sample was approximately evenly divided between males and females. Analyses of gender differences showed that males had higher  $\text{VO}_2\text{peak}$  ( $M = 39.08$  mL/kg/min,  $SD = 7.49$ ) than females ( $M = 35.64$  mL/kg/min,  $SD = 7.12$ ),  $t(71) = 2.01$ ,  $p = .048$ . Males also engaged in more accelerometer-determined MVPA (males:  $M = 56.03$  min/day,  $SD = 21.90$ ; females:  $M = 42.77$  min/day,  $SD = 15.81$ ),  $t(71) = 2.97$ ,  $p = .004$ ). Although adolescents in the study fell short of meeting current recommendations for activity (60 minutes of MVPA on most days), they did engage, on average, in about 50 minutes of MVPA per day. BMI percentile and self-reported PA levels did not differ according to gender.



Table 3.1.  
*Participant Characteristics at Baseline (n = 73)*

		N	%
Gender	Male	36	49
	Female	37	51
Race/ethnicity	Latino	35	48%
	Non-Latino White	13	18%
	African-American	9	12%
	Asian/Pacific Islander	7	9%
	Multiracial/Other	9	12%
		<i>M</i>	<i>SD</i>
Age		11.11	.43
VO <sub>2</sub> peak (L/min)		1.74	.31
VO <sub>2</sub> peak (mL/kg/min)		37.34	7.46
BMI percentile		71.36	28.36
MVPA (accelerometry, avg min/day)		49.30	20.07
MVPA (self-reported, avg min/day) <sup>a</sup>		54.05	38.51

<sup>a</sup> n = 70

**Manipulation check.** A manipulation check of intensity revealed that adolescents perceived comparable levels of exertion based on the RPE scale in response to the baseline and follow-up exercise tasks. Ratings of perceived exertion demonstrated excellent stability as reflected in an ICC of .78.

**Affective response stability.** To evaluate the stability of adolescents' affective responses, ICCs were computed for responses during exercise, after exercise, and across the total task. ICC stability estimates and associated 95% confidence intervals are presented in Table 3.2.

Table 3.2.

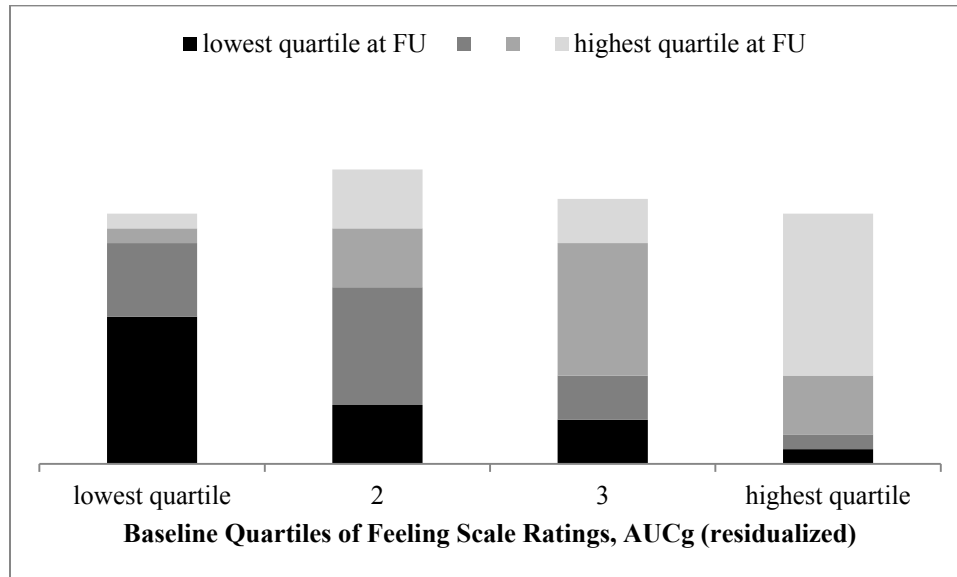
*Stability of exercise-related affective responses over time*

	ICC (95% CI) <sup>a</sup>		
	During	After	Total (AUC <sub>g</sub> )
Affective Response ( <i>n</i> = 73)	.58 (.409-.717)	.54 (.350-.681)	.61 (.437-.733)

<sup>a</sup> All ICCs significant at  $p < .001$

ICC analyses indicated good within-person stability over time for acute affective responses during exercise, after exercise, and across the total task. No differences in stability of affective responses were observed on the basis of baseline PA levels or gender. Figure 3.1 illustrates the overall pattern of responses over time by showing the quartiles of the residualized areas under the curve for the follow-up assessment overlaid on the quartiles for the baseline assessment. This visual representation clearly demonstrates that individuals who were in the lowest quartile for affective response at baseline had a very low likelihood of being in the highest quartile at follow-up. Similarly, adolescents whose affective response at baseline placed them in the highest quartile were unlikely to manifest a response at follow-up that would place them in the lowest quartile.

Figure 3.1. Affective responses to exercise (area under the curve;  $AUC_g$ ) by quartile at baseline and follow-up



## Discussion

The objective of this study was to evaluate the stability of adolescents' affective response to a standardized moderate-intensity exercise task. The results demonstrate that exercise-related affective responses are considerably stable over time, with the area-under-the-curve measure of affective response to the total task being slightly more stable than either during- or after-exercise assessments of affect. Confirming the indirect evidence provided by correlational studies of exercise-associated affect, this study is the first to show temporal stability of the affective response to exercise. As such, the finding lends support to the proposition that individuals may be characterized according to a dispositional tendency to respond to exercise with more or less positive affect.

Whether or not the affective response to exercise is a stable trait-like characteristic has implications for physical activity promotion planning. If we assume that individuals can be characterized according to their likelihood of enjoying exercise for its own sake, then the success of future interventions may be enhanced through tailoring to meet the needs of these different subgroups. More specifically, there may be some individuals, those who fall in the highest quartile of positive affective response to exercise, who will engage in PA of their own volition if they are simply provided with the appropriate opportunities. In contrast, individuals who manifest a tendency to respond to PA with a more negative affective experience may require more resources to motivate their participation. It is this latter group that is at highest risk for maturing into sedentary adults, and therefore at most need for targeted programs to promote activity.

Evidence of just such a dynamic was found in a study in which self-reported enjoyment of exercise at baseline emerged as a moderator of adolescents' change in PA in response to a

school-based intervention (Schneider & Cooper, 2011). Among the adolescents in this study, an intervention designed to make physical education more palatable than the typical class (e.g., by allowing participants input into the curriculum, by eliminating the Timed Mile Run, and by restricting participation to only relatively low-fit females) increased PA among girls who reported low enjoyment of exercise at baseline but had no such effect on girls who reported high enjoyment of exercise at baseline. The latter group engaged in considerably more activity at baseline compared to their low-enjoyment counterparts, suggesting that even among non-athletic adolescents, those who are predisposed to enjoy exercise will engage in greater activity than those predisposed to dislike exercise.

It should be noted that whereas the present study offers substantiation of the stability of the affective response to exercise, the data do not indicate that this response is immutable. Rather, some participants who scored in the lowest quartile for affective response to exercise at baseline later scored in the highest quartile for affective response to exercise. Thus, although the tendency may be for individuals to respond to exercise in a consistent manner, clearly there are conditions under which this consistency fails to manifest. Prior work has demonstrated that situational stimuli can impact the affective response to acute exercise. The presence or absence of music (Karageorghis & Priest, 2012), recent ingestion of carbohydrate (Backhouse, Bishop, Biddle, & Williams, 2005), and cooling of the neck region during exercise (Tyler & Sunderland, 2011) all have been demonstrated to impact the affective response to exercise. In the present study, efforts were made to keep conditions consistent across assessments (e.g., no music, limited interaction with study participants), but room temperature was a factor that could not be controlled, owing to the school-based setting. Consequently, the temperature in the assessment room may have fluctuated between assessments, causing the affective response to the exercise

task to differ between baseline and follow-up. In addition, participants may have engaged in behaviors prior to the assessment that could impact their affective response (e.g., eating—or not eating—a high-carbohydrate breakfast). Future studies should be designed to distinguish between situational and dispositional factors that influence the affective response.

Another question raised by the present study is whether individuals who respond to moderate-intensity exercise with negative affect might be able to find an intensity that generates a more positive affective response. Several recent studies have allowed participants to select a “preferred” intensity of exercise, and have found that on average individuals tend to choose an intensity that would typically be expected to confer health benefits and that promotes a positive affective experience during the task (Parfitt, Alrumh, & Rowlands, 2012; Parfitt, Blisset, Rose, & Eston, 2012; Schneider, in press). As of yet, it is unclear whether simply allowing individuals the autonomy to select their own intensity promotes enjoyment of the activity, or whether there may be, in fact, an intensity for each person that will generate positive affect. If, in fact, there is an intensity level that generates positive affect for each individual, then identifying this level may be a useful tool for promoting lifelong PA.

Recent PA recommendations (Physical Activity Guidelines Advisory Committee, 2008) have incorporated the concept that enjoyment of activity should be considered as one factor when designing interventions for either groups or individuals. This attention to affect as a factor in PA behavior is an evolution from a long preoccupation with determining the intensity and frequency of exercise that carries the most potent health impact. Over time, a growing acknowledgment that any exercise is better than no exercise (Physical Activity Guidelines Advisory Committee, 2008) has led to widespread adoption of more flexible PA goals. The current evidence that individuals may experience more or less positive affect in response to



exercise in a measurable and predictable manner affirms the utility of affording individuals the opportunity to find a form and intensity of activity that is likely to be maintained by virtue of being enjoyable. Moreover, the present study suggests that PA promotion resources should be directed toward assisting those who find exercise less pleasant to find a strategy for incorporating regular activity into their lifestyle in a way that is sustainable.

As mentioned above, this study has some limitations in that it was a field-based investigation and therefore did not control for all of the situational variables that may impact the affective response to exercise. In addition, although standardizing the type and setting of exercise reduces potential bias and enhances validity of our findings, it limits our ability to generalize to other exercise modalities and to ecologically valid settings. Furthermore, a longer-term follow-up may be needed to determine whether the affective response to exercise is a characteristic that endures as adolescents mature into adults. A very important question that is not addressed by the current study is whether the affective response to exercise can be modified over time as a function of experience. Future research, therefore, can further advance the field by controlling more situational variables, by examining stability of the affective response to exercise across different exercise modalities and settings and over longer periods of time, and by exploring strategies for modifying the affective response to exercise through experience.

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## CHAPTER 4

### General Conclusions



Recent psychological and neurophysiological findings have suggested the possibility that affective responses to exercise constitute an underlying trait-like disposition, implying a tendency for individuals to construe physical activity through an “affective lens” that can be generalized across occasions. The primary goal of the present dissertation was to provide a direct test of the notion that the affective response to exercise represents a dispositional trait by evaluating its intraindividual consistency and stability in healthy adolescents.

In light of the two studies presented above, evidence is in favor of the affective response to exercise as a dispositional trait. Although the results of Study 1 were not uniformly consistent with this notion, more weight is given to the uniform evidence provided by Study 2, which has numerous methodological advantages over Study 1.

Although Study 1 had certain methodological strengths (e.g., exercise intensity was set in relation to individual anaerobic threshold, exercise tasks were completed in clinic-based and ecologically valid, field-based settings), its conclusions are limited by variations in assessment procedures and incomplete and/or missing data. Affective responses in a free-living setting were assessed only before and after exercise and in a response format inconsistent with that of clinic-based responses. Clinic-based affective responses were assessed across exercise tasks of different intensity. Attempts to standardize the intensity of exercise across free-living and clinic-based settings by using strict criteria resulted in a substantially reduced number of cases. These weaknesses did not enable a strong test of the main hypothesis and likely minimized response consistency and stability.

Study 2 improved on the methodological weaknesses of Study 1 in several ways. First, affective responses were assessed before, during, and after exercise in a standardized response format across exercise occasions. Second, participants completed the same moderate-intensity

clinic-based exercise task at two points in time. So, not only was the setting of exercise controlled but also its intensity. Thus, Study 2 enabled a more methodologically robust test of the hypothesis that affective responses to exercise are stable over multiple occasions.

Given the importance of affective experience to shaping repeated behavior, there are numerous practical implications of this dissertation research for helping youth experience optimal health. First, an assessment of affective response to exercise may be used to identify adolescents at increased risk for a sedentary lifestyle. This information can be used to develop targeted and tailored interventions for this group of at-risk adolescents in order to promote physically active and prevent sedentary lifestyles early on. Considering the noted benefits of physical activity from a holistic health perspective (World Health Organization, 2012), such early intervention strategies not only may prevent increases in major risk factors for disease, but also may promote improvements in the totality of individual health inclusive of cognitive, emotional, intellectual, physical, social, and spiritual dimensions (Bailey, Hillman, Arent, & Petitpas, 2013). Second, findings also have implications for those in a position to support youth in their journey toward becoming autonomous, intentional creators of their own health. To help youth who are reluctant to engage in exercise form positive impressions of physical activity, parents, clinicians, and educators can introduce and help youth explore the wide array of physical activities they can engage in, and provide opportunities, resources, and/or encouragement for them to initiate and maintain those activities that they find affectively pleasing. Such efforts that aim to enhance enjoyment of physical activity hold considerable promise for promoting physical activity behavior (Pate et al., 2005).

Future research is needed to replicate the findings of this dissertation in diverse populations and ecologically valid settings, and also to extend the findings by systematically

evaluating the implications of consistency and stability of affective responses for physical activity behavior. For example, future studies may employ mobile-based Ecological Momentary Assessment (mEMA), an ecologically valid tool to gather self-report real-time measurements of psychological processes and physical activity (Spook, Paulussen, Kok, & Van Empelen, 2013), along with accelerometers as an objective measure of physical activity while individuals are exercising in their natural environment (e.g., walking/jogging or bicycling on a paved trail, working out at the gym, playing sports at a recreation center or outdoor field). Cutting edge applications of mEMA to detecting probable physical activity and sedentary behavior (Dunton et al., 2014) suggest a potential application to prompt individuals to report their affect at an increasing rate during exercise. This approach would enable ecologically valid measurement of affective responses during exercise across numerous occasions and would extend existing work relating affective states, captured with EMA, to physical activity behavior (Dunton et al., 2013).

Because individuals differ in “traitedness” of dispositional response patterns, future research is also needed to delineate occasion-specific, momentary circumstances (e.g., carbohydrate intake—Backhouse, Bishop, Biddle, & Williams, 2005; environmental and internal body temperature—Tyler & Sunderland, 2011) from dispositional tendencies that may impact the affective response to exercise. With mEMA, real-time self-report measures of affect and cognitions during and outside of exercise, and information on carbohydrate intake in the hours prior to exercise, can be obtained. Sensors from mEMA technology also can provide objective measures of temperature, and therefore can be used to examine the extent to which within-person fluctuations in affective responses to exercise are dispositional or occasion-specific.

A worthwhile area for future research also is to investigate whether the affective response to exercise can be modified by experience or repeated training, and if so, whether changes are

durable over time or revert, fully or partially, back to previous patterns. In an intervention study using affective persuasion messages, college students showed an immediate improvement in affective attitudes toward physical activity, but this improvement was not sustained just two weeks after the intervention (Tăaut & Băban, 2012). Although to date no interventions have targeted affective responses to exercise, recent research suggests that attention, which serves to regulate affective experience (Pashler, Johnston, & Ruthruff, 2001), is malleable and that emotion regulatory processes can be trained and affective experience changed through repeated practice of attention-based strategies (Wadlinger & Isaacowitz, 2011).

Given growing interest in epigenetic mechanisms involved in health behavior change (Bryan & Hutchison, 2012), another interesting avenue for future research is to explore potential epigenetic factors underlying physical activity behavior and/or response to physical activity promotion interventions, and whether these factors contribute to differences in the “affective lens” through which individuals construe physical activity behavior. Embracing the holistic nature of behavior—exploring interactions among affective, cognitive, physical, social, and genetic-epigenetic dimensions—promises greater understanding of engagement in physical activity and opportunity for building a physically active, health-conscious population.

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## Appendix A

### Assignment

#### Instructions

Find a time to do a 30-minute exercise session sometime during the week.

- Exercise at a level that increases your heart rate and makes you breathe harder (i.e., at least a brisk walk).
- Record the time you started and the time you stopped.
- Record your mood immediately before you start and immediately after you stop.

### Assignment

#### Part 1

Day of week: \_\_\_\_\_

Date: \_\_\_\_\_

Type of exercise: \_\_\_\_\_

Time started: \_\_\_\_\_

Before the exercise:

How do you feel right now?

Very bad	1	2	3	4	5	Very good
Nervous	1	2	3	4	5	At ease
Sad	1	2	3	4	5	Happy
Tired	1	2	3	4	5	Energetic

### Assignment

#### Part 2

Time stopped: \_\_\_\_\_

After the exercise:

How do you feel right now?

Very bad	1	2	3	4	5	Very good
Nervous	1	2	3	4	5	At ease
Sad	1	2	3	4	5	Happy
Tired	1	2	3	4	5	Energetic

## Appendix B

### Moderate- and Hard-Intensity Exercise Task Protocols

#### I. Moderate-Intensity Exercise Task Protocol

1) Turn bike on. a. Turn on fitness test cart (green switch on bottom left corner of cart, near floor) b. Press green button on back of bike, under seat.
2) Select “manual mode” on exercise bike’s computer screen.
3) Adjust to 15 watts (warm-up resistance).
4) Invite the <b>participant to climb onto the bike</b> by placing feet into pedals. Do not let the participant step on the bike frame since they may slip!
5) <b>Strap their feet</b> into the pedals snugly. Balls of the feet should be on pedal.
6) <b>Adjust the seat height and handle-bar height</b> , as needed. Have them pedal and ask them if they think any more adjustment is needed.
7) <b>Introduce</b> participant to the task: a) “Today you are going to be doing 30 minutes of cycling.” b) Recite Feeling Scale and Rating of Perceived Exertion Scale scripts. c) Let them know to pedal at 60-70 RPM once test begins.
8) <b>Before they begin pedaling note that RPE is marked at 6 and watts at 0 on form. Ask them the FS and then record their HR.</b>
9) To <b>start warm up, simultaneously start the timer (press red button on the polar watch) and press “start”</b> on bike computer screen and allow participant to pedal at 15 watts for 2 minutes.
10) After 2 minutes, <b>start test</b> by adjusting resistance to 80% of VT.
11) Sit or stand outside of visual field of participant between measurements.
12) Record FS at 9 min 30 sec, 19 min 30 sec, 29 min 30 sec, and 39 min 30 sec. Record RPE, watts, and HR every 3 min throughout the exercise task.
13) If participant is unable to maintain 60-70 RMPs, or their HR exceeds 170 BPM for more than one minute, decrease resistance by 10 watts and take a note of reason for decrease on the form.
14) At 15 minutes, <b>offer the participant water</b> . Encourage small sips. Let him/her know that water and a towel are available whenever they need it and let them know they are half way through the test with another 15 minutes to go.
15) <b>End test</b> only after final recording of FS, RPE, HR and watts. End test by pressing “end” on computer screen of bike.
<b>Post Exercise task</b>
1) <b>Cool down</b> for 2 minutes at low resistance. The 2 minute cool down is counted when considering the 10 minute post-exercise FS and HR assessment.



<p><b>2) Protect participant</b> as they step off exercise bike: Ask them to step off bike towards you. Spot them so they do not fall (sometimes participants get wobbly legs after exercise tasks).</p>
<p>3) Seat the participant in a comfortable chair. Record the participant's FS and HR 10 minutes into the <b>recovery period</b>.</p>

## II. Hard-Intensity Exercise Task Protocol

<p>1) Turn bike on.  a. Turn on fitness test cart (green switch on bottom left corner of cart, near floor)  b. Press green button on back of bike, under seat.</p>
<p>2) Select "manual mode" on exercise bike's computer screen.</p>
<p>3) Adjust to 15 watts (warm-up resistance).</p>
<p>4) Invite the <b>participant to climb onto the bike</b> by placing feet into pedals. Do not let the participant step on the bike frame since they may slip!</p>
<p>5) <b>Strap their feet</b> into the pedals snugly. Balls of the feet should be on pedal.</p>
<p>6) <b>Adjust the seat height and handle-bar height</b>, as needed. Have them pedal and ask them if they think any more adjustment is needed.</p>
<p>7) <b>Introduce</b> participant to the task:  a) "Today you are going to be doing 30 minutes of cycling."  b) Recite Feeling Scale and Rating of Perceived Exertion Scale scripts.  c) Let them know to pedal at 60-70 RPM once test begins.</p>
<p>8) <b>Before they begin pedaling note that RPE is marked at 6 and watts at 0 on form. Ask them the FS and then record their HR.</b></p>
<p>9) To <b>start warm up, simultaneously start the timer (press red button on the polar watch) and press "start"</b> on bike computer screen and allow participant to pedal at 15 watts for 2 minutes.</p>
<p>10) After 2 minutes, <b>start test</b> by adjusting resistance to midway point between VO<sub>2</sub>peak and VT.</p>
<p>11) Sit or stand outside of visual field of participant between measurements.</p>
<p>12) Record FS at 9 min 30 sec, 19 min 30 sec, 29 min 30 sec, and 39 min 30 sec. Record RPE, watts, and HR every 3 min throughout the exercise task.</p>
<p>13) If participant is unable to maintain 60-70 RMPs, or their HR exceeds 170 BPM for more than one minute, decrease resistance by 10 watts and take a note of reason for decrease on the form.</p>
<p>14) At 15 minutes, <b>offer the participant water</b>. Encourage small sips. Let him/her know that water and a towel are available whenever they need it and let them know they are half way through the test with another 15 minutes to go.</p>
<p>15) <b>End test</b> only after final recording of FS, RPE, HR and watts. End test by pressing "end" on computer screen of bike.</p>

<b>Post Exercise task</b>
1) <b>Cool down</b> for 2 minutes at low resistance. The 2 minute cool down is counted when considering the 10 minute post-exercise FS and HR assessment.
2) <b>Protect participant</b> as they step off exercise bike: Ask them to step off bike towards you. Spot them so they do not fall (sometimes participants get wobbly legs after exercise tasks).
3) Seat the participant in a comfortable chair. Record the participant's FS and HR 10 minutes into the <b>recovery period</b> .

## Appendix C

### 3 Day Physical Activity Recall (3dPAR)

*The purpose of this questionnaire is to estimate the amount of physical activity that you perform.*

*The name of each day (Monday, Sunday, and Saturday) that you will describe is located in the top left hand corner of each time sheet.*

1. For each time period, write in the activity number which corresponds to the **main** activity you actually performed during that particular time period.
2. Then rate how physically **hard** each activity was. Place a “☺” in the time table to indicate one of the following intensity levels for each activity.

**-Light** - Slow breathing, little or no movement. (examples include sitting, brushing teeth, reading, eating)



**-Moderate** - Normal breathing and some movement. (examples include walking, stretching, gardening)



**-Hard** - Increased breathing and moderate movement. (examples include dancing, aerobics, soccer, weight-lifting)



**-Very Hard** - Hard breathing and quick movement. (examples include running, tennis, fast bicycling, rock-climbing)



## **Activity Number**

### **Eating**

- 1.) Eating a meal
- 2.) Snacking

### **Work**

- 3.) Working (e.g., part-time job, child care)  
(list) \_\_\_\_\_
- 4.) Doing house chores (e.g., vacuuming, dusting, washing dishes, animal care, etc.)
- 5.) Yard Work (e.g., mowing, raking)

### **After School/Spare Time/Hobbies**

- 6.) Church
- 7.) Hanging around
- 8.) Homework
- 9.) Listening to music
- 10.) Marching band/flag line/ drill team
- 11.) Music lesson/playing instrument
- 12.) Playing video games/surfing Internet
- 13.) Reading
- 14.) Shopping
- 15.) Talking on Phone
- 16.) Watching TV or movie

### **Transportation**

- 17.) Riding in a car/bus
- 18.) Travel by walking
- 19.) Travel by bicycling

### **Sleep/Bathing**

- 20.) Getting dressed
- 21.) Getting ready (hair, make-up, etc)
- 22.) Showering/bathing
- 23.) Sleeping

## **School**

- 24.) Club, student activity
- 25.) Lunch/free time/study hall
- 26.) P.E. class
- 27.) ROTC
- 28.) Sitting in class

## **Physical Activities and Sports**

- 29.) Aerobics/aerobic dancing
- 30.) Basketball
- 31.) Bicycling
- 32.) Bowling
- 33.) Calisthenics (i.e., jumping jacks, sit ups)
- 34.) Cheerleading
- 35.) Dancing (social, recreational)
- 36.) Dancing (ballet, jazz, modern, tap)
- 37.) Field Hockey
- 38.) Frisbee
- 39.) Golf
- 40.) Horseback riding
- 41.) Ice/roller skating
- 42.) Jogging/running
- 43.) Karate/judo/martial arts/self defense
- 44.) Rollerblading
- 45.) Skateboarding
- 46.) Soccer
- 47.) Softball/baseball
- 48.) Stationary exercise machines (e.g., cycle, ski machine, stair climber, treadmill)
- 49.) Street hockey
- 50.) Swimming, water exercise
- 51.) Tennis
- 52.) Volley ball
- 53.) Walking (briskly)
- 54.) Weight/circuit training
- 55.) Other (list) \_\_\_\_\_

**Day of Week:**

**DATE:**

Put a '✓' to rate the intensity of each activity

Write activity numbers in this column

		Activity Number	Light	Moderate	Hard	Very Hard
Before school	7:00-7:30					
	7:30-8:00					
During school	8:00-8:30					
	8:30-9:00					
	9:00-9:30					
	9:30-10:00					
	10:00-10:30					
	10:30-11:00					
	11:00-11:30					
Lunch time	11:30-12:00					
	12:00-12:30					
	12:30-1:00					
	1:00-1:30					
	1:30-2:00					
	2:00-2:30					
	2:30-3:00					
After school	3:00-3:30					
	3:30-4:00					
	4:00-4:30					
	4:30-5:00					
	5:00-5:30					
	5:30-6:00					
	6:00-6:30					
Supper time	6:30-7:00					
	7:00-7:30					
	7:30-8:00					
	8:00-8:30					
	8:30-9:00					
	9:00-9:30					
	9:30-10:00					
Evening	10:00-10:30					
	10:30-11:00					
	11:00-11:30					
	11:30-12:00					

## Appendix D

### School Sports Participation

Have you been on any sports teams during the **past year** at school?  
 (For each sport, circle 0 for No or 1 for Yes)

<b>School Sports</b>	<b>No</b>	<b>Yes</b>
a. Baseball or softball	0	1
b. Basketball	0	1
c. Cheerleading	0	1
d. Football	0	1
e. Golf	0	1
f. Ice, field, roller hockey	0	1
g. Soccer	0	1
h. Swimming	0	1
i. Tennis	0	1
j. Track and field	0	1
k. Volleyball	0	1
l. Gymnastics	0	1
m. Wrestling	0	1
n. Other (specify):	0	1
o. Other (specify):	0	1

### Out-of-School Sports Participation

Have you been on any sports teams during the **past year** outside of school?  
 (For each sport, circle 0 for No or 1 for Yes)

<b>Out-of-School Sports</b>	<b>No</b>	<b>Yes</b>
a. Baseball or softball	0	1
b. Basketball	0	1
c. Cheerleading	0	1
d. Football	0	1
e. Golf	0	1
f. Ice, field, roller hockey	0	1
g. Soccer	0	1
h. Swimming	0	1
i. Tennis	0	1
j. Track and field	0	1
k. Volleyball	0	1
l. Gymnastics	0	1
m. Wrestling	0	1
n. Other (specify):	0	1
o. Other (specify):	0	1

## Appendix E

Table 1.

*Effects of Affective Response During Exercise and Affective Response Consistency on Accelerometer-Determined Moderate Physical Activity (n = 114)*

Variable	Model 1			Model 2		
	<i>b</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	-5.411	3.764	-.168	-5.429	3.769	-.169
Body fat percentage	.029	.200	.017	.051	.205	.030
FS during exercise	-1.016	1.153	-.079	-1.950	1.363	-.151
Baseline FS	.191	.976	.017	.347	1.003	.032
Baseline Moderate PA	.356	.068	.469 ***	.357	.068	.470 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-1.806	4.537	-.036	-1.201	4.864	-.024
Inconsistent	-2.343	3.115	-.064	-2.174	3.122	-.059
Interactions						
FS during exercise X Moderately Consistent				2.130	3.346	.063
FS during exercise X Inconsistent				3.422	2.762	.119
(Constant)	26.199	6.696		26.303	6.707	
F(df)		5.996(7, 107)			4.843(9, 105)	
$\Delta R^2$		0.282***			0.012	
Adjusted R <sup>2</sup>		0.235			0.233	

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 2.

*Effects of Affective Response After Exercise and Affective Response Consistency on Accelerometer-Determined Moderate Physical Activity (n = 113)*

Variable	Model 1			Model 2		
	<i>b</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	-5.241	3.811	-.163	-3.386	3.908	-.105
Body fat percentage	.028	.204	.016	-.034	.208	-.020
FS after exercise	-2.353	1.160	-.195 *	-1.672	1.294	-.138
Baseline FS	-.704	1.044	-.064	-.793	1.047	-.073
Baseline Moderate PA	.353	.066	.465 ***	.363	.066	.478 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-10.190	5.914	-.152	-7.331	7.202	-.109
Inconsistent	-4.852	4.444	-.096	-6.582	4.517	-.130
Interactions						
FS after exercise X Moderately Consistent				1.950	3.957	.054
FS after exercise X Inconsistent				-4.502	2.603	-.170
(Constant)	26.529	6.671		23.270	6.846	
F(df)	6.681(7, 106)			5.670(9, 104)		
$\Delta R^2$	0.306***			0.023		
Adjusted R <sup>2</sup>	0.260			0.271		

Note.  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\*  $p < .001$



Table 3.

*Effects of Affective Response During Exercise and Affective Response Consistency on Accelerometer-Determined Vigorous Physical Activity (n = 114)*

Variable	Model 1			Model 2		
	<i>b</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Competence	.026	.338	.006	.020	.342	.005
Body fat percentage	-.030	.045	-.052	-.030	.046	-.052
FS during exercise	-.094	.331	-.022	-.154	.386	-.035
Baseline FS	-.185	.288	-.051	-.167	.299	-.046
Baseline Vigorous PA	.410	.041	.711 ***	.411	.041	.712 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-.220	1.225	-.013	-.134	1.312	-.008
Inconsistent	.282	.871	.022	.297	.881	.023
Interactions						
FS during exercise X Moderately Consistent				.219	.910	.019
FS during exercise X Inconsistent				.185	.765	.019
(Constant)	1.048	.517		1.047	.522	
F(df)	17.226(7, 107)			13.171(9, 105)		
$\Delta R^2$	0.530***			0.000		
Adjusted R <sup>2</sup>	0.499			0.490		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 4.

*Effects of Affective Response After Exercise and Affective Response Consistency on Accelerometer-Determined Vigorous Physical Activity (n = 113)*

Variable	Model 1			Model 2		
	<i>b</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Competence	.135	.360	.033	.150	.365	.036
Body fat percentage	-.028	.046	-.047	-.013	.047	-.021
FS after exercise	-.243	.354	-.060	-.460	.383	-.113
Baseline FS	-.310	.316	-.086	-.258	.321	-.071
Baseline Vigorous PA	.408	.040	.709***	.415	.040	.720***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-1.963	1.688	-.086	-.172	2.024	-.008
Inconsistent	-.395	1.212	-.023	-.234	1.249	-.014
Interactions						
FS after exercise X Moderately Consistent				1.763	1.096	.144
FS after exercise X Inconsistent				.461	.713	.051
(Constant)	1.285	.467		1.262	.465	
F(df)	17.435(7, 106)			13.961(9, 104)		
$\Delta R^2$	0.535***			0.012		
Adjusted R <sup>2</sup>	0.504			0.508		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 5.

*Effects of Affective Response During Exercise and Affective Response Consistency on Accelerometer-Determined MVPA (n = 115)*

Variable	Model 1			Model 2		
	<i>b</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	-3.912	4.748	-.096	-3.950	4.743	-.097
Body fat percentage	-.061	.256	-.028	-.047	.261	-.022
FS during exercise	-.698	1.467	-.043	-2.078	1.730	-.127
Baseline FS	-.205	1.227	-.015	.121	1.262	.009
Baseline MVPA	.371	.071	.478 ***	.372	.071	.479 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	2.364	5.629	.038	3.863	5.967	.062
Inconsistent	.087	3.944	.002	.291	3.943	.006
Interactions						
FS during exercise X Moderately Consistent				4.357	4.179	.103
FS during exercise X Inconsistent				4.355	3.488	.120
(Constant)	40.316	7.439		40.487	7.431	
F(df)		5.799(7, 108)			4.773(9, 106)	
$\Delta R^2$		0.273***			0.015	
Adjusted R <sup>2</sup>		0.226			0.228	

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 6.

*Effects of Affective Response After Exercise and Affective Response Consistency on Accelerometer-Determined MVPA (n = 114)*

Variable	Model 1			Model 2		
	<i>b</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	-3.462	4.754	-.085	-1.542	4.892	-.038
Body fat percentage	-.060	.258	-.028	-.110	.264	-.051
FS after exercise	-1.801	1.263	-.132	-1.845	1.273	-.136
Baseline FS	-3.224	1.432	-.211 *	-2.713	1.612	-.178
Baseline MVPA	.377	.068	.486 ***	.386	.068	.498 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-14.964	7.353	-.176 *	-10.217	9.018	-.120
Inconsistent	-7.453	5.522	-.116	-9.137	5.638	-.143
Interactions						
FS after exercise X Moderately Consistent				3.756	4.981	.082
FS after exercise X Inconsistent				-4.309	3.270	-.129
(Constant)	41.777	7.436		38.794	7.653	
F(df)	6.996(7, 107)			5.772(9, 105)		
$\Delta R^2$	0.314***			0.017		
Adjusted R <sup>2</sup>	0.269			0.274		

Note.  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 7.

*Effects of Affective Response During Exercise and Affective Response Consistency on Self-Reported Moderate Physical Activity (n = 169)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	.750	1.371	.039	.855	1.372	.044
Family Support	.221	.151	.104	.220	.151	.103
FS during exercise	.943	.560	.127	.644	.656	.087
Baseline FS	.594	.510	.091	.540	.525	.082
Baseline Moderate PA	.387	.067	.400***	.379	.067	.392***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-2.696	2.206	-.094	-3.419	2.425	-.119
Inconsistent	-3.682	1.585	-.167*	-3.767	1.585	-.171*
Interactions						
FS during exercise X Moderately Consistent				-.700	1.685	-.035
FS during exercise X Inconsistent				1.698	1.308	.103
(Constant)	13.916	2.128		13.820	2.129	
F(df)	6.784(7, 162)			5.520(9, 160)		
$\Delta R^2$	0.227***			0.010		
Adjusted R <sup>2</sup>	0.193			0.194		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 8.

*Effects of Affective Response After Exercise and Affective Response Consistency on Self-Reported Moderate Physical Activity (n = 168)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	.460	1.388	.024	.633	1.420	.033
Family Support	.168	.154	.079	.186	.156	.087
FS after exercise	1.097	.569	.158	1.270	.614	.183 *
Baseline FS	.994	.555	.151	.944	.561	.144
Baseline Moderate PA	.376	.069	.389 ***	.382	.069	.396 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-1.610	3.019	-.039	-1.513	3.204	-.037
Inconsistent	.322	2.330	.010	.095	2.351	.003
Interactions						
FS after exercise X Moderately Consistent				-.067	2.164	-.002
FS after exercise X Inconsistent				-1.309	1.429	-.073
(Constant)	13.109	2.175		12.843	2.219	
F(df)		5.796 (7, 161)			4.569(9, 159)	
$\Delta R^2$		0.201***			0.004	
Adjusted R <sup>2</sup>		0.167			0.161	

Note.  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 9.

*Effects of Affective Response During Exercise and Affective Response Consistency on Self-Reported Hard Physical Activity (n = 171)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Family support	.125	.131	.076	.114	.129	.069
Competence	1.034	.575	.174	.940	.568	.158
Body fat percentage	-.067	.068	-.080	-.058	.068	-.069
FS during exercise	-.364	.432	-.063	-.976	.488	-.170 *
Baseline FS	-.268	.407	-.052	-.180	.415	-.035
Baseline Hard PA	.317	.064	.362 ***	.329	.063	.377
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	.249	1.619	.011	.520	1.761	.023
Inconsistent	3.197	1.169	.187 **	3.099	1.153	.181 **
Interactions						
FS during exercise X Moderately Consistent				1.100	1.232	.071
FS during exercise X Inconsistent				2.508	.958	.196 *
(Constant)	6.842	.638		6.910	.630	
F(df)	8.696(8, 163)			7.874(10, 161)		
$\Delta R^2$	0.299***			0.029*		
Adjusted R <sup>2</sup>	0.265			0.287		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 10.

*Effects of Affective Response After Exercise and Affective Response Consistency on Self-Reported Hard Physical Activity (n = 170)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Family support	.162	.132	.098	.162	.133	.098
Competence	1.053	.610	.177	1.180	.614	.198
Body fat percentage	-.055	.071	-.065	-.041	.072	-.048
FS after exercise	-.681	.453	-.126	-.637	.479	-.118
Baseline FS	-.553	.453	-.108	-.631	.457	-.123
Baseline Hard PA	.327	.065	.372 ***	.330	.065	.376 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	1.937	2.273	.061	2.611	2.377	.082
Inconsistent	-1.049	1.719	-.043	-1.330	1.729	-.054
Interactions						
FS after exercise X Moderately Consistent				1.451	1.584	.068
FS after exercise X Inconsistent				-1.232	1.042	-.088
(Constant)	7.711	.558		7.715	.557	
F(df)		7.843(8, 162)			6.543(10, 160)	
$\Delta R^2$		0.279***			0.011*	
Adjusted R <sup>2</sup>		0.244			0.246	

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$



Table 11.

*Effects of Affective Response During Exercise and Affective Response Consistency on Self-Reported MVPA  
(n = 170)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Family support	.477	.199	.181 *	.486	.196	.184 *
Competence	.655	.761	.069	.462	.751	.049
FS during exercise	.649	.675	.071	-.183	.763	-.020
Baseline FS	.187	.632	.023	.237	.639	.029
Baseline MVPA	.441	.069	.433 ***	.438	.068	.430 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-2.883	2.565	-.080	-3.458	2.770	-.097
Inconsistent	-1.380	1.881	-.050	-1.607	1.851	-.058
Interactions						
FS during exercise X Moderately Consistent				.097	1.949	.004
FS during exercise X Inconsistent				4.159	1.519	.202 **
(Constant)	22.649	1.015		22.768	.999	
F(df)	10.181(7, 163)			9.058(9, 161)		
$\Delta R^2$	0.304***			0.032*		
Adjusted R <sup>2</sup>	0.274			0.299		

Note.  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 12.

*Effects of Affective Response After Exercise and Affective Response Consistency on Self-Reported MVPA (n = 170)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Family support	.448	.199	.170 *	.468	.198	.178 *
Competence	.716	.777	.075	.855	.776	.090
FS after exercise	.579	.687	.067	.868	.725	.101
Baseline FS	.345	.693	.042	.165	.698	.020
Baseline MVPA	.448	.070	.439 ***	.462	.070	.453 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	.023	3.566	.000	.586	3.727	.011
Inconsistent	-1.405	2.716	-.036	-2.043	2.723	-.052
Interactions						
FS after exercise X Moderately Consistent				1.039	2.474	.030
FS after exercise X Inconsistent				-2.986	1.645	-.134
(Constant)	22.069	.879		22.055	.874	
F(df)	9.799(7, 163)			8.111(9, 161)		
$\Delta R^2$	0.296***			0.016		
Adjusted R <sup>2</sup>	0.266			0.273		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 13.

*Effects of Affective Response During Exercise and Affective Response Consistency on Physical Fitness (n = 169)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	-.120	.071	-.086	-.120	.071	-.086
Competence	.019	.025	.035	.017	.025	.030
Family support	-.001	.006	-.006	-.001	.006	-.008
Body fat percentage	-.007	.004	-.087	-.006	.004	-.079
FS during exercise	-.003	.019	-.005	-.021	.021	-.039
Baseline FS	-.003	.018	-.007	-.002	.018	-.004
Baseline Physical Fitness	.868	.048	.798 ***	.876	.048	.804 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	.018	.072	.008	.012	.079	.005
Inconsistent	-.005	.051	-.003	-.009	.051	-.006
Interactions						
FS during exercise X Moderately Consistent				.013	.054	.009
FS during exercise X Inconsistent				.082	.042	.069
(Constant)	2.719	.108		2.721	.107	
F(df)	97.637(9, 160)			81.102(11, 158)		
$\Delta R^2$	0.846***			0.004		
Adjusted R <sup>2</sup>	0.837			0.839		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 14.

*Effects of Affective Response After Exercise and Affective Response Consistency on Physical Fitness (n = 169)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Gender	-.117	.071	-.084	-.095	.073	-.068
Competence	.017	.027	.030	.020	.027	.037
Family support	-.001	.006	-.006	-.001	.006	-.005
Body fat percentage	-.007	.004	-.090	-.007	.004	-.094
FS after exercise	.006	.020	.011	.010	.021	.019
Baseline FS	-.001	.020	-.002	-.003	.020	-.007
Baseline Physical Fitness	.869	.048	.798 ***	.874	.048	.803 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-.050	.101	-.016	-.028	.105	-.009
Inconsistent	-.004	.074	-.002	-.013	.074	-.006
Interactions						
FS after exercise X Moderately Consistent				.043	.069	.021
FS after exercise X Inconsistent				-.052	.046	-.041
(Constant)	2.719	.108		2.686	.111	
F(df)	97.855(9, 160)			80.149(11, 158)		
$\Delta R^2$	0.846***			0.002		
Adjusted $R^2$	0.838			0.837		

Note.  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 15.

*Effects of Affective Response During Exercise and Affective Response Consistency on Sports Participation  
(n = 118)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Competence	.207	.118	.156	.206	.120	.155
FS during exercise	-.297	.113	-.226	-.307	.137	-.234 *
Baseline FS	-.026	.098	-.023	-.024	.101	-.022
Baseline Sports Participation	.612	.099	.522 **	.612	.100	.522 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-.198	.390	-.042	-.195	.418	-.041
Inconsistent	-.499	.302	-.129	-.501	.305	-.129
Interactions						
FS during exercise X Moderately Consistent				.017	.310	.005
FS during exercise X Inconsistent				.033	.235	.013
(Constant)	2.144	.167		2.146	.169	
F(df)	11.205(6, 112)			8.257(8, 110)		
$\Delta R^2$	0.375***			0.000		
Adjusted R <sup>2</sup>	0.342			0.330		

*Note.*  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Table 16.

*Effects of Affective Response After Exercise and Affective Response Consistency on Sports Participation (n = 117)*

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE(b)</i>	$\beta$	<i>b</i>	<i>SE(b)</i>	$\beta$
Competence	.248	.124	.186 *	.233	.125	.175
FS after exercise	-.299	.120	-.240 *	-.348	.128	-.279 **
Baseline FS	-.064	.109	-.057	-.039	.112	-.035
Baseline Sports Participation	.552	.101	.467 ***	.551	.101	.466 ***
Affective Response Consistency <sup>a</sup>						
Moderately Consistent	-.001	.638	.000	.145	.720	.019
Inconsistent	-.655	.407	-.131	-.605	.411	-.121
Interactions						
FS after exercise X Moderately Consistent				.204	.403	.046
FS after exercise X Inconsistent				.261	.245	.092
(Constant)	2.072	.144		2.077	.144	
F(df)	11.139(6, 111)			8.455(8, 109)		
$\Delta R^2$	0.376***			0.007		
Adjusted R <sup>2</sup>	0.342			0.338		

Note.  $\Delta R^2$  refers to the change in  $R^2$  associated with the addition of interaction terms into the regression equation.

<sup>a</sup> The reference group is Strongly Consistent.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

## Appendix F

### Moderate-Intensity Exercise Task Protocol

1) Turn bike on. a. Turn on fitness test cart (green switch on bottom left corner of cart, near floor) b. Press green button on back of bike, under seat.
2) Select “manual mode” on exercise bike’s computer screen.
3) Adjust to 15 watts (warm-up resistance).
4) Invite the <b>participant to climb onto the bike</b> by placing feet into pedals. Do not let the participant step on the bike frame since they may slip!
5) <b>Strap their feet</b> into the pedals snugly. Balls of the feet should be on pedal.
6) <b>Adjust the seat height and handle-bar height</b> , as needed. Have them pedal and ask them if they think any more adjustment is needed.
7) <b>Introduce</b> participant to the <b>Moderate Exercise Task</b> : a) “Today you are going to be doing 30 minutes of cycling <b>at a level we already know is within your ability.</b> ” b) Recite Feeling Scale and Rating of Perceived Exertion Scale scripts. c) Let them know to pedal at 60-70 RPM once test begins.
8) <b>Before they begin pedaling note that RPE is marked at 6 and watts at 0 on form. Ask them the FS and then record their HR.</b>
9) To <b>start warm up, simultaneously start the timer (press red button on the polar watch) and press “start”</b> on bike computer screen and allow participant to pedal at 15 watts for 2 minutes
10) After 2 minutes, <b>start test</b> by adjusting resistance to 50% of VO <sub>2</sub> max.
11) Sit or stand outside of visual field of participant between measurements.
12) Record FS and RPE at 2 min 30 sec, 5 min 30 sec, and so on. Record watts and HR at 3 min, 6 min, and so on.
13) If participant is unable to maintain 60-70 RMPs, or their HR exceeds 170 BPM for more than one minute, decrease resistance by 10 watts and take a note of reason for decrease on the form.
14) At 15 minutes, <b>offer the participant water</b> . Encourage small sips. Let him/her know that water and a towel are available whenever they need it and let them know they are half way through the test with another 15 minutes to go.
15) <b>End test</b> only after final recording of FS, RPE, HR and watts. End test by pressing “end” on computer screen of bike.
<b>Post Exercise task</b>
1) <b>Cool down</b> for 3 minutes at low resistance. The 3 minute cool down is counted when considering the 3 and 6 minute post-exercise FS and HR assessment.
2) <b>Protect participant</b> as they step off exercise bike:

Ask them to step off bike towards you. Spot them so they do not fall (sometimes participants get wobbly legs after exercise tasks.)

3) Seat the participant in a comfortable chair. Record the participant's FS and Heart rate at 3 and 6 minutes during the **recovery period**.



## Appendix G

ID # \_\_\_\_\_

The following questions are about physical activity. Fill in the circle for the number of days in a week and how many minutes each day that best describes how much activity you do when you are not in school:

### 1. Strenuous activity (it makes my heart beat quickly, and makes me sweat).

Examples are running, jogging, fast bicycling, aerobic dance, rollerblading, fast swimming, soccer, basketball, football, martial arts.

a. How many days a week do you do this?

0 1 2 3 4 5 6 7



b. How many minutes each day?

10 20 30 40 50 60+



### 2. Moderate activity (it doesn't make me tired and makes me sweat just a little).

Examples are fast walking, easy swimming, weight lifting, baseball, softball, tennis, volleyball.

a. How many days a week do you do this?

0 1 2 3 4 5 6 7



b. How many minutes each day?

10 20 30 40 50 60+



**3. Mild activity (it makes me use little effort, and doesn't make me sweat).**

Examples are easy walking, bowling, fishing, golf, yoga.

a. How many days a week do you do this?

- 0  1  2  3  4  5  6  7



b. How many minutes each day?

- 10  20  30  40  50  60+

