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THE ROLE OF PERCEIVED PSYCHOLOGICAL NEED SATISFACTION IN EXERCISE-RELATED AFFECT

Philip M. Wilson[1], Diane E. Mack[1], Chris M. Blanchard[2], & Casey E. Gray[1]

[1]Brock University, St. Catharines, Ontario, Canada, & [2]Dalhousie University Halifax, Nova Scotia, Canada

Abstract: The aim of this investigation was to examine the role of psychological need fulfillment in promoting affective responses to exercise from the perspective of self-determination theory. Participants in the two studies (*N* ranged from 140 to 175) were university students and staff who completed measures of psychological need satisfaction and exercise-related affect. Descriptive statistics across both studies indicated that participants reported greater satisfaction of competence and autonomy than relatedness needs in exercise although minimal differences were evident in Study 2. Structural equation modeling analyses conducted in Study 1 supported the contribution of a latent variable representing overall psychological need satisfaction to positive well-being and psychological distress. Multiple regression analyses conducted in Study 2 supported the link between greater satisfaction of SDT-based needs with enhanced positive and reduced negative affect in exercise settings and provided no support for the influence of gender on the perceived psychological need satisfaction-exercise affect relationship.

Key words: Internalization, Self-determination theory, Well-being.

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Address: Philip M. Wilson, Department of Physical Education & Kinesiology, 500 Glenridge Avenue, Brock University, St. Catharines, Ontario, L2S 3A1 Canada. Phone: +1-905-6885550 Ext. 4997, Fax: (905) 688-8364. E-mail: phwilson@brocku.ca

INTRODUCTION

There has been increased recognition for the importance of understanding motivational processes in physical activity contexts given the documented health benefits of an active lifestyle and epidemiological health data indicating low participation levels amongst North American populations (Katzmarzyck, Gledhill, & Shepherd, 2000; Sapkota, Bowles, Ham, & Kohl, 2005). One theoretical framework that is proving useful in terms of understanding physical activity behaviours is Self-Determination Theory (SDT; Deci & Ryan, 1985, 2002). According to Deci and Ryan (1985, 2002), the motives underpinning behaviours such as physical activity reside along a continuum ranging from controlling motives that regulate behaviour via external controls or introjected pressures to more autonomous motives that rely on personal values, task integration with the self, or interest in the behaviour to motivate persistence. While the distinction between controlled and autonomous motivational processes forwarded by SDT's organismic integration sub-theory has shown links with readiness to change exercise patterns (Mullan & Markland, 1997) and frequency of exercise behaviour (Wilson, Rodgers, Fraser, & Murray, 2004), SDT is comprised of four sub-theories that collectively inform our understanding of human motivation and development. One sub-theory proposed by Deci and Ryan (1985, 2002) as fundamental for understanding the internalization of motivation and development of well-being concerns the role of basic psychological needs.

The basic psychological needs sub-theory of SDT proposes that people have innate psychological needs that when fulfilled exert universal effects on personal growth, psychosocial adjustment, and eudaimonic well-being (Deci & Ryan, 1985, 2002; Ryan & Deci, 2001). The approach taken towards psychological needs within SDT differs from other frameworks insofar as SDT considers psychological needs to be innate tendencies requiring fulfillment and thereby differentiated from any motivational force or desire prompting behaviour (Deci & Ryan, 1985, 2002). Consequently, the approach to basic psychological needs embraced by SDT is that contexts which satisfy innate psychological needs foster a sense of eudaimonic well-being while environments that stifle opportunities for basic psychological need fulfillment promote alienation and impede human development (Deci & Ryan, 1985, 2002; Ryan, 1995). While SDT's approach has not gone without criticism (Schwartz, 2000), the specification of specific psychological needs that serve to nourish motivation and human development provide targets for intervention to improve well-being while simultaneously presenting a framework that can account for phenomena integral to understanding behavioural change attempts (Sheldon, Williams, & Joiner, 2003).

Deci and Ryan (1985, 2002) contend that competence, autonomy, and relatedness represent three basic psychological needs that, when fulfilled in social contexts, promote the internalization of behavioural regulation and enhance eudaimonic well-being. Competence refers to interacting in a capable fashion within one's environment during the process of mastering challenging tasks (White, 1959). Autonomy is characterized by a sense of volition and self-direction accompanied by an internal locus of causality motivating behaviour (deCharms, 1968). Finally, relatedness refers to having a sense of meaningful interpersonal connection or belonging with others in one's social milieu (Baumeister & Leary, 1995). Although some dispute exists regarding the number of basic psychological needs considered integral to human development (Sheldon, Elliot, Kim, & Kasser 2001), a growing body of evidence highlights the positive behavioural and psychological consequences stemming from social contexts that satisfy competence, autonomy, and relatedness needs in accordance with SDT (Deci & Ryan, 1985, 2002; Ryan & Deci, 2001).

Despite the appeal of SDT's basic psychological needs sub-theory, the preponderance of exercise-based research applying SDT has focused on instrument development issues (Mullan, Markland, & Ingledew, 1997) or examined the degree to which fulfillment of basic psychological needs is associated with motives for exercise that vary in self-determination (Wilson, Rodgers, & Fraser, 2002; Wilson, Rodgers, Blanchard, & Gessell, 2003). A small number of studies, however, have examined links between SDT-based variables and exercise affect as an index of well-being. For example, two lab-based experimental studies with young adults showed that reduction in negative affect (Daley & Maynard, 2003) and psychological distress (Parfitt & Gledhill, 2004) were linked to perceived choice of exercise mode along with increased positive well-being (Parfitt & Gledhill, 2004) that appears independent of exercise intensity (Parfitt, Rose, & Markland, 2000). Complimenting this line of research, other studies have demonstrated that autonomous motives predict positive affect and energetic arousal experienced post-exercise in aerobic exercisers (Lutz, Lochbaum, & Turnbow, 2003) and elevated perceptions of physical self-worth (Georgiadis, Biddle, & Chatzisarantis, 2001; Wilson & Rodgers, 2002).

While the aforementioned studies provide insight into the utility of SDT for understanding exercise-related affect, there appear to be a number of reasons for further investigation. First, the majority of existing research examining affective experiences in exercise from the perspective of SDT has linked motives, not basic psychological needs, with affective consequences of exercise involvement (Georgiadis et al., 2001; Lutz et al., 2003; Wilson & Rodgers, 2002). Deci and

Ryan (1985, 2002) have made clear distinctions between motives and needs in their formulation of SDT and consider environments supporting the satisfaction of competence, autonomy, and relatedness needs to be pivotal influences on indices of well-being (e.g., affective experiences). Second, previous studies have restricted the focus of their investigations to perceived choice as a proxy marker of autonomy and excluded any consideration of competence and relatedness needs (Daley & Maynard, 2003; Parfitt & Gledhill, 2004; Parfitt et al., 2000). Reeve (2002) has suggested that perception of choice reflects only one dimension of perceived autonomy which is also characterized by a sense of volition and an internal perceived locus of causality from the perspective of SDT (Deci & Ryan, 1985, 2002). Therefore, it appears that considerable scope exists for further investigation into the role played by satisfying competence, autonomy, and relatedness needs proposed within SDT (Deci & Ryan, 1985, 2002) and affective experiences in exercise settings.

Ryan (1995) has recommended testing general principles derived from SDT in specific domains such as exercise given that such approaches foster theoretical development and provide a platform for altering social practice within that domain. Given the available evidence concerning applications of SDT's basic psychological needs sub-theory to exercise-related issues, the overall purpose of this investigation was to examine the relationship between perceived competence, autonomy, and relatedness and affective experiences in exercise contexts. Exercise affect was chosen as the criterion variable of interest for the present investigation for three reasons. First, affect-laden self-perceptions appear to play a pivotal role in physical activity participation decisions (Biddle, Fox, & Boutcher, 2000). Second, positively activated affective states have been identified as hallmark characteristics of well-being (Russell, 2003; Yik, Russell, & Feldman Barret, 1999). Third, Ekkekakis and Petruzello (1999) have argued that motivational variables play a central role in exercise-related affect and yet few studies have investigated mechanisms of affect generation using motivational theory (Lutz et al., 2003). To address the overall purpose of this investigation, two studies were conducted to examine the influence of perceived psychological need satisfaction on subjective experiences of positive well-being and psychological distress (Study 1), and the contributions of satisfying each psychological need proposed within SDT to positive and negative affect while controlling for the effects of gender as a plausible moderator (Study 2).

STUDY 1

The aim of Study 1 was to examine the relationship between subjective exercise experiences that reflect different psychological interpretations of exercise stimuli and indices of perceived psychological need satisfaction drawn from exercise contexts. Towards this end, this study examined the degree to which perceived satisfaction of competence, autonomy, and relatedness needs were associated with greater positive well-being than psychological distress following a regularly scheduled bout of exercise. On the basis of arguments forwarded by Deci and Ryan (1985, 2002) within SDT, we hypothesized that satisfaction of each psychological need would be associated with more positive well-being and negatively associated with psychological distress.

Method

Participants

Participants (N = 143) were 25 male and 118 female students/staff recruited from a Canadian university. Participants were predominantly young (M = 30.92 years, SD = 15.96 for males; M = 25.98 years, SD = 11.17 for females) and healthy based on their self-reported Body Mass Index (BMI) values (for males mean BMI was 25.73 kg/m^2, SD = 4.27 kg/m^2, 46.8% ≥ 25.00 kg/m^2; for females mean BMI was 22.71 kg/m^2; SD = 2.89 kg/m^2, 31.5% ≥ 25.00 kg/m^2). All participants were enrolled in a 12-week non-instructional exercise class offered through the university's campus recreation department. Each class (n = 18) met twice per week, was taught by a certified instructor, and lasted for approximately 55 minutes in duration including warm-up/cool-down periods separated by bouts of self-paced exercise activity.

Measures

Psychological Need Satisfaction scale (PNS). Perceived psychological need satisfaction was assessed with the PNS, which comprises three items representing context-specific feelings of competence ("Feeling competent and capable in the exercises I attempt"), autonomy ("Feeling autonomous and choiceful in the exercises I do"), and relatedness ("Feeling related and connected to the people I exercise with"). Following the stem, "To what extent do you typically have these experiences in your exercise classes...", participants responded to each item on a scale anchored by 1 (very little) and 7 (very much). While the use of single-item indi-

cators in psychological research is controversial (Crocker & Algina, 1986), empirical data indicate that scores derived from single items approximating a normal distribution and adequately representing the focal construct of interest can be as good (or as poor) as their multi-item counterparts (Gardner, Cummings, Dunham, & Pierce, 1998). These items were modified by Wilson et al. (2002) from Sheldon and Elliot (1999) who reported that scores on these items correlated with improved emotional adjustment in college students. Wilson et al. (2002) supported the criterion validity of PNS scores by reporting correlations with exercise motives that are consistent with SDT (Deci & Ryan, 1985, 2002). Considering that the original items were developed by Sheldon and Elliot (1999) to test propositions put forth within SDT, and the modified items used by Wilson et al. have been linked with exercise motives in a manner consistent with SDT and display no aberrant distributional concerns in this study (see Table 1), their inclusion in this study appears justified.

Subjective Exercise Experiences Scale (SEES). Participants completed eight items drawn from the SEES (McAuley & Courneya, 1994) as indicators of Positive Well-Being (PWB; 4 items) and Psychological Distress (PD; 4 items).[1] These dimensions of the SEES were chosen to differentiate positive from negative interpretations of exercise participation. Following the stem ("Please indicate to what extent you typically experience each feeling after exercise"), participants responded to each item on a scale anchored by 1 (not at all) and 7 (very much so). Courneya and McAuley (1994) supported the structural validity of SEES scores in young and middle-aged adults, and SEES scores appear sensitive to exercise intensity (Blanchard, Rodgers, Wilson, & Bell, 2004). (For the reliability of SEES scores in the present study see the Results section.)

Procedure – Analyses

Participants were informed about the purpose of the study at the start of a regularly scheduled exercise-class, given an opportunity to ask questions regarding the nature of the study, and invited to complete written informed consent prior to completing a questionnaire at the end of the class. Participants completed demographic and PNS indicators during the first test administration (Week 2), while SEES responses were collected during the second test administration (Week 10).

1. The SEES also contains a fatigue subscale that was removed prior to data collection in Study 1 since these four items capture the degree of exertion or perceived deactivation in exercise as opposed to markers of well-being per se which was the focus of this investigation.

Standard instructions were used by the same investigator while collecting the data to reduce potential response bias associated with test administration. Scores for PNS and SEES subscales were created by averaging the scored responses per relevant item (Morris, 1979).

Data analysis proceeded in three sequential stages. First, the data were screened for discrepant or missing responses and examined for conformity with relevant statistical assumptions. Second, descriptive statistics, internal consistency estimates, and bivariate correlations were computed for all relevant study variables. Finally, a conceptual model based on SDT was evaluated using Structural Equation Modeling (SEM) that has been advocated for testing psychological models (MacCallum & Austin, 2000). The SEM analyses conceptualized positive well-being and psychological distress as endogenous variables which manifest themselves as a function of the degree to which exercise-contexts satisfy competence, autonomy, and relatedness needs.

Consistent with Anderson and Gerbing's (1988) recommendations, a two-step SEM approach was taken where the full measurement model (one latent factor defined by 3 PNS items and two latent factors defined by 4 SEES items/factor) was evaluated using confirmatory factor analysis prior to testing the structural model. PNS items were treated as manifest indicators loading on a unidimensional latent factor representing psychological need satisfaction in exercise contexts which is consistent with previous research (Hagger, Chatzisarantis, & Harris, 2006). In the SEM analyses, items were loaded exclusively on their target latent factors, latent factors were correlated, uniquenesses were not free to correlate, and the loading of a manifest indicator was fixed at 1.0 to define the scale for each latent factor in the model.

Several indices were used to evaluate global model fit: Comparative Fit Index (CFI), Incremental Fit Index (IFI), Root Mean Square Error of Approximation (RMSEA), and the 90% confidence interval (90%CI) around the RMSEA point estimate. These indices have been recommended by measurement experts for use when the sample size is small and the data likely deviate from normality (Hu & Bentler, 1999; West, Finch, & Curran, 1995). While values indicative of model fit remain contentious in hypothesis-driven approaches to SEM (Marsh, Hau, & Wen, 2004), it is generally accepted that models with CFI and IFI values exceeding .90 and .95 represent acceptable and excellent fit, respectively, while RMSEA values less than .05 are considered excellent and greater than .10 unacceptable (Browne & Cudeck, 1993; Hu & Bentler, 1999; West et al., 1995).

Table 1. Descriptive statistics for manifest items used in CFA and SEM analyses across Study 1 and Study 2

Latent Subscales and item abbreviations	*M*	*SD*	Skewness	Kurtosis	λ	EV
	Study 1					
Psychological Need Satisfaction						
PNS-Competence	5.63	.91	-0.33	-0.14	.75	.42
PNS-Autonomy	5.60	1.05	-0.50	-0.27	.75	.56
PNS-Relatedness	4.68	1.39	-0.51	0.11	.34	.21
SEES-Positive Well-Being						
SEES-Terrific	5.90	1.01	-1.01	1.13	.92	.15
SEES-Great	5.84	1.03	-1.09	1.36	.81	.37
SEES-Positive	5.58	1.17	-0.78	0.43	.80	.48
SEES-Strong	5.73	1.16	-1.32	2.55	.81	.46
SEES-Psychological Distress						
SEES-Miserable	1.44	.79	2.25	5.89	.92	.17
SEES-Awful	1.41	.86	2.68	8.24	.94	.80
SEES-Crummy	1.64	1.16	2.13	4.25	.63	.09
SEES-Discouraged	1.31	.84	3.79	16.26	.87	.07
	Study 2					
PNSE-Perceived Competence						
PNSE-confident I can do challenging exercise	5.06	.85	-0.58	-0.34	.65	.48
PNSE-capable of doing challenging exercises	4.63	1.06	-0.46	-0.08	.75	.49
PNSE-capable of completing exercise challenges	4.88	1.01	-0.72	-0.05	.85	.28
PNSE-able complete personal exercise challenge	4.94	1.01	-1.00	1.23	.86	.24
PNSE-confident in my ability to exercise	4.76	1.08	-0.75	0.01	.72	.37
PNSE-feel good about ability to exercise	4.89	1.02	-0.63	-0.17	.79	.38
PNSE-Perceived Autonomy						
PNSE-free to choose exercises I participate in	5.00	1.13	-0.94	0.17	.77	.52
PNSE-have a say in choosing exercises I do	4.97	1.07	-0.80	0.18	.87	.26
PNSE-I'm in charge of my exercises	4.93	1.07	-0.63	-0.51	.88	.25
PNSE-I decide what exercises I do	4.99	1.08	-1.09	0.99	.83	.35
PNSE-free to make my own exercise decisions	5.01	1.03	-0.72	-0.39	.84	.29
PNSE-free to exercise in my own way	5.02	1.07	-0.97	0.49	.87	.27
PNSE-Perceived Relatedness						
PNSE-connected to people I interact with	4.41	1.20	-0.82	0.81	.70	.74
PNSE-share a common bond with people	4.40	1.22	-0.54	-0.14	.83	.45
PNSE-close to my exercise companions	4.37	1.32	-0.52	-0.27	.76	.73
PNSE-sense of camaraderie with companions	4.43	1.15	-0.53	0.18	.78	.52
PNSE-get along with people I interact with	4.49	1.18	-0.51	-0.23	.83	.44
PNSE-attached to exercise companions	4.55	1.20	-0.71	0.43	.82	.45

Note: PNS = Psychological Need Satisfaction; SEES = Subjective Exercise Experiences Scale; PNSE = Psychological Need Satisfaction in Exercise Scale; λ = Standardized Parameter Loading from CFA of the full measurement model. EV = Error Variance associated with manifest item loadings in CFA of the full measurement model. In the present sample, interscale relationships between PNSE factors were as follows: (a) Competence-Autonomy, φ = .88; (b) Competence-Relatedness, φ = .68; (c) Autonomy-Relatedness, φ = .59.

Results

Preliminary data analyses

No missing cases or aberrant responses were observed in the data and no grave distributional concerns were evident in either the PNS or PWB data, however, the PD items deviated markedly from normality (see Table 1). Multivariate kurtosis was evident in the analysis of the full measurement model (Mardia's coefficient = 83.61) and as a consequence maximum likelihood estimation was used in all SEM analyses given that this estimation procedure appears more tolerant to data that deviate from normality in applications of SEM using small samples (West et al., 1995). Internal consistency reliability (Cronbach's alpha; Cronbach, 1951) estimates ranged from .62 to .90 (see Table 2). Descriptive statistics (see Table 2) indicated that participants reported greater fulfillment of competence and autonomy than relatedness needs in exercise, and experienced greater positive well-being than psychological distress typically post-exercise. Pearson's correlation coefficients (see Table 2) indicated that psychological need satisfaction scores were all positively correlated with each other, and all three need satisfaction indices were associated with enhanced positive well-being.

Table 2. Descriptive statistics and bivariate correlations between PNS, SEES, PNSE, and PANAS scores across Study 1 and Study 2

Variables	*M*	*SD*	Skewness	Kurtosis	α	1	2	3	4	5
			Study 1							
1. PNS-Competence	5.63	.91	-.33	-.14	--	--				
2. PNS-Autonomy	5.60	1.05	-.50	-.27	--	.54	--			
3. PNS-Relatedness	4.68	1.39	-.51	.11	--	.23	.28	--		
4. SEES-Positive Well-Being	5.76	.97	-1.06	.98	.90	.38	.36	.20	--	
5. SEES-Psychological Distress	1.84	.78	2.79	10.11	.88	-.10	-.14	-.14	-.58	--
			Study 2							
1. PNSE-Competence	4.82	.91	-.82	1.28	.91	--				
2. PNSE-Autonomy	4.96	.99	-.95	1.19	.94	.82	--			
3. PNSE-Relatedness	4.44	1.04	-.59	.83	.92	.65	.58	--		
4. PANAS-Positive Affect	3.79	.82	-.83	1.37	.88	.63	.62	.52	--	
5. PANAS-Negative Affect	1.66	.83	1.82	3.75	.85	-.34	-.40	-.22	-.26	--

Note: PNS = Perceived Psychological Need Satisfaction. SEES = Subjective Exercise Experiences Scale. PNSE = Psychological Need Satisfaction in Exercise Scale. α = Cronbach's alpha. Correlation matrix is based upon pairwise comparisons between each variable set and sample sizes are consistent across each comparison made in the matrix per study. All *r*s > .21 in both studies were significant at $p < .01$ (two-tailed). All *r*s > .12 in both studies were significant at $p < .05$ (two-tailed). The internal consistency reliability estimate (Cronbach's α) for the item scores comprising the latent PNS variable was .62 in the sample data provided in Study 1.

Main data analysis

Consistent with SDT (Deci & Ryan, 1985, 2002; Sheldon & Elliot, 1999), a conceptual model positing psychological distress and positive well-being as manifestations of psychological need satisfaction experienced in exercise contexts was evaluated using SEM procedures.[2] An examination of the model fit indices (Table 3) suggested that the full measurement model appears tenable given the distribution of standardized residuals (80.0%z < | 1.0 |, 0.0%z > | 2.0 |) indicating minimal over- and under-estimation of fitted correlations and the pattern of weak-to-strong standardized parameter loadings observed per latent factor (see Table 1). Phi coefficients indicated negative relationships between PD and both the PNS (φ = -.18; p = .10)

Table 3. Global model fit indices for measurement and structural models in Study 1 and study 2

Models	χ^2	*df*	*N*	*p*	CFI	IFI	RMSEA (90%CI)	mean λ	λ range
			Study 1						
1. Full measurement model	67.49	41	143	< .01	.96	.97	.07 (.40-.10)	.77	.34-.94
2. Structural model	104.56	42	143	< .01	.93	.94	.10 (.80-.13)	.77	.36-.93
			Study 2						
1. PNSE measurement model	327.46	132	174	< .01	.92	.92	.09 (.08-.11)	.80	.65-.88

Note: PNSE = Psychological Need Satisfaction in Exercise Scale. λ = Standardized Parameter Loading from CFA.

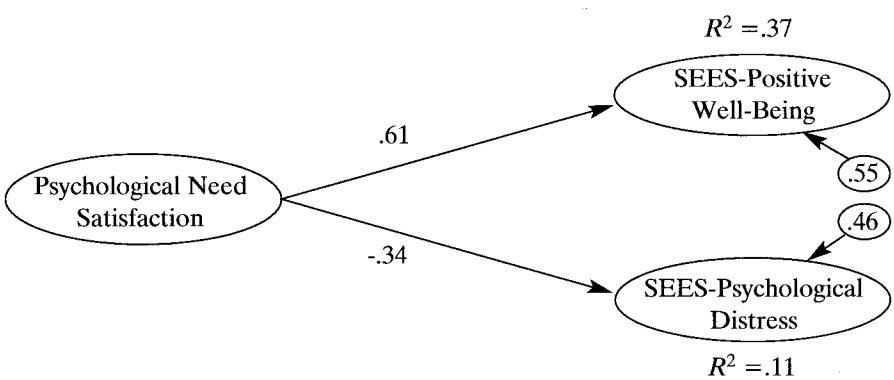

Figure 1. Structural equation modeling analysis depicting subjective exercise experiences as a function of perceived psychological need satisfaction in exercise.

Note: Large circles represent latent variables. Small circles represent residual error variances. Solid lines are significant at p < .05 in the present sample. SEES = Subjective Exercise Experiences Scale.

2. The raw data used in the SEM analyses for Study 1 is available from the first author upon request.

and PWB (φ = -.56; p < .01), while positive relationships were evident between PNS and PWB (φ = .52; p < .01). The fit of the structural model appeared tenable given the observed indices (see Table 3). An inspection of the standardized structure coefficients (see Figure 1) indicated that PNS made positive contributions to the prediction of PWB and negative contributions to the prediction of PD accounting for variance consistent with medium-to-large effect sizes.[3]

Conclusion

The aim of Study 1 was to examine the utility of using basic psychological needs sub-theory proposed by Deci and Ryan (1985, 2002) within SDT for understanding subjective exercise experiences characterized by scores on the PWB and psychological distress subscales of the SEES. The results of Study 1 support the utility of the basic psychological needs proposed by Deci and Ryan as a plausible framework for understanding different subjective experiences in exercise given that greater perception of psychological need fulfillment was associated with increased feelings of positive well-being and reduced psychological distress experienced during one's typical exercise sessions.

STUDY 2

The main aim of Study 2 was to examine the contribution of satisfying each psychological need proposed within SDT's framework (Deci & Ryan, 1985, 2002) to positive and negative affect experienced during one's typical exercise sessions. An obvious limitation inherent in Study 1 concerns the latent modeling of single-item indicators used to measure psychological need satisfaction. This approach restricted the range of conclusions concerning the satisfaction of each psychological need proposed by Deci and Ryan in relation to affective experiences in exercise contexts. In an attempt to address these concerns, this study used the Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006) to test the relationship between perceived competence, autonomy, and relatedness with positive and negative affective experiences reported in exercise contexts.

A second aim of Study 2 was to explore the moderating effect of gender on the perceived psychological need satisfaction-exercise with affect relationship. Gender

3. R^2 values ranging from .06 to .11 correspond to medium effect sizes, while R^2 values exceeding .14 correspond to large effect sizes (Cohen, 1992).

was selected as a moderator for several reasons. First, gender differences in affect-laden self-perceptions have been consistently reported in previous studies (Biddle et al., 2000) and have been noted in SDT-based research describing participant motivation in exercise (Frederick-Recascino, 2002). Second, while Deci and Ryan (2002) recognize that the experiences promoting fulfillment of psychological needs may vary, the link between psychological need satisfaction and indices of well-being such as affect is considered universal within SDT and therefore «must apply across ages, genders, and cultures» (p. 23). While an isolated number of studies have examined the universal nature of psychological need satisfaction within physical education contexts from an SDT perspective (Ntoumanis, 2001; Standage, Duda, & Ntoumanis, 2005), no attempt has been made to examine Deci and Ryan's assertion directly in exercise settings with reference to the impact of psychological need fulfillment on affective experiences. Standage et al. (2005) contend that the lack of attention to gender in research testing the relationship between SDT-based psychological needs and relevant criterion of interest such as affective experiences represents «a significant void in the existing literature» (p. 416). Consistent with Deci and Ryan's arguments, we hypothesized that greater experience of psychological need satisfaction would be associated with more positive and less negative affect and gender would not moderate this relationship.

Method

Participants

Participants (N = 174) were 83 male and 91 female students/staff enrolled in a physical-activity program sponsored by the Campus Recreation Department at a Canadian university. Participants were predominantly young (71.1% of the males and 74.4% of the females aged between 18 and 23 years) and ranged in age from 18 to 44 years (M = 22.77 years, SD = 3.51 for males; M = 22.23 years, SD = 3.72 for females). Self-reported Body Mass Index (BMI) values suggested that the majority of male (M = 23.91 kg/m^2, SD = 4.68 kg/m^2, 37.3% ≥ 25.00 kg/m^2) and female (M = 22.12 kg/m^2, SD = 2.88 kg/m^2, 15.40% ≥ 25.00 kg/m^2) participants fell within the healthy range. Both males (M_{METS} = 40.08, SD = 34.45) and females (M_{METS} = 53.27, SD = 61.74) were physically active at the time of data collection.[4]

4. Physical activity scores were calculated from the Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985) which provides an omnibus indicator of weekly physical

Measures

Psychological Need Satisfaction in Exercise Scale (PNSE). Participants completed the 18-item PNSE as a measure of psychological need satisfaction experienced in exercise contexts (Wilson et al., 2006). A stem statement anchored each item in terms of how people usually felt while exercising (i.e., "The following statements represent different feelings people have when they exercise. Please answer the following questions by considering how you typically feel while you are exercising."). Participants responded to each PNSE item on a 6-point Likert-type scale anchored by 1 (False) and 6 (True). Wilson et al. (2006) have supported the structural and convergent validity of PNSE scores and report internal consistency reliability estimates (Cronbach's alpha) ranging from .90 to .91 across PNSE scores in two samples.

Positive Affect Negative Affect Schedule (PANAS). Participants completed the 10-item short form of the PANAS as an index of affect typically experienced during exercise activities (Watson, Clark, & Tellegren, 1988). Participants responded to each item on a 5-point Likert-type scale anchored by 1 (Very slightly or not at all) and 5 (Extremely). Five PANAS items were used to capture positive (inspired, alert, excited, enthusiastic, determined) and negative (distressed, scared, nervous, upset, afraid) dimensions of affect typically felt when exercising (stem statement: "Indicate to what extent you generally feel this way when you exercise"). Mackinnon et al. (1999) have supported the structural validity of PANAS scores and indicate the short-form of the instrument is less burdensome to respondents and invariant across age.

Procedure – Analyses

Participants were informed about the purpose of the study at the start of a scheduled physical-activity session, were given an opportunity to ask questions regarding the study, and provided written informed consent prior to completion of the study questionnaires. Subscale scores were created by averaging the scored PNSE and PANAS item responses (Morris, 1979). Data analysis proceeded in three stages. First, the data were screened for discrepant or missing responses and

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exercise participation based on self-report estimates of mild, moderate, and strenuous physical exercises. METS (or metabolic equivalents) represent units for classifying physical activity behaviour based on a person's oxygen consumption at rest (Bouchard, Blair, & Haskell, 2007). The omnibus GLTEQ physical activity score is expressed in METS.

examined for conformity with statistical assumptions. Second, a confirmatory factor analysis was conducted to evaluate the structural validity of PNSE scores given that only one previous study has evaluated the measurement model underpinning responses to PNSE items (Wilson et al., 2006). Indices of global model fit, model identification, and estimation procedures used in the confirmatory factor analysis were identical to those described in Study 1. Third, descriptive statistics and internal consistency reliability estimates were computed for all study variables and Pearson *r* correlations were calculated to examine bivariate relationships between indices of need satisfaction and exercise affect. Finally, a series of multiple regression analyses were computed to examine the moderating influence of gender on the relationship between perceived psychological-need-satisfaction and exercise affect relationship. Regression analyses test the interaction between predictor variables (i.e., perceived competence, autonomy, and relatedness) with a moderator variable (i.e., gender) on a criterion variable (i.e., exercise affect) to determine if the influence of the predictors vary as a function of the moderator (Aiken, West, & Pitts, 2003). Consistent with the recommendations of Aiken et al. (2003), a series of interaction terms were created by multiplying the centered scores for each predictor variable with a contrast code denoting male (.500) and female (-.500) group membership such that any contribution from the interaction term indicates the presence of a moderating effect attributable to gender.

Results

Preliminary data analyses

No missing cases or aberrant responses were evident in the data. An inspection of the item-level distributional properties for PNSE responses (see Table 1) suggested no grave departures from normality, however, deviation from multivariate normality was evident in the PNSE data (Mardia's coefficient = 137.33). Examination of the global model fit indices (see Table 3) suggests that the 3-factor oblique PNSE measurement model provides a reasonable account for the observed data considering the degree of departure from multivariate normality although it is noted that the RMSEA values are higher than desirable. A pattern of moderate-to-strong standardized parameter loadings across latent PNSE factors was evident (mean λ = .80; range = .65 to .88; see Table 1 for specific values) and the distribution of standardized residuals indicates minimal evidence of over- or under-estimation of fitted correlations (94.29%z < |1.0|; 0%z > |2.0|). Inspection of the

observed φ coefficients indicated a pattern of moderate-to-strong positive relationships between latent PNSE factors (see Table 1). No grave concerns were evident in the distributional properties of the PNSE or PANAS subscale scores (see Table 2). Inspection of the scatterplot of residuals indicated that linearity and homoscedasticity were tenable assumptions in the present data. Internal consistency reliability (Cronbach's alpha) estimates ranged from .85 to .94 across PNSE and PANAS scores (see Table 2 for specific estimates). Descriptive statistics indicated that participants in this study reported comparable fulfillment of competence, autonomy, and relatedness needs in exercise, as well as, greater positive than negative affect following a typical exercise session. Pearson correlations (see Table 2) indicated that perceptions of competence, autonomy, and relatedness were all positively intercorrelated, and correlated with greater positive affect and less negative affect during a typical session of exercise. Finally, positive and negative affect were weakly correlated.

Main data analysis

Three separate regression analyses examined the influence of gender on the relationship between perceived psychological need satisfaction in exercise with affect in line with the recommendations of Aiken et al. (2003). Inspection of the variance-inflation factor (.96-1.00) and tolerance values (1.00-1.01) implied the presence of collinearity, however, all condition indices were low (1.00-1.36) and the only variance-proportion values that exceeded threshold values (.50 on any two variance-proportion values; Pedhazur, 1997) were evident in the regression model including perceived relatedness scores. A closer inspection of the data indicated that the variance-proportion values exceeding .50 were associated with the centered predictor-variable and its corresponding interaction term in the regression model.

The results of the regression analyses revealed several noteworthy findings. First, it is evident that perceived competence and autonomy were the strongest predictors of positive affect compared with perceived relatedness based on the magnitude of the standardized regression coefficients (see Table 4). Second, none of the perceived psychological need satisfaction variables accounted for a sizeable portion of the negative affect variance although the equations including perceptions of competence and autonomy demonstrated meaningful trends whereby greater need fulfillment was associated with reduced negative affect experienced in exercise settings. Collectively, the amount of variance accounted for in positive affect by PNSE subscale scores represented medium effect sizes while the range of variance accounted for in negative affect by these predictor variables was con-

Table 4. Simultaneous multiple regression analyses examining the moderating influence of gender on the perceived psychological need satisfaction-exercise affect relationship

Predictors	Positive affect				Negative affect			
	β	$r_{Y,Xn}$	*t*	*p*	β	$r_{Y,Xn}$	*t*	*p*
	Model 1				Model 1			
PNSE-Competence	.54	.29	8.31	< .01	-.20	.04	-2.56	< .01
Gender	-.11	.01	-1.64	*ns*	.02	.00	.30	*ns*
Interaction Term	-.10	.01	-1.53	*ns*	-.00	.00	-.04	*ns*
	$F(3, 164) = 23.94$, Adjusted $R^2 = .29$				$F(3, 164) = 2.19$, Adjusted $R^2 = .02$			
	Model 2				Model 2			
PNSE-Autonomy	.52	.27		< .01	-.26	.07	-3.49	< .01
Gender	-.01	.00	7.86	*ns*	-.02	.00	-.26	*ns*
Interaction Term	-.12	.01	-1.82	*ns*	.04	.01	.50	*ns*
	$F(3, 164) = 22.41$, Adjusted $R^2 = .28$				$F(3, 164) = 4.21$, Adjusted $R^2 = .06$			
	Model 3				Model 3			
PNSE-Relatedness	.44	.19	6.21	< .01	-.01	.01	-.98	*ns*
Gender	-.08	.01	-1.09	*ns*	.01	.00	.10	*ns*
Interaction Term	.07	.00	.96	*ns*	-.09	.01	-.09	*ns*
	$F(3, 164) = 13.05$, Adjusted $R^2 = .18$				$F(3, 164) = .60$, Adjusted $R^2 = .01$			

Note: PNSE = Psychological Need Satisfaction in Exercise Scale. $r_{Y,Xn}$ = Unique variance calculation using formulae ($[r_{Y,Xn}]^2$ where $r_{Y,Xn}$ is the partial correlation coefficient controlling for the influence of all other predictor variables in the regression equation; Hair, Black, Babib, Anderson, & Tatham, 1998). Values reported as .00 in Table 4 did not account for at least 1.0% of the unique variance when rounding to two decimal places. All $F > |3.00|$ were significant at $p < .01$ across each regression model estimated in this study. The degrees of freedom vary as a function of the removal of cases exhibiting large ($\geq |3.0|$) standardized residual values per regression model.

sistent with small effect sizes (Cohen, 1992). Finally, an inspection of the interaction terms indicates that gender does not moderate the influence of perceived psychological need satisfaction on either positive or negative affect typically experienced in exercise.

Conclusion

The main aim of Study 2 was to examine the contribution of satisfying each psychological need proposed within SDT's framework (Deci & Ryan, 1985, 2002) on exercise-related affective experiences. The results of the regression analyses indicate that perceptions of psychological need satisfaction facilitate feelings of positive affect and to a lesser extent deter experiences of negative affect in people's typical exercise sessions. Perhaps of greater theoretical interest from Study 2 is the evidence that satisfaction of competence, autonomy, and relatedness needs promote more positive and less negative affect in an equivalent fashion across

gender. The lack of moderation attributable to gender supports Deci and Ryan's argument concerning the universal effects stemming from social contexts that fulfill basic psychological needs for competence, autonomy, and relatedness on indices of well-being such as affect in exercise settings.

GENERAL DISCUSSION

The aim of the present two studies was to examine the argument forwarded by Deci and Ryan (1985, 2002) that enhanced perceptions of competence, autonomy, and relatedness contribute to markers of well-being represented in this study by affective states experienced in exercise. Towards this end, the results of the two studies, using different measures of psychological need satisfaction and exercise-affect, provide converging lines of evidence. Specifically, the fulfilment of competence, autonomy, and relatedness needs in exercise as proposed within SDT contribute to enhanced feelings of positive well-being and positive affect and reduced experiences of psychological distress and negative affect during exercise participation. Furthermore, the results of Study 2 lends partial support to the claim that satisfaction of SDT-based psychological needs exert universal effects on well-being indices given that gender did not moderate the perceived psychological need satisfaction-exercise affect relationship.

Although not included in our original hypotheses, a key finding emerging from the present investigation is the complementary nature of need satisfying experiences evident across scores from two different instruments used in this investigation. One criticism of SDT's basic psychological needs sub-theory concerns the inability to provide opportunities to exercise volition and agency whilst at the same time engendering a sense of connection to others that contributes to perceptions of relatedness (Sampson, 1977; Smith, 1978). Notwithstanding this criticism, the data from both studies comprising this investigation fail to provide convincing support of antagonism between satisfying autonomy and relatedness

5. Three nested measurement models which constrained 2 different phi-coefficients/model to 1.0 were estimated to evaluate the discriminant validity of PNSE subscale scores. Notable deterioration in model fit was observed in each nested measurement model ($\Delta\chi^2$ values ranged from 13.23 to 24.93, all $p < .05$). Furthermore, none of the 90%CI's surrounding the φ point estimate in the original three-factor oblique PNSE measurement model encompassed 1.0 in the data provided by the sample in Study 2. Given that previous studies have reported considerable overlap between indices of psychological need satisfaction in general (Hagger et al., 2006), and in exercise contexts in particular (Wilson et al., 2002), the PNSE scores observed in Study 2 of this investigation do not appear wholly inconsistent with previous research on SDT.

needs in exercise settings and suggest that feeling volitional does not require social isolation and exclusion in this context. Overall, our data indicate that the processes influencing the satisfaction of psychological needs proposed by SDT are neither mutually exclusive or independent in nature which is in line with SDT's contentions given that need satisfaction is seen to be the cornerstone associated with integration of the self within social environments and promotion of eudaimonic well-being (Deci & Ryan, 2002; Ryan & Deci, 2001). While these findings are consistent with theoretical arguments, one troubling result emerging from the present studies concerns the magnitude of the associations between perceived competence and autonomy scores derived particularly from the PNSE.[5] Future research may wish to consider these interrelationships carefully in predictive analyses where collinearity is likely, and consider disentangling the unique effects of need satisfaction on criterion of interest such as motivation and different forms of exercise-specific affect.

The observation that current exercisers reported greater satisfaction of competence and autonomy than relatedness needs in exercise is consistent with previous research on university-based exercise attendees (Wilson et al., 2002) and community-based adults participating in a university-based fitness training program (Wilson et al., 2003). Interestingly, however, this discrepancy was most obvious in the responses provided by university fitness class attendees in Study 1 and was less evident in participant responses in Study 2. A number of plausible explanations can be offered for this observation. First, it is possible that the sample of participants in Study 1 were habitual exercisers who had internalized the importance of regular physical activity into their self-identity whereas the sample used in Study 2 represented a more diverse group with a broader range of exercise habits.[6] Deci and Ryan (1985, 2002) contend that feeling meaningfully connected to others, or belonging to a larger community, prompts the internalization of social norms and values with the self and therefore may be less salient in groups such as those in Study 1 where behaviour is already habitual.

A second possible explanation concerns the timing and nature of the instruments used to measure perceived relatedness across this investigation. The use of different instruments in this investigation may have impacted the nature of the

6. Although not a direct test of this assertion, the self-report physical activity data derived from the GLTEQ completed by participants in Study 2 lends credence to this assertion given that 50% of the sample did not engage in more than two sessions of strenuous exercise or five sessions of moderate exercise on a weekly basis.

7. We appreciate the insight of an anonymous reviewer of our original submission for bringing this point to our attention.

relationships evident between perceived psychological need satisfaction and exercise-affect. It also seems plausible that the timing of test administrations in Study 1 may have impacted the sense of relatedness exercisers felt to one other given that they completed this assessment early in the exercise class schedule.[7] Future studies would do well to explore the importance of timing associated with test administration and sample heterogeneity in terms of exercise history to reveal greater insight into the impact of perceived psychological need satisfaction on exercise-affect at different stages of the exercise adoption process. Careful attention should also be afforded in these endeavours to the selection of suitable instruments to assess psychological need satisfaction in exercise contexts to prevent obfuscation of the literature in this area.

Both the SEM and regression analyses conducted in the present studies support the role afforded perceptions of psychological need satisfaction within exercise contexts in terms of well-being indexed by greater endorsement of positive affect and positive well-being and reduced experiences of psychological distress and negative affect. These findings are largely in line with SDT and emerging research in other domains that supports the centrality of need satisfying experiences to the promotion of well-being (Deci, Ryan, Gagné, Leone, Usunov, & Kornazheva, 2001; LaGaurdia, Ryan, Couchman, & Deci, 2000; Sheldon et al., 2001). Perhaps a greater theoretical interest in this investigation concerns the results of the regression analyses that supported equivalent effects of psychological need satisfying experiences on affective markers of well-being across gender as proposed by Deci and Ryan (1985, 2002). The practical importance of these data concern the unique insight offered into the role of psychological need satisfaction in promoting optimal affective states which have been linked with enduring physical activity behaviour (Biddle et al., 2000). On the basis of this investigation, it would seem prudent to suggest that health professionals interested in cultivating prolonged involvement in exercise behaviour may wish to shape the environment to provide opportunities for satisfying competence, autonomy, and relatedness needs. Future research may wish to expand on this issue by examining the contribution of SDT-based needs in conjunction with other candidate psychological needs to alternative markers of well-being and evaluate the importance of other moderator variables (such as age, cultural orientation, ethnicity, or exercise conditions including mode and intensity for example) to verify the argument that satisfying basic psychological needs as proposed within SDT exerts universal effects on markers of well-being.

Although the findings from the present two studies are theoretically meaningful and hold some practical appeal for promoting optimal affective experiences

via exercise, a number of limitations should be recognized and future directions outlined. First, this investigation employed non-probability based sampling techniques that afford minimal confidence in generalizing the results of the present study. Consequently, the results of the present studies should be regarded as preliminary evidence that warrants replication and extension in different demographic cohorts using more sophisticated sampling procedures where affective experiences have implications for sustaining persistence behaviour (e.g., older adults, rehabilitation clinics, etc.). Second, while SDT's argument that perceived psychological need satisfaction promotes affective experiences seems tenable on the basis of the present findings, the causal implications associated with Deci and Ryan's (1985, 2002) arguments were not directly examined in the present study. Future research could use both longitudinal and experimental research designs to test these assertions given that such design considerations afford greater confidence in the direction of causal flow between psychological need satisfaction and affective experiences.

Finally, the two studies presented in this investigation employed a restrictive range of instruments that tapped merely a portion of the conceptual domain defining affective exercise experiences. Although both PANAS and SEES scores have been linked to positive well-being (Reed & Ones, 2006; Yik et al., 1999), the measurement of exercise-affect remains a controversial issue (Ekkekakis & Petruzzello, 2001) and comprise merely a component of eudaimonic well-being as defined within the framework of SDT (Deci & Ryan, 2002). Future studies would do well to determine the relationship between perceived psychological need satisfaction and a broader range of cognitive and affective experiences such as enhanced physical self-worth and global self-esteem or more discreet emotional qualities such as anxiety and happiness to determine the scope and magnitude of effects attributable to basic psychological need fulfillment on well-being markers.

Overall, the results of the present studies make it apparent that satisfying competence, autonomy, and relatedness needs is linked with an enhanced sense of well-being in the form of positive versus negative affect and positively-laden subjective exercise experiences in exercise contexts. These findings represent an attempt to evaluate the argument that satisfaction of basic psychological needs represents an important foundation for well-being in exercise contexts from the perspective of SDT (Deci & Ryan, 1985, 2002; Ryan, 1995). Although the present investigation is preliminary, it would seem prudent on the basis of these findings to consider structuring environments such that they maximise the opportunity to feel connected, engage in actions volitionally, and feel capable and effective while doing so. Such environments will likely satisfy basic psychological needs for competence, autonomy

and relatedness and consequently promote positive feelings of psychological health and well-being which are logically linked with adherence and participation decisions. Extrapolating from the present investigation, future research will need to consider elaborating on the causal links responsible for well-being promotion through exercise and in this regard SDT's basic psychological needs sub-theory appears promising as a general framework worthy of consideration.

REFERENCES

Aiken, L. S., West, S. G., & Pitts, S. C. (2003). Multiple linear regression. In J. Schinka & W. Velicer (Eds.), *Comprehensive handbook of psychology: Vol. 2. Research methods in psychology* (pp. 483-508). New York: Wiley.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*, 411-423.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*, 497-529.

Blanchard, C. M., Rodgers, W. M., Wilson, P. M., & Bell, G. J. (2004). Does equating total volume of work between two different exercise conditions matter when examining exercise-induced feeling states? *Research Quarterly for Exercise & Sport, 75*, 209-215.

Biddle, S. J. H., Fox, K. R., & Boutcher, S. (2000). *Physical activity and psychological well-being*. London: Routledge.

Bouchard, C., Blair, S. N., & Haskell, W. L. (2007). *Physical activity and health*. Champaign, IL: Human Kinetics.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162). Newbury Park, CA: Sage.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155-159.

Courneya, K. S., & McAuley, E. (1994). Are there different determinants of the frequency, intensity, and duration of physical activity? *Behavioral Medicine, 20*, 84-90.

Crocker, L., & Algina, J. (1986). *Introduction to classical and modern test theory*. Belmont, CA: Wadsworth.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*, 297-234.

Daley, A. J., & Maynard, I. W. (2003). Preferred exercise mode and affective responses in physically active adults. *Psychology of Sport and Exercise*, 4, 347-356.

deCharms, R. (1968). *Personal causation: The internal affective determinants of behavior*. New York: Academic.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.

Deci, E. L., Ryan, R. M., Gagné, M., Leone, D. R., Usunov, J., & Kornazheva, B. P. (2001). Need satisfaction, motivation, and well-being in the work organizations of a former Eastern Bloc country. *Personality and Social Psychology Bulletin, 27*, 930-942.

Ekkekakis, P., & Petruzzello, S. J. (1999). Acute aerobic exercise and affect: Current status, problems, and prospects regarding dose-response. *Sports Medicine, 28*, 337-374.

Ekkekakis, P., & Petruzzello, S. J. (2001). Analysis of the affect measurement conundrum in exercise psychology II: A conceptual and methodological critique of the Subjective Exercise Experiences Scale. *Psychology of Sport and Exercise, 4*, 205-232.

Frederick-Recascino, C. (2002). Self-determination theory and participant motivation in the sport and exercise domain. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 278-294). Rochester, NY: University of Rochester Press.

Gardner, D. G., Cummings, L. L., Dunham, R. B., & Pierce, J. L. (1998). Single item versus multiple item measurement scales: An empirical example. *Educational and Psychological Measurement, 58*, 898-906.

Georgiadis, M. M., Biddle, S. J. H., & Chatzisarantis N. L. D. (2001). The mediating role of self-determination in the relationship between goal orientations and physical self-worth in Greek exercisers. *European Journal of Sport Sciences, 1*, 1-8.

Godin, G., & Shephard, R. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Science, 10*, 141-146.

Hagger, M. S., Chatzisarantis, N., & Harris, J. (2006). From psychological need satisfaction to intentional behavior: Testing a motivational sequence in two behavioral contexts. *Personality and Social Psychology Bulletin, 32*, 131-138.

Hair, J. F., Black, B., Babib, B., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Toronto, Canada: Prentice Hall.

Hu, L., & Bentler, P. M. (1999). Cut-off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Katzmarzyk, P. T., Gledhill, N., & Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. *Canadian Medical Association Journal, 163*, 1435-1440.

La Guardia, J. G., Ryan, R. M., Couchman, C. E., & Deci, E. L. (2000). Within-person variation in security of attachment: A self-determination theory perspective on attachment, need fulfillment, and well-being. *Journal of Personality and Social Psychology, 79*, 367-384.

Lutz, R., Lochbaum, M., & Turnbow, K. (2003). The role of relative autonomy in post-exercise affect responding. *Journal of Sport Behavior, 26*, 137-154.

MacCallum, R. C., & Austin, J. T. (2000). Applications of structural equation modeling in psychological research. *Annual Review of Psychology, 51*, 201-226.

Mackinnon, A., Jorm, A. F., Christensen, H., Korten, A. E., Jacomb, P. A., & Rodgers, B. (1999). A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences, 27*, 405-416.

Marsh, H. W., Hau, K., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's findings. *Structural Equation Modeling, 11*, 320-341.

McAuley, E., & Courneya, K. (1994). The Subjective Exercise Experiences Scale (SEES): Development and preliminary validation. *Journal of Sport and Exercise Psychology, 16*, 163-177.

Morris, J. D. (1979). A comparison of regression prediction accuracy on several types of factor scores. *American Educational Research Journal, 16,* 17-24.

Mullan, E., & Markland, D. (1997). Variations in self-determination across the stages of change for exercise in adults. *Motivation and Emotion, 21,* 349-362.

Mullan, E., Markland, D., & Ingledew, D. K. (1997). A graded conceptualization of self-determination in the regulation of exercise behaviour: Development of a measure using confirmatory factor analysis procedures. *Personality & Individual Differences, 23*, 745-752.

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British Journal of Educational Psychology, 71*, 225-242.

Parfitt, G., & Gledhill, C. (2004). The effect of choice of exercise mode on psychological responses. *Psychology of Sport and Exercise, 2*, 111-117.

Parfitt, G., Rose, E. A., & Markland, D. (2000). The effect of prescribed and preferred intensity exercise on psychological affect and the influence of baseline measures of affect. *Journal of Health Psychology, 5*, 231-240.

Pedhazur, E. J. (1997). *Multiple regression in behavioural research: Explanation and prediction*. Orlando, FL: Harcourt Brace.

Reed, J., & Ones, D. (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7*, 477-512.

Reeve, J. (2002). Self-determination theory applied to educational settings. In E. L., Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 183-203). Rochester, NY: University of Rochester Press.

Ryan, R. M. (1995). Psychological needs and the facilitation of integrative processes. *Journal of Personality, 63*, 397-428.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. In S. Fiske (Ed.), *Annual review of psychology* (Vol. 52, pp. 141-166). Palo Alto, CA: Annual Reviews.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145-172.

Sampson, E. E. (1977). Psychology and the American ideal. *Journal of Personality and Social Psychology, 35*, 767-782.

Sapkota, S., Bowles, H. R., Ham, S. A., & Kohl, H. W. (2005). Adult participation in recommended levels of physical activity—United States, 2001 and 2003. *Morbidity and Mortality Weekly Report, 54*, 1208-1212.

Schwartz, B. (2000). Self-determination: The tyranny of freedom. *American Psychologist, 55*, 79-88.

Sheldon, K. M., & Elliot, A. J. (1999). Goal striving, need satisfaction, and longitudinal well-being: The self-concordance model. *Journal of Personality and Social Psychology, 76*, 492-497.

Sheldon, K. M., Elliot, A. J., Kim, Y., & Kasser, T. (2001). What's satisfying about satisfying events? Comparing ten candidate psychological needs. *Journal of Personality and Social Psychology, 80*, 325-339.

Sheldon, K., Williams, G., & Joiner, T. (2003). *Self-determination theory in the clinic: Motivating physical and mental health*. Yale, CT: Yale University Press.

Smith, M. B. (1978). Perspectives on selfhood. *American Psychologist, 33*, 1053-1063.

Standage, M., Duda, J. L., & Ntoumanis, N. (2005). A test of self-determination theory in school physical education. *British Journal of Educational Psychology, 75*, 411-433.

Watson, D., Clark, L. A., & Tellegren, A. (1988) Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

West, S. G., Finch, J. F., & Curran, P. J. (1995). Structural equation models with non-normal variables: Problems and remedies. In R. H. Hoyle (Ed.), *Structural equation modeling: Concepts, issues, and applications* (pp. 56-75). Thousand Oaks, CA: Sage.

White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review, 66*, 297-333.

Wilson, P. M., & Rodgers, W. M. (2002). The relationship between exercise motives and physical self-esteem in female exercise participants: An application of Self-Determination Theory. *Journal of Applied Biobehavioral Research, 7*, 30-43.

Wilson, P. M., Rodgers, W. M., & Fraser, S. N. (2002). Examining the psychometric properties of the behavioural regulation in exercise questionnaire. *Measurement in Physical Education and Exercise Science, 6*, 1-21.

Wilson, P. M., Rodgers, W. M., Blanchard, C. M., & Gessell, J. G. (2003). The relationships between psychological needs, self-determined motivation, exercise attitudes, and physical fitness. *Journal of Applied Social Psychology, 33*, 2373-2392.

Wilson, P. M., Rodgers, W. M., Fraser, S. N., & Murray, T. C. (2004). The relationship between exercise regulations and motivational consequences. *Research Quarterly for Exercise and Sport, 75*, 81-91.

Wilson, P. M., Rogers, W. T., Rodgers, W. M., & Wild, T. C. (2006). The Psychological Need Satisfaction in Exercise Scale. *Journal of Sport & Exercise Psychology, 28*, 231-251.

Yik, M. S. M., Russell, J. A., & Feldman Barrett, L. F. (1999). Structure of current affect: Integration and beyond. *Journal of Personality and Social Psychology, 77*, 600-619.