The Relationship Between Psychological Needs, Self-Determined Motivation, Exercise Attitudes, and Physical Fitness[1]

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The primary purpose of this study was to examine the relationships between psychological need satisfaction (competence, autonomy, and relatedness), exercise regulations, and motivational consequences proposed by Self-Determination Theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2000). The secondary purpose was to explore changes in these constructs over the course of a 12-week prescribed exercise program. Results indicated competence and autonomy were positively correlated with more self-determined exercise regulations, which in turn were more positively related to exercise behavior, attitudes, and physical fitness. Multiple regression analyses revealed that exercise behavior mediated the relationship between self-determined motives and physical fitness, and both identified and intrinsic exercise regulations contributed significantly to the prediction of attitudes. Paired-sample *t* tests supported modest to large changes in need satisfaction constructs, as well as identified and intrinsic regulations over the 12-week exercise program. These results suggest that SDT is a useful framework for studying motivational issues in the exercise domain.

Despite the well-documented health benefits of regular exercise (Blair & Connelly, 1996), the participation and adherence rates associated with structured exercise programs remain poor (Dishman, 1994). Consequently, understanding why people exercise is a central focus of motivational research in both health and exercise psychology (Dishman, 1994), and calls for more theoretically driven approaches to elucidate the determinants of exercise behavior have been forthcoming (for a review, see Biddle, Fox, & Boutcher, 2000). One theoretical approach that is receiving growing attention in various health promotion domains is self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2000).

[1]The authors thank James R. Whitehead, who provided numerous helpful comments throughout the process of preparing this manuscript. Funding for the study was provided through a grant awarded to Wendy M. Rodgers by the Social Sciences and Humanities Research Council of Canada.

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Journal of Applied Social Psychology, 2003, **33**, 11, pp. 2373-2392.

SDT proposes that motives (called *regulations* in SDT parlance) reside along a self-determination continuum, and specifies the psychological conditions (called *nutriments* in SDT parlance) responsible for motivational development (Deci & Ryan, 1985; Ryan & Deci, 2000). According to the theory, social contexts that satisfy the psychological needs for competence, autonomy, and relatedness nurture the development of more self-determined regulations, which in turn underpin task persistence and psychological well-being (Ryan & Deci, 2000; Sheldon, Elliot, Kim, & Kasser, 2001).

Competence refers to interacting effectively with one's environment by mastering challenging tasks (White, 1959). *Autonomy* involves feeling free to choose one's own behavior, and more importantly, that one's behavior emanates from an internal perceived locus of causality (deCharms, 1968). Finally, relatedness refers to feeling meaningfully connected to others within a given social milieu (Baumeister & Leary, 1995).

According to SDT, motives range along a continuum from being highly controlling to volitionally endorsed (Deci & Ryan, 1985; Ryan & Deci, 2000). In the exercise domain, *external regulation* represents the least self-determined form of extrinsic motivation, and involves exercising to satisfy an external demand. *Introjected regulation*, the next point along the continuum, involves feeling coerced to exercise in order to avoid negative feelings or to support conditional self-worth. Finally, *identified regulation* refers to participating because one values the important benefits associated with exercising, even though the behavior itself is not inherently enjoyable. Conceptually, identified regulation represents the lower boundary of self-determined regulation, but is still considered to be extrinsically motivated because the behavior itself is not enjoyable.

In addition to extrinsic motives, SDT also contends that behavior can be intrinsically motivated. *Intrinsic regulation* refers to participation that is undertaken volitionally for the pleasure, satisfaction, and interest derived from exercise itself (Deci & Ryan, 1985; Ryan & Deci, 2000). From an SDT perspective, all behaviors regulated via intrinsic motives are self-determined. Therefore, intrinsic regulation conceptually represents the upper boundary of self-determined motivation.[3]

The appeal of SDT's continuum is that it facilitates a more refined analysis of the relationship between different regulations and motivational consequences (Deci & Ryan, 1985; Ryan & Deci, 2000; Vallerand, 1999). Given that greater need satisfaction is associated with enhanced psychological well-being and motivational development (Ryan, 1995; Sheldon et al., 2001), it follows that the

[3]In the broader context of self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000), there is another form of extrinsic motivation, termed *integrated regulation*, that occurs "when identified regulations have been fully assimilated to the self" (Ryan & Deci, 2000, p. 62). Conceptually, *integrated regulation* represents a point along the motivational continuum between identified regulation and intrinsic regulation.

motives nurtured by different degrees of need satisfaction underpin various consequences in the exercise domain.

SDT contends that intrinsic regulation predicts the most positive consequences in terms of task persistence and psychological well-being, and evidence in a broad array of domains now supports this contention (for a review, see Vallerand, 1997). Ryan, however, contends that "the lion's share of social development concerns the assimilation of culturally transmitted behavioral regulations and valuations that are neither spontaneous or inherently satisfying" (p. 405). That is to say, in exercise contexts, although some people do enjoy exercising per se, a great deal of exercise behavior is not intrinsically motivated (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Moreover, even though intrinsic regulation is undoubtedly desirable, it seems unlikely that people at the initial stages of exercise adoption participate solely for the satisfaction derived from the exercise itself (Dishman, 1994; Mullen & Markland, 1997). From an SDT perspective, this suggests that people internalize the value associated with regulating exercise behavior, even if such a task is not initially perceived as pleasurable. Therefore, it seems that the quality of regulation associated with both behavioral and psychological consequences of motivation seems worthy of further investigation, particularly in those domains (e.g., exercise) where the target behavior is unlikely to be construed as inherently pleasurable or enjoyable.

Although relatively few studies have examined SDT's propositions in the exercise domain, the available evidence suggests that SDT is a useful framework from which to examine exercise motivation issues (Kowal & Fortier, 2000; Mullen & Markland, 1997; Mullen, Markland, & Ingledew, 1997). For example, research has supported the link between greater need satisfaction and more self-determined motives (Kowal & Fortier, 2000; Li, 1999) and the presence of a self-determined continuum of exercise regulations (Mullen et al., 1997). SDT stipulates that regulations ordered along a continuum should display a pattern of relationships referred to as a *simplex structure* (Ryan, 1995), whereby adjacent points along the continuum are related more positively to one another than distal points. Research by Li and by Mullen et al. supports the presence of an exercise regulation continuum that is consistent with SDT's notion of a simplex structure.

Finally, there is preliminary evidence supporting the link between more self-determined regulations and positive motivational consequences in the exercise domain. For example, people who regularly participate in exercise report more self-determined reasons for exercise involvement (Mullen & Markland, 1997), and more self-determined regulations have been linked positively with higher levels of flow (Kowal & Fortier, 2000) and greater interest in exercise (Li, 1999).

Despite the intuitive appeal associated with SDT, our understanding of the link between identified regulation and various motivational consequences in the exercise domain remains limited (Vallerand, 1999). For example, previous

research has combined the various points along the self-determination continuum into an overall motivational index (Kowal & Fortier, 2000), which limits our understanding of the relationship between different exercise regulations, persistence behavior, and psychological well-being. Furthermore, previous exercise psychology research has focused predominantly on competence and autonomy needs and has largely excluded relatedness needs (Kowal & Fortier, 2000). Therefore, the primary purpose of this study is to extend previous SDT research in the exercise domain by examining the relationships between psychological need satisfaction, exercise regulations positioned along the self-determination continuum, and motivational consequences in the form of exercise behavior, attitudes toward exercise, and physical fitness.

In addition to understanding the impact of endorsing different regulatory styles, determining the influence of the social context on both need satisfaction and exercise regulations across the exercise experience is important for understanding long-term exercise behavior (Mullen & Markland, 1997; Ryan et al., 1997). For example, Mullen and Markland contended that "there is likely to be a shift in an individual's motivational focus from extrinsic to intrinsic between initial exercise adoption and adherence to a program of regular exercise" (p. 350). This notion has some support, given that Ryan et al. demonstrated that extrinsic motives predicted short-term adherence among university fitness center users, but prolonged involvement required the influence of more intrinsic motives. This suggests that, consistent with SDT, people who adhere to exercise behavior over time internalize their reasons for involvement into more self-determined regulations. Despite the appeal of this contention, previous research has relied predominantly on cross-sectional designs that preclude an examination of changes in theoretical constructs (Vallerand, 1999). Consequently, a secondary purpose of this study is to explore changes in psychological need satisfaction and exercise regulation during participation in a structured exercise program.

Our hypotheses are based on previous research (Mullen et al., 1997) and on SDT propositions (Deci & Ryan, 1985; Ryan & Deci, 2000). First, we hypothesize that greater psychological need satisfaction will be associated positively with more self-determined exercise regulations. Second, it is hypothesized that exercise regulation will display a pattern of relationships indicative of a simplex structure, and that both identified and intrinsic exercise regulation will be associated positively with patterns of exercise behavior, physical fitness, and attitudes toward exercise. Consistent with this hypothesis, it is anticipated that the influence of exercise regulations on physical fitness will be mediated by current exercise behavior. Finally, we hypothesize that psychological need satisfaction and self-determined (identified and intrinsic) exercise regulations will increase following adherence to a structured exercise program. No changes are expected in external or introjected regulation since neither motive underpins long-term adherence behavior.

Method

Participants

Participants ($N = 53$; 44 females and 9 males) were volunteers recruited from the local community in a large, urban city located in western Canada.[4] Demographic data suggest that participants were slightly older ($M_{age} = 41.75$, $SD = 10.75$) than samples used in previous self-determination research (Mullen & Markland, 1997). Baseline data indicate that participants, on average, were not particularly physically fit prior to study enrollment. Specifically, body mass index (BMI) values ($M = 27.6$ kg/m^2, $SD = 5.41$ kg/m^2) marginally exceeded the desirable health range, and maximal aerobic capacity (VO_{2max}) test scores ($M = 30.34$, $SD = 8.03$) were indicative of low (<35th percentile) cardiorespiratory fitness (American College of Sports Medicine [ACSM], 1995). These observations were corroborated by self-report data (Leisure Time Exercise Questionnaire scores; Godin & Shepherd, 1985) indicating participants engaged in less frequent exercise ($M = 20.26$, $SD = 20.73$) prior to study enrollment compared with previous research (Hayes, Crocker, & Kowalski, 1999).

Measures

Activity Feeling Scale (AFS). The AFS (Reeve & Sickenius, 1993) is a 14-item self-report measure of the degree of psychological need satisfaction associated with a target activity or social context. The AFS contains four subscales assessing the degree of psychological need satisfaction associated with competence, autonomy, and relatedness, as well as a perceived tension subscale. Following the stem ("Participation in exercise makes me feel . . ."), participants responded to each question on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous research has supported the four-factor structure of the AFS in samples of university students and the internal consistency of each subscale (Cronbach's αs ranged from .53 to .93 across subscales; Reeve & Sickenius, 1993). Following the removal of two competence items and one autonomy item because of low (rs < .35) item-to-total correlations, the internal consistency estimates of each AFS subscale were acceptable at both

[4]Participants in this study were involved in a larger project examining the psychological and physiological consequences of exercising at different intensities and durations over a 12-week structured exercise program. From the initial sample, 7 dropped out because of illness, 3 performed the initial testing and never returned, and 6 stopped for unknown reasons. There were no differences between study adherents and dropouts in terms of BREQ scores (Behavioral Regulation in Exercise Questionnaire; Mullen et al., 1997; Wilk's $\Lambda = .96$), $F(4, 49) = 0.45$, $p > .10$; AFS scores (Activity Feeling Scale; Reeve & Sickenius, 1993; Wilk's $\Lambda = .95$), $F(3, 50) = 0.58$, $p > .10$; exercise behavior, $t_{METS}(53) = -1.01$, $p > .10$; exercise attitudes, $t(53) = -0.83$, $p > .10$; or initial physical fitness as measured by VO_{2max} (maximal aerobic capacity) scores at Time 1, $t(53) = -1.32$, $p > .10$.

time points (competence, $\alpha = .85$ and .93; autonomy, $\alpha = .74$ and .68; relatedness, $\alpha = .75$ and .81). Scores were computed for competence, autonomy, and relatedness by averaging the relevant items per subscale retained from the reliability analysis.[5]

Behavioral Regulation in Exercise Questionnaire (BREQ). The BREQ (Mullen et al., 1997) is a 15-item self-report measure of motivation developed to assess the self-determination continuum in exercise contexts (Deci & Ryan, 1985; Ryan & Deci, 2000). The BREQ contains four subscales that measure external, introjected, identified, and intrinsic regulation of exercise behavior. Following the stem, "Why do you exercise?" participants responded to each item on a 5-point Likert scale ranging from 1 (*not true for me*) to 5 (*very true for me*).

Previous research has supported the BREQ's (Mullen et al., 1997) multidimensional four-factor structure, invariance across gender (Mullen et al., 1997), and the internal consistency of each subscale (αs range from .76 to .90; Mullen & Markland, 1997). Construct validity for the scale has been established through research demonstrating a simplex pattern of relationships between BREQ subscales (Mullen & Markland, 1997). Following the removal of one introjected regulation item that exhibited low corrected item-to-total correlations, the internal consistency of each BREQ subscale was adequate at both time points (external, $\alpha = .84$ and .86; introjected, $\alpha = .67$ and .83; identified, $\alpha = .72$ and 70; intrinsic $\alpha = .93$ and .90).[6] BREQ subscale scores were calculated by averaging the relevant items retained from the reliability analyses.

Leisure Time Exercise Questionnaire (LTEQ). The LTEQ (Godin & Shepherd, 1985) was used to assess patterns of self-reported exercise behavior. The LTEQ contains three questions assessing the frequency of mild, moderate, and strenuous exercise engaged in for a minimum of 15 min during a typical week. An overall exercise behavior score (METS or units of metabolic equivalence) can be calculated by averaging the weighted product of each question as follows: (mild × 3) + (moderate × 5) + (strenuous × 9). Previous research has found this instrument to possess adequate reliability and validity based on correlations with objective indicators of exercise behavior and physical fitness, including exercise monitors and maximal aerobic capacity test scores (Jacobs, Ainsworth, Hartman, & Leon,

[5]The specific items retained from the AFS for use in this study were as follows: competence ("capable," "competent"), autonomy ("free," "I want to do this," "My participation is voluntary"), and relatedness ("involved with friends," "part of a team," "brotherly/sisterly"). The tension subscale was not used since it was deemed irrelevant to the purpose of this study.

[6]Sample items characterizing each of the four BREQ subscales used in this study were as follows: "I exercise because other people say I should" (external, 4 items); "I feel guilty when I don't exercise" (introjected, 3 items); "I value the benefits of exercise" (identified, 4 items); and "I enjoy my exercise sessions" (intrinsic, 4 items). The introjected subscale item that was removed was "I feel like a failure when I haven't exercised in a while," given the low (.21) corrected item-to-total correlation observed in this sample.

1993). The response to each question was multiplied by its corresponding MET value and then summed to form a composite METS score.

Attitudes. Attitudes toward exercise were measured using 9-point Likert type adjective scales that have been used in previous research (Courneya & Bobick, 2000). The stem that precedes the 10 adjective pairs is "Please circle one number on each row that best describes how you feel about exercise . . ." Five items tap instrumental attitudes (*worthless–worthwhile, bad–good, foolish–wise, useless–useful, harmful–beneficial*), and 5 items tap affective attitudes (*dull–interesting, aggravating–calming, unpleasant–pleasant, exhausting–invigorating, boring–fun*). Previous research has suggested that this scale is reliable ($\alpha = .81$) and positively related to both intention and exercise behavior (Courneya & Bobick, 2000). The items were averaged to create an overall attitude toward exercise scale score, and the internal consistency was adequate ($\alpha = .86$).

Physical fitness. Participants completed a maximal aerobic capacity exercise test (VO_{2max}) on a Monark™ cycle ergometer at the start and end of the 12-week structured exercise program. The test proceeds in regular increments of resistance until volitional exhaustion, where the participants indicate that they cannot continue. During the test, expired gases are collected and monitored to determine the ratio of oxygen consumed per minute in relation to a person's body weight. This ratio (expressed in units of $ml/kg/min^{-1}$) indicates the person's current state of training, with higher values indicative of greater physical fitness (ACSM, 1995). A detailed description of the exercise testing protocol employed in this study has been published elsewhere (Bell, Snydmiller, Davies, & Quinney, 1997).

Procedure

Participants were recruited using posters, flyers, and announcements in the local media. All recruitment materials indicated that participants had the opportunity to engage in a 12-week structured exercise program conducted under the supervision of a trained exercise professional at no financial cost. Interested participants contacted the researchers by telephone for further information.

At this point, participants were given the opportunity to ask questions about the study and were screened for inclusion criteria. The inclusion criteria were as follows: (a) participants must be adults (defined as over 18 years of age); (b) healthy to the degree that maximal exercise testing and structured exercise would not exacerbate any existing health conditions; (c) not currently engaging in organized sport; (d) must receive physician clearance to participate; and (e) must be willing to commit to the length of the study. Participants meeting these criteria were scheduled for an orientation session and initial fitness test. At the orientation session, the overall purposes of the study were explained in more detail, and participants were provided an opportunity to ask additional questions concerning the

nature of the study and their participation. At this point, informed consent was obtained and a survey packet containing the study measures was completed. The same procedures were repeated at Time 2 before the second fitness test.

The overall goal of the exercise program was to improve cardiorespiratory fitness using a program of regular exercise on a stationary bike. Participants exercised three times per week for the duration of the 12-week program in the same facility under the supervision of trained exercise specialists. Each participant completed a warm-up and cool-down period prior to starting each exercise session to minimize the potential for injury. Participants' initial fitness scores (VO_{2max}) were used to design individual exercise programs that involved a prescribed intensity (60 revolutions per minute at a fixed resistance), frequency (3 sessions per week), and duration (time in minutes). The duration of each exercise session varied according to the prescribed resistance that was increased every nine sessions.[7]

Results

Preliminary Data Analysis

Prior to running the statistical analysis, the data were screened for missing values and outliers (values greater than 4 *SD* from the *M* on any measure) and were examined to assess the assumptions associated with multiple regression (normality, linearity, and homoscedasticity) in this sample. An inspection of the data indicated that no missing values were present, and no cases presented particular problems on the basis of extreme variable scores. The distributional properties of each variable and a histogram of the standardized residuals indicated that only the external regulation and METS variables deviated marginally from normality. Both variables were normalized using the square-root transformation procedures suggested by Tabachnik and Fidell (2001).

An inspection of a scatterplot of the residuals indicated that both linearity and homoscedasticity assumptions were tenable for all regression analyses, and both variance inflation (1.07 to 1.89) and tolerance (0.53 to 0.97) values suggested that there were no particular problems with multicollinearity in the data. Based on the sample size used in this study ($N = 53$), our observed power in the regression analysis was .79, assuming a given level of alpha ($\alpha = .05$) and a moderate-to-large ($R^2 = .20$) effect size (Cohen, 1969).

[7]Participants were randomly assigned to two training groups based on ventilatory threshold values exhibited during the physical fitness test. One group ($n = 19$) trained at an intensity equivalent to the first ventilatory threshold, and the other ($n = 18$) trained at an intensity equivalent to the second ventilatory threshold. The total amount of work performed by both groups was equated by altering the duration of each exercise session to isolate the effect of different training intensities on physiological adaptations. There were no significant differences between the groups on physical fitness after completing the exercise program, $t_{VO2max}(37) = -1.51, p > .10$.

Descriptive Statistics

Descriptive statistics for all study variables (Tables 1 and 2) were consistent with previous self-determination (Mullen & Markland, 1997; Reeve & Sickenius, 1993) and exercise psychology research examining the influence of attitudes on exercise intentions and behaviors (Courneya & Bobick, 2000).

Relationship Between Psychological Need Satisfaction and Exercise Regulation

The relationships between need satisfaction and exercise regulations proposed by SDT (Deci & Ryan, 1985; Ryan & Deci, 2000) were examined using Pearson correlations. Consistent with our hypothesis, perceived competence was modestly related to identified regulation (r = .29) and more strongly associated with intrinsic regulation (r = .53); whereas, perceived autonomy was moderately correlated only with identified regulation (r = .33). Perceived relatedness was not associated with any of the exercise regulation constructs (rs ranged from .01 to .19).

Relationship Between Exercise Regulation and Behavior

The relationships between exercise regulations and behavioral indexes proposed by SDT (Deci & Ryan, 1985; Ryan & Deci, 2000) were examined using Pearson correlation coefficients (Table 2) and multiple regression analyses (Tables 3 and 4). Identified and intrinsic regulations were moderately correlated with both exercise behavior and physical fitness.

The regression procedures advocated by Baron and Kenny (1986) were employed to examine the mediating influence of exercise behavior on the relationship between exercise regulations and physical fitness. This involved the calculation of three regression equations for both identified and intrinsic regulation that examined the relationships between the predictor variable (identified or intrinsic regulation), the mediator (METS), and the criterion variable (physical fitness).[8] Each equation was computed while controlling for the influence of age and BMI, given that these variables have been linked with both physical fitness and exercise behavior in previous research (Dishman,

[8]Mediation analyses were not conducted for either external regulation or introjected regulation, as they failed to meet the minimum criteria specified by Baron and Kenny (1986). Specifically, there was no significant relationship between external regulation and either physical fitness (β = -.07, p = .60) or METS (β = -.25, p = .10). A similar pattern was observed for the relationship between introjected regulation and physical fitness (β = -.04, p = .77) and METS (β = .01, p = .97). Future research may wish to consider establishing the conditions under which both regulations influence exercise behavior.

Table 1

Relationships Among Self-Determination Theory's Psychological Need Satisfaction and Motivational Continuum Constructs

Variable	*M*	*SD*	1	2	3	4	5	6
1. AFS—autonomy	6.51	0.70	—					
2. AFS—competence	5.04	1.01	.27*	—				
3. AFS—relatedness	3.55	1.31	-.04	.31*	—			
4. BREQ—external regulation	1.53	0.72	-.18	-.16	.01	—		
5. BREQ—introjected regulation	2.42	0.89	.02	.25	.19	.27*	—	
6. BREQ—identified regulation	3.65	0.81	.33*	.29*	.04	-.12	.19	—
7. BREQ—intrinsic regulation	3.33	0.97	.18	.53**	.06	-.20	.17	.65**

Note. AFS = Activity Feeling Scale (Reeve & Sickenius, 1993). BREQ = Behavioral Regulation in Exercise Questionnaire (Mullen et al., 1997). Values represent relationships among constructs at the start of the prescribed exercise training program.
*$p < .05$. **$p < .01$, two-tailed.

Table 2

Bivariate Correlations Between Self-Determination Theory's Exercise Regulations and Motivational Consequences

Variable	METS	Exercise attitudes	Physical fitness
BREQ—external regulation	-.20	-.02	-.09
BREQ—introjected regulation	.05	.13	.10
BREQ—identified regulation	.50**	.66**	.51**
BREQ—intrinsic regulation	.45**	.76**	.53**
M	21.65	7.78	30.63
SD	14.94	0.77	7.01

Note. METS = typical exercise level (weighted Leisure Time Exercise Questionnaire subscales over previous week; Godin & Shepherd, 1985). BREQ = Behavioral Regulation in Exercise Questionnaire (Mullen et al., 1997). Physical fitness = maximal aerobic capacity test scores at program outset (VO_{2max}). Values represent relationships among constructs at the start of the prescribed exercise training program.
**$p < .01$, two-tailed.

1994). The results of these analyses reveal that identified and intrinsic regulations predicted both physical fitness and exercise behavior (Tables 3 and 4) and supported the mediating influence of exercise behavior on exercise-regulation/physical-fitness relationship.

Relationship Between Exercise Regulation and Attitude Toward Exercise

The relationships between exercise regulations and attitudes proposed within SDT (Deci & Ryan, 1985; Ryan & Deci, 2000) were examined using Pearson correlation coefficients (Table 2) and multiple regression analyses (Table 5). Both identified and intrinsic exercise regulations were associated strongly with more favorable attitudes toward exercise behavior. Hierarchical multiple regression analysis examined the influence of each exercise regulation on attitudes toward exercise behavior. Exercise regulations (BREQ scales; Mullen et al., 1997) were entered on four separate steps in the analysis to determine their individual contribution in the prediction of exercise attitudes. The results of this analysis reveal that both identified and intrinsic regulations contributed significantly to the prediction of exercise attitudes in the final model that accounted for 62% of the variance.

Table 3

Regression Analyses Examining the Mediating Influence of Exercise Behavior on the Identified-Regulation/Physical-Fitness Relationship Controlling for Age and BMI Influences

Predictor variable	Adj. R^2	Δ Adj. R^2	β	*t*
Physical fitness (VO_{2max})				
Step 1: $F(2, 51) = 10.83, p < .001$				
Age			-.35	-2.75**
BMI	.36	.36**	-.41	-3.20**
Step 2: $F(3, 50) = 11.86, p < .001$				
Age			-.29	-2.47*
BMI			-.36	-3.08**
Identified regulation	.48	.12**	.38	3.29**
Exercise behavior (METS)				
Step 1: $F(2, 51) = 1.09, p = .35$				
Age			-.03	-0.21
BMI	.01	.01	-.16	-1.01
Step 2: $F(3, 50) = 6.21, p < .001$				
Age			.06	0.39
BMI			-.09	-0.64
Identified regulation	.22	.21**	.51	3.66**
Physical fitness (VO_{2max})				
Step 1: $F(2, 51) = 10.83, p < .001$				
Age			-.35	-2.75**
BMI	.36	.36**	-.41	-3.20**
Step 2: $F(4, 49) = 16.96, p < .001$				
Age			-.32	-3.30**
BMI			-.26	-3.31**
Identified regulation			.13	1.19
METS	.66	.30**	.49	4.65**

Note. BMI = body mass index. METS = typical exercise level (weighted Leisure Time Exercise Questionnaire subscales over previous week; Godin & Shepherd, 1985). Physical fitness = VO_{2max} scores from testing at program outset. Values represent relationships among constructs at study outset.

*$p < .05$. **$p < .01$.

Table 4

Regression Analyses Examining the Mediating Influence of Exercise Behavior on the Intrinsic-Regulation/Physical-Fitness Relationship Controlling for Age and BMI Influences

Predictor variable	Adj. R^2	ΔAdj. R^2	β	t
Physical fitness (VO_{2max})				
Step 1: $F(2, 51) = 12.25, p < .001$				
Age			-.35	-2.75**
BMI	.36	.36**	-.41	-3.20**
Step 2: $F(3, 50) = 12.58, p < .001$				
Age			-.33	-2.93**
BMI			-.31	-2.68*
Intrinsic regulation	.50	.14**	.40	3.62**
Exercise behavior (METS)				
Step 1: $F(2, 51) = 1.09, p = .35$				
Age			-.03	-0.21
BMI	.01	.01	-.16	-1.01
Step 2: $F(3, 50) = 5.28, p < .05$				
Age			-.01	-0.07
BMI			-.06	-0.37
Intrinsic regulation	.15	.14*	.43	2.95**
Physical fitness (VO_{2max})				
Step 1: $F(2, 51) = 10.83, p < .001$				
Age			-.35	-2.75**
BMI	.36	.36**	-.41	-3.20**
Step 2: $F(4, 49) = 17.14, p < .001$				
Age			-.33	-3.60**
BMI			-.29	-3.05**
Intrinsic regulation			.20	2.06*
METS	.68	.32**	.47	4.81**

Note. BMI = body mass index. METS = typical exercise level (weighted Leisure Time Exercise Questionnaire subscales over previous week; Godin & Shepherd, 1985). Physical fitness = VO_{2max} scores from testing at program outset. Values represent relationships among constructs at study outset.

*$p < .05$. **$p < .01$.

Table 5

Regression Analyses Examining the Influence of Motivational Regulations on Exercise Attitudes

Predictor variable	Adj. R^2	Δ Adj. R^2	β	*t*
Step 1: $F(1, 52) = 0.16, p = .89$				
External regulation	.01	.01	-.02	-0.13
Step 2: $F(2, 51) = 0.42, p = .65$				
External regulation			-.05	-0.35
Introjected regulation	.01	.00	.14	0.91
Step 3: $F(3, 50) = 11.52, p < .001$				
External regulation			.08	0.64
Introjected regulation			-.02	-0.15
Identified regulation	.41	.40**	.68	5.75**
Step 4: $F(4, 49) = 119.69, p < .001$				
External regulation			.17	1.69
Introjected regulation			.01	0.05
Identified regulation			.27	2.13*
Intrinsic regulation	.62	.22**	.63	4.99**

Note. BREQ (Behavioral Regulation in Exercise Questionnaire; Mullen et al., 1997) subscales were entered on separate four steps of the regression analysis as predictor variables. Values represent relationships among constructs at the start of the exercise training program.
*$p < .05$. **$p < .01$.

Changes in Exercise Regulation Over the 12-Week Prescribed Exercise Program

Changes in psychological need satisfaction constructs, exercise regulations, and physical fitness indexes (VO_{2max}) over the 12-week structured exercise program were examined using paired-sample *t* tests and effect sizes calculated using the within-group design procedures advocated by Johnson and Eagly (2000). Consistent with our original hypotheses, the results of these analyses (Table 6) indicate that perceptions of competence and relatedness, in conjunction with identified and intrinsic regulations, increased significantly over the 12-week exercise program. Furthermore, physical fitness (VO_{2max}) increased significantly over the 12-week exercise period, supporting the validity of the exercise program used in this study.

Table 6

Descriptive Statistics and t *Values for Psychological Need Satisfaction and Exercise Regulation Variables Over the Course of a 12-Week Structured Exercise Program*

Variable	M_1	M_2	t^a	Effect size[b]
AFS—autonomy	6.43 (0.80)	5.08 (1.19)	6.82**	-1.19
AFS—competence	5.05 (0.93)	6.00 (1.00)	-5.78**	0.69
AFS—relatedness	3.57 (1.15)	4.98 (1.46)	-6.72**	1.46
BREQ—external regulation	1.54 (0.74)	1.63 (0.83)	-1.08	0.19
BREQ—introjected regulation	2.39 (0.77)	2.41 (1.05)	-0.09	0.02
BREQ—identified regulation	3.62 (0.72)	4.10 (0.62)	-5.73**	0.93
BREQ—intrinsic regulation	3.26 (0.98)	3.55 (0.84)	-2.61**	0.42
VO_{2max}	30.34 (8.03)	35.11 (8.54)	-9.98**	1.64

Note. M_1 = Mean variable score at program outset. M_2 = Mean variable score at program completion. Standard deviations are presented in parentheses. The time span between the measurement of all variables was 12 weeks. (N = 37 at both Time 1 and Time 2).

[a] $t = D/(SD_{difference}/\sqrt{N})$, where D = mean difference, $SD_{difference}$ = standard deviation of the difference, N = number of pairs. [b] Effect size = $(M_1 - M_2)/SD_{difference}$ (for details, see Johnson & Eagly, 2000).

**$p < .01$.

Contrary to our original hypotheses, perceived autonomy decreased markedly over the 12-week exercise program. The changes in perceived autonomy, relatedness, identified regulation, and physical fitness scores represent large effect sizes, whereas the change in perceived competence and intrinsic regulation was somewhat smaller by comparison (Cohen, 1969).

Discussion

This study both supports and extends previous exercise psychology research that has examined the relationship between need satisfaction, exercise regulations, and motivational consequences within the framework of SDT (Deci & Ryan, 1985; Ryan & Deci, 2000). The results partially supported most of our initial hypotheses, given the positive relationships exhibited between greater need satisfaction and self-determined exercise regulation; the ordered pattern of relationships among exercise regulation constructs spanning the self-determination

continuum; and the positive relationships between self-determined regulations, exercise behavior, and attitudes. Further support for our original hypotheses was demonstrated through increases in perceived competence and relatedness, as well as identified and intrinsic exercise regulation among participants adhering to the structured exercise program. However, perceptions of relatedness were not associated with either perceived autonomy or exercise regulation in a manner outlined within SDT (Deci & Ryan, 1985; Ryan & Deci, 2000), and perceptions of autonomy were reduced markedly as a function of adherence to the exercise program in this study.

The positive relationships between satisfaction of the psychological needs for competence and autonomy with more self-determined exercise regulations supports previous research (Kowal & Fortier, 2000; Markland, 1999) and theory (Deci & Ryan, 1985; Ryan & Deci, 2000). Furthermore, some support for the simplex pattern of relationships among exercise regulation constructs was evident, particularly at the endpoints of the self-determination continuum, which is consistent, in part, with theoretical expectations and previous research (Mullen et al., 1997; Ryan & Deci, 2000). The lack of significant relationships between all exercise regulation constructs is likely a function of the small sample size employed in the present study. Future research may wish to address this issue carefully using the procedures outlined by Li and Harmer (1996) to test the structural relationships among latent BREQ (Mullen et al., 1997) subscales.

Although these findings partially support our original hypotheses regarding the positive relationships between need satisfaction constructs and exercise regulations, perceived relatedness demonstrated a pattern of relationships with other theoretical constructs that was inconsistent with previous research (Kowal & Fortier, 2000). One possible explanation for these findings is that the measure of perceived relatedness used in this study failed to adequately represent the content of relatedness in the exercise domain. An alternative explanation is that perceived relatedness is not as important in terms of behavioral regulation in exercise contexts. Indeed, recent contentions have argued that perceived relatedness may simply catalyze the internalization of different motives that in the absence of autonomy result in controlling forms of external or introjected regulation (Ryan & Deci, 2000). Future research may consider addressing this issue by developing exercise-specific measures of psychological need satisfaction in line with recent advances in the process of construct validation (Messick, 1995), and conceptual developments that define the appropriate content of each psychological need construct (Baumeister & Leary, 1995; Ryan, 1995; Ryan & Deci, 2000). Such an endeavor would allow a more careful examination of SDT's propositions in the exercise domain and perhaps elucidate the interrelationships among need satisfaction constructs that nurture exercise regulation development (Vallerand, 1999).

Consistent with theoretical arguments (Ryan & Deci, 2000; Vallerand, 1999) and previous research (Kowal & Fortier, 2000), intrinsic regulation appears to

underpin positive motivational consequences in the exercise domain. Our findings also extend previous research (Kowal & Fortier, 2000; Li, 1999) by indicating that identified regulation is associated with positive motivational consequences in the form of more frequent exercise behavior, positive attitudes toward exercise, and overall physical fitness. These results support Ryan's (1995) contentions regarding the importance of identified regulation, and suggest that this form of motivation may nurture desirable patterns of persistence behavior and psychological well-being in the exercise domain. The major practical implication of this finding is that altering dysfunctional exercise habits might be accomplished through the development of identified regulation, which in the present study was favorably linked with satisfying the need for autonomy and competence in a structured exercise context. Future research should address this contention carefully by examining the longitudinal impact of endorsing different exercise regulations that vary in self-determination on both adherence behavior and psychological well-being in the exercise domain.

Consistent with previous research, changes in need satisfaction and more self-determined exercise regulations occurred over the course of completing the prescribed exercise program (Deci & Ryan, 1985; Ryan & Deci, 2000; Ryan et al., 1997). Perceived competence and relatedness along with identified and intrinsic exercise regulations increased, while perceived autonomy decreased over the 12-week period. The overall decrease in perceptions of autonomy was not hypothesized and was likely a function of the prescribed and supervised nature of the context in which the exercise program was conducted. Although the direction of changes in all constructs was not originally anticipated, the magnitude of these changes was quite large, suggesting that both need-satisfaction constructs and self-determined exercise regulations are amenable to change as a result of the social context in which exercise occurs. Future research may wish to consider examining the influence of both prescribed and preferred exercise programs, as well as other characteristics of the social context outlined by SDT (e.g., perceptions of autonomy support) on both motivational development and persistence behavior.

In summary, the purpose of the present study was to examine and extend the evidence linking psychological need satisfaction with exercise regulations, to examine the relationship between different exercise regulations and motivational consequences, and to explore the changes in SDT's constructs over a structured exercise program. The findings suggest that perceptions of competence and autonomy appear to be important for self-determined exercise regulations; identified regulation is linked positively with favorable motivational consequences; and constructs central to SDT appear amenable to change as a function of exercise participation. Overall, the results lend some support to SDT as a viable framework for examining the conditions in which exercise motives develop, as well as the motivational consequences of different exercise regulations.

Consequently, it seems reasonable to suggest that future research examining the influence of psychological need satisfaction and exercise regulations employing SDT as a guiding theoretical framework appears warranted.

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