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Physical Activity Motivation and Behavior Across the Transition to University

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Background: Little longitudinal data about physical activity behavior and motivation exist on the transition from high school to university. This study prospectively examined how physical activity motivation regulations, defined by self-determination theory, and physical activity behavior change from high school to university. Additionally, key antecedents of this change were explored. ***Methods:*** Incoming freshmen to a large northwestern university completed online questionnaires before and after entering university. Questionnaires included measures of psychological need satisfaction, motivation regulations, and self-reported physical activity behavior. ***Results:*** Identified regulation and physical activity behavior decreased and introjected regulation and amotivation increased from high school to university. A self-determination theory-based model was supported using path analysis. Self-determined motivation regulations were positively predicted by competence; external regulation was negatively predicted by autonomy and positively predicted by relatedness; identified and introjected regulations were positively predicted by relatedness; physical activity was positively predicted by intrinsic motivation. ***Conclusions:*** Findings suggest that there is a decline in the value of physical activity and an increase in feelings of guilt and shame associated with not being physically active when students move to university. Fostering perceptions of competence and autonomy across the transition to university are key antecedents to adaptive changes in physical activity motivation.

Keywords: exercise, university students, health, self-determination theory

The transition from high school to university coincides with a significant period of change. A host of new expectations and experiences accompany the environmental and social changes that occur during the transition. Students are faced with both opportunities and challenges associated with moving to a new location, meeting new people, and increased autonomy to make lifestyle decisions. Unfortunately, negative trends in health behaviors are frequently observed during this time period, including problematic drinking (Hingson, Wenxing, & Weitzman, 2009), low levels of physical activity (Bray & Born, 2004), and relatively poor dietary quality (Strong, Parks, Anderson, Winett, & Davy, 2008). Trends of weight gain in university students have also been identified (Butler, Black, Blue, & Gretebeck, 2004), though there is considerable variability in the literature. Weight gain in university students has been specifically linked to decreases in physical activity but seems to be *unrelated* to dietary intake (Butler et al., 2004). Given that physical activity appears to be a defining health behavior implicated in the weight gain/loss of

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university students (Jung, Bray, & Martin Ginis, 2008), as well as providing a multitude of physical, social, and psychological benefits (Physical Activity Guidelines Advisory Committee, 2008), it is an important health behavior to target for this population.

Unfortunately, research has illustrated significant declines in physical activity from mid- to late adolescence (Nelson, Neumark-Stzalner, Hannan, Sirard, & Story, 2006); recent data from the National University Health Assessment (American College Health Association, 2011) indicate that only 9.6% and 12.2% of university students report meeting minimum recommended physical activity levels (i.e., 30 min of moderate activity 5 days a week or 20 min of vigorous activity 3 days a week, respectively). Although cross-sectional data suggest that physical activity levels of university students are substantially lower than those of high school students (Hasse, Steptoe, Sallis, & Wardle, 2004; Physical Activity Guidelines Advisory Committee, 2008), little longitudinal data exist on the transition from high school to university. The research on physical activity behavior of university students has largely been cross-sectional (Baranowski et al., 1999; Bray & Born, 2004; Hasse et al., 2004), reliant on retrospective reports (Han et al., 2008), or initiated after the transition to university (Butler et al., 2004; Jung et al., 2008; Wengreen & Moncur, 2009). Therefore, longitudinal research using a prospective design is needed to examine physical activity behavior both before and after the transition to university. In addition, a specific focus on more vigorous physical activity behavior is appropriate to target the types of activities most likely to produce health effects, particularly for a relatively healthy population.

Physical activity trends demonstrate that it is difficult to maintain adequate levels of physical activity for the majority of adults, including university students. In one recent study, physical activity and healthy eating were not considered high priorities in a sample of relatively fit and largely normal weight university students despite having adequate free time, high exercise self-confidence, positive outcome expectations of exercise, and a desire to exercise more (Strong et al., 2008). Self-regulation may help us understand this apparent paradox, as it has been shown to be a vital component of healthy choices in university student populations (Strong et al., 2008); therefore, one way to better understand physical activity motivation is to examine the different sources (e.g., self or other) that regulate students' exercise behavior.

This perspective on motivation is most clearly delineated by self-determination theory (SDT), which defines different reasons for engaging in a behavior that regulate behavior (Ryan & Deci, 2002, 2007). These motivation regulations can range from being completely self-regulated or determined (i.e., intrinsic motivation) to being completely controlling (i.e., external regulation). The most adaptive form of motivation is intrinsic motivation, made up of self-determined reasons for performing a given behavior. Organismic Integration Theory (OIT) further specifies four distinct forms of extrinsic motivation, which fall along a continuum according to their relative level of self-determination (see Ryan & Deci, 2007). Integrated regulation, considered a self-determined form of motivation, is driven by the assimilation of the activity into one's sense of self. Identified regulation, also considered self-determined, is considered extrinsic because it is driven by value and identification with the activity as important. Introjected regulation stems from the avoidance of guilt or shame or seeking social approval and is considered controlling or non–self-determined. External regulation, the least self-determined and most controlling form of motivation, is regulated by external contingencies (e.g., to satisfy others). Amotivation refers to the absence of intentionality and personal causation or simply a state of being unmotivated, often considered outside the continuum of self-determination.

SDT specifies that more self-determined forms of motivation lead to more adaptive consequences, such as positive affect and long-term behavior. According to the Basic Psychological Needs Theory (BPNT), more adaptive self-determined motivation is derived from the fulfillment of three innate psychological needs to feel competent, autonomous, and related (see Ryan & Deci, 2007). There has been considerable use of SDT in physical activity research with youth and adult populations, with good evidence validating the theoretical propositions above (see Hagger & Chatzisarantis, 2007). For example, one recent study found support for this theoretical sequence in an adolescent sample. Specifically, competence and autonomy need

satisfaction positively predicted autonomous motivation for physical education at Time 1, which subsequently positively predicted autonomous motivation for exercise at Time 2, which, in turn, positively predicted exercise (pedometer step count) at Time 3 (Standage, Gillison, Ntoumanis, & Treasure, 2012). In addition, numerous studies have demonstrated positive associations between autonomous motivation and both self-reported exercise (e.g., Wilson, Rodgers, Fraser, & Murray, 2004) and objectively measured physical activity (e.g., Standage, Sebire, & Loney, 2008).

The use of the SDT perspective to examine physical activity motivation prospectively across the transition to university will extend the current literature by addressing the underlying reasons why students may change their physical activity behaviors during this critical period of development. Therefore, the first purpose of this study was to describe how motivation regulations and self-reported physical activity behavior change across the transition to university. Given physical activity trends, we hypothesized that physical activity would be lower after entry to university. We did not have sufficient evidence to hypothesize how specific motivation regulations would change. The second purpose was to examine the relationships among perceived competence, autonomy, relatedness, motivation regulations, and physical activity behavior across this transition by testing a SDT-based model. We did so using path analysis to test these relationships after the transition to university while controlling for these variables when students were in high school. This allowed us to explain residual change in dependent variables. Based on SDT, we hypothesized that after controlling for Time 1 variables, perceptions of competence, autonomy, and relatedness would positively predict self-determined motivation regulations across the transition and that self-determined motivation regulations would positively predict physical activity behavior across the transition.

Method

Participants

Incoming freshmen at a large university in the Northwest United States comprised the participants in this study. A larger initial sample ($N = 382$) had complete data in the preuniversity data collection; however, the number of participants who also participated in the fall semester of their freshman year was smaller ($N = 244$). Although not ideal, the rate of retention is similar to, and even slightly higher than, other prospective studies on this population (Han et al., 2008). Significant attrition at the second time-point was anticipated due to individuals changing their contact information or not attending the target university. A MANOVA comparing those who did and did not participate in the second data collection on physical activity and motivation regulations at Time 1 identified that those in the second data collection had lower physical activity, intrinsic motivation, identified regulation, and introjected regulation, but the magnitude of these differences was small ($\eta_p^2 = .00–.03$). Examination of group differences on demographic variables revealed that participants who discontinued were slightly more likely to be females ($\eta_p^2 = .01$), but age and race did not differ. Six participants were missing data on more than one item on any given subscale, and these cases were removed. Because the amount of missing data was quite small for each subscale (range: .00%–.04%), we used person mean substitution at the item level to retain the maximum number of participants in the sample and increase power for the multivariate analyses (Hawthorne & Elliott, 2005). Participants comprising the final sample ranged from 18 to 20 years old ($M = 18.65$, $SD = 0.32$). The sample ethnicity was 1.3% African American, 0.8% American Indian, 10.1% Asian, 75.2% European American, 5.5% Latino, 2.5% Pacific Islander, and 2.1% Other. The majority of participants were female (70%) and were varsity athletes in high school (60%).

Procedure

Approval for the study procedures was granted by the institutional review board. Incoming freshmen were e-mailed an invitation to participate in the study. Consenting participants completed an online survey during the late spring or summer before attending university and in early November of the fall semester as a university freshman. The survey took approximately 20 to 30 min to complete. Students were included in a drawing for a local book store gift

certificate as incentive to participate. The data used for the current study represent one portion of a larger study examining the transition to university.

Measures

Motivation regulations. The Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2, Markland & Tobin, 2004) was used to measure exercise motivation regulations based on SDT. The BREQ-2 is composed of four items assessing external regulation (e.g., "I exercise because other people say I should"), three items assessing introjected regulation (e.g., "I feel guilty when I don't exercise"), four items assessing identified regulation (e.g., "I value the benefits of exercise"), four items assessing intrinsic motivation (e.g., "I exercise because it is fun"), and four items assessing amotivation (e.g., "I don't see the point in exercising"). Responses fall on a 5-point scale where 1 corresponds to "not true for me," 3 corresponds to "sometimes true for me," and 5 corresponds to "very true for me"; higher scores represent higher endorsement of each respective regulation. There is good evidence for the validity and reliability of the BREQ (which did not include amotivation) and the BREQ-2 measures using adult samples (Markland & Tobin, 2004). This measure does not include integrated regulation because of difficulty in empirically distinguishing it from identified regulation during initial measurement development.

Need satisfaction. The Psychological Needs Satisfaction in Exercise Scale (Wilson, Rogers, Rodgers, & Wild, 2006) has 18 items and includes six items assessing the degree to which the needs to feel competent ("I feel confident in my ability to do exercises that personally challenge me"), autonomous ("I feel free to exercise in my own way"), and socially connected/related ("I feel connected to the people who I interact with while we exercise together") are satisfied during exercise. Responses to items fall on a 6-point Likert scale ranging from "False" to "True" in considering how one typically feels about exercise. Higher scores reflect a greater degree of satisfaction for each respective need. Support has been reported for the reliability and validity of this measure using university age samples (Wilson et al., 2006).

Physical activity behavior. Self-reported vigorous exercise behavior was assessed using one item from Godin and Shepherd's (1985) Leisure Time Exercise Questionnaire (LTEQ). The item asked participants to respond to the following question on a 7-point scale: "Considering a 7-day period (a week), during your leisure time how often do you engage in any regular activity long enough to work up a sweat (heartbeats rapidly)?" Higher scores represent more vigorous physical activity. This item has been used successfully in previous research with university populations, demonstrating theoretically consistent relationships with SDT-relevant constructs (Ullrich-French, Smith, & Cox, 2011).

Data Analysis

Descriptive statistics were calculated, including means, standard deviations, internal consistency reliabilities, and bivariate correlations among all study variables. To describe the stability of study variables across the two time points, two-way mixed model intraclass correlations were calculated. To test for change in motivation regulations and self-report physical activity behavior across the transition to university, a repeated measures multivariate analysis of covariance (MANCOVA) was conducted using the motivation regulations and physical activity behavior at Time 1 and Time 2 as the within-subjects factors, with gender and high school varsity athlete status included as covariates. Path analysis was used to test the hypothesized relationships among study variables at Time 2. Time 1 scores were entered as predictive variables for each respective Time 2 score to examine autoregressive effects and predict residual change in psychological need satisfaction, motivation, and physical activity. High school varsity athlete status and gender were also entered as predictors of physical activity at Time 2. Based on SDT (Ryan & Deci, 2007) and past literature, errors among the psychological needs (Ullrich-French et al., 2011) and among the motivation regulations that are adjacent to one another on the self-determination continuum were allowed to correlate in the model at Time 2. To assess model fit, we examined absolute (chi square, goodness of fit index [GFI]) and incremental (comparable fit index [CFI]) fit indices, as well as the magni-

tude of residuals (root mean square error of approximation [RMSEA], standardized root-mean-square residual [SRMR]) using Hu and Bentler's (1999) fit criteria. The strength and direction of path coefficients, including indirect effects, and explained variance were also used to assess the model.

Results

See Table 1 for all descriptive statistics. Internal consistency reliabilities were acceptable (α range: .74–.94) for all measures (see Table 1). Data screening revealed that distributions for all variables were approximately normal, with the exception of amotivation, which was kurtotic. A natural log transformation was conducted on amotivation at both time points and used in the primary analyses. Outliers were examined using recommendations of Tabachnik and Fidell (2007). No cases were identified as multivariate outliers based on Mahalanobis distance ($p < .001$) criteria. There were 26 cases that were identified as univariate outliers based on Z score >3 criteria. Analyses run with and without univariate outliers resulted in the same interpretations, so all cases were retained. Although standardized values for multivariate skewness (14.25) and kurtosis (7.07) were significant ($p < .01$), maximum likelihood estimation was used, as it performs well under such conditions (Hu & Bentler, 1998). At Time 1, students reported moderately high self-determined forms of motivation, moderate introjected regulation, and low external regulation and amotivation, moderately high perceptions of competence, autonomy, and relatedness, and moderate physical activity (see Table 1). At Time 2, students reported moderate self-determined forms of motivation and introjected regulation, low external regulation and amotivation, moderately high perceptions of competence, autonomy, and relatedness, and moderate physical activity. The correlations among motivation regulations were largely consistent with theoretical expectations representing a simplex pattern (e.g., intrinsic motivation was positively related to identified regulation and negatively related to external regulation; Ryan & Connell, 1989). Intraclass correlations (ICC) of each variable at the two time points demonstrated moderately high stability (ICC > .50) across the transition, with the

Table 1
Means, Standard Deviations, and Bivariate Correlations Among Study Variables

	T1			T2											
Variable	N	α	Mean (*SD*)	N	α	Mean (*SD*)	Scale	IM	IDR	INT	ER	AM	COMP	AUT	REL	PA
IM	238	.92	3.62 (1.03)	238	.92	3.62 (1.01)	1–5	**0.66****	0.71**	0.25**	−0.04	−0.47**	0.61**	0.38**	0.38**	0.40**
IDR	238	.80	3.58 (0.88)	238	.84	3.39 (0.93)	1–5	0.74**	**0.64****	0.52**	0.14*	−0.42**	0.44**	0.22**	0.38**	0.40**
INT	238	.76	2.33 (0.99)	238	.83	2.51 (1.06)	1–5	0.25**	0.49**	**0.57****	0.42**	−0.16*	0.06	−0.09	0.20**	0.16*
ER	238	.75	1.71 (0.69)	238	.74	1.76 (0.70)	1–5	−0.20*	−0.03	0.31**	**0.46****	0.20**	−0.08	−0.23**	0.13	0.06
AM	238	.85	1.37 (0.59)	238	.81	1.54 (0.70)	1–5	−0.61**	−0.60**	−0.29**	0.12	**0.55****	−0.24**	−0.21**	−0.15*	−0.19**
COMP	238	.93	4.67 (1.11)	238	.94	4.65 (1.10)	1–6	0.64**	0.58**	0.22**	−0.14*	−0.50**	**0.69****	0.52**	0.50**	0.33**
AUT	238	.90	5.35 (0.72)	238	.93	5.25 (0.84)	1–6	0.34**	0.25**	−0.04	−0.28**	−0.27**	0.43**	**0.37****	0.21*	−0.02
REL	238	.92	4.05 (1.27)	238	.93	4.04 (1.31)	1–6	0.43**	0.40**	0.22**	0.00	−0.38**	0.43**	0.19**	**0.54****	0.24**
PA	236	—	3.46 (1.48)	236	—	3.25 (1.66)	1–7	0.46**	0.43**	0.18**	−0.09	−0.41**	0.42**	0.17**	0.19**	**0.41****

Note. α = internal consistency reliability. Scale = measurement scale for each construct. Time 1 correlations below the diagonal. Time 2 correlations above the diagonal. Time 1 and Time 2 intraclass correlations are bold on the diagonal. IM = intrinsic motivation; IDR = identified regulation; INT = introjected regulation; ER = external regulation; AM = amotivation; COMP = perceived competence; AUT = perceived autonomy; REL = perceived relatedness; PA = physical activity.
* $p < .05$. ** $p < .01$.

exception of physical activity (ICC = .41) and perceived autonomy (ICC = .38) demonstrating fair stability.

The repeated measures MANCOVA omnibus test for time was significant, Wilks' $\lambda = .80$, $F(6, 221) = 9.15$, $p < .01$, $\eta_p^2 = .20$. Effect size for this model was moderate. Gender (Wilks' $\lambda = .93$, $F(6, 221) = 2.61$, $p < .05$, $\eta_p^2 = .07$) and high school varsity athlete status (Wilks' $\lambda = .86$, $F(6, 221) = 6.21$, $p < .01$, $\eta_p^2 = .14$) were significant covariates. Follow-up univariate analyses identified decreased ($p < .01$) identified regulation ($\eta_p^2 = .08$) and physical activity ($\eta_p^2 = .03$) and increased ($p < .05$) introjected regulation ($\eta_p^2 = .02$) and amotivation ($\eta_p^2 = .03$). These findings represent relatively modest effect sizes for average change after controlling for gender and high school varsity athletic experience. There was no significant univariate time effect for intrinsic motivation or external regulation (see Table 2). Univariate follow-up analyses on the covariates indicated that at both time points high school athletes had higher ($p < .01$) intrinsic motivation, identified regulation, introjected regulation, and physical activity compared with nonathletes, and females reported higher ($p < .05$) introjected regulation and lower ($p < .05$) physical activity compared with males. There were no significant interactions.

Table 2
Repeated Measures Univariate Follow-Ups for Motivation and Physical Activity With Estimated Marginal Means

Measure	Time	Mean	*SE*	$F(1, 204)$	η_p^2
PA	1	3.57	0.11	7.34**	.03
	2	3.22	0.12		
IM	1	3.66	0.08	0.56	.00
	2	3.61	0.08		
IDM	1	3.56	0.06	20.81**	.08
	2	3.30	0.07		
INTJ	1	2.22	0.07	4.45*	.02
	2	2.36	0.08		
EM	1	1.68	0.05	1.19	.00
	2	1.74	0.05		
AM^	1	0.25	0.03	19.28**	.08
	2	0.36	0.03		

Note. IM = intrinsic motivation; IDR = identified regulation; INT = introjected regulation; EM = external regulation; AM = amotivation; PA = physical activity, ^ AM is transformed; $N = 230$; estimated marginal means control for gender and high school varsity athlete status.
* $p < .05$. ** $p < .01$.

Path analysis testing the hypothesized model resulted in a good model fit ($df = 81$, $\chi^2 = 185.49$, $p < .01$; GFI = 0.92; CFI = 0.97; RMSEA = 0.07; SRMR = 0.08). High school varsity athlete status and gender were not significant predictors of physical activity and were removed from the model. After controlling for Time 1 variables, the paths from perceived competence to intrinsic motivation and identified regulation were significant ($p < .01$) and positive. The path from perceived autonomy to external regulation was significant ($p < .01$) and negative. The paths from perceived relatedness to identified regulation, introjected regulation, and external regulation were significant ($p < .05$) and positive. No significant predictors of amotivation emerged. Finally, the path from intrinsic motivation to physical activity was significant ($p < .05$) and positive. Significant paths and explained variance are displayed in Figure 1. Effect sizes were small to moderate, with explained variance ($R^2 = .11$–$.53$) including both autoregressive effects and predictor variables at Time 2. At Time 2, perceived competence ($\beta = .09$, $p < .01$) and relatedness ($\beta = .04$, $p < .05$) had significant indirect effects on physical activity.

To examine possible direct effects of psychological needs on physical activity, we tested an alternative model including both direct and indirect paths between the three psychological needs and physical activity behavior. This model demonstrated a significantly better ($\Delta\chi^2(3) = 20.56$, $p < .01$) and good fit to the data (GFI = 0.93; CFI = 0.98; RMSEA = 0.07; SRMR = 0.08). The only difference in paths was the additions of significant direct paths from perceived competence ($\beta = .17$, $p < .05$) and perceived relatedness ($\beta = -.21$, $p < .01$) to physical activity and a slight change in the path from intrinsic motivation to physical activity ($\beta = .19$ to $\beta = .18$). In this model, only the indirect path from competence to physical activity at Time 2 remained significant ($\beta = .09$, $p < .01$).

Discussion

This study described how motivation regulations and self-report physical activity behavior change across the transition to university, using a prospective design and conceptualizing motivation from a self-determination theory per-

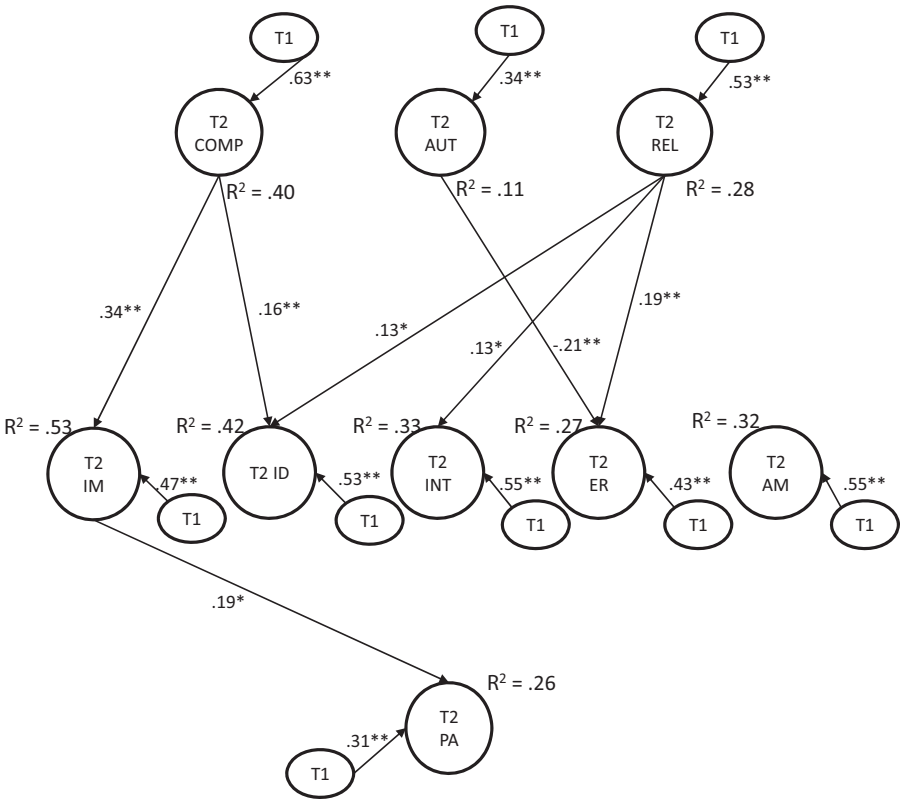

Figure 1. Self-determination theory path model. *Note*. $^{*}p < .05$, $^{**}p < .01$; COMP = perceived competence; AUT = perceived autonomy; REL = perceived relatedness; IM = intrinsic motivation; ID = identified regulation; INT = introjected regulation; ER = external regulation; AM = amotivation; PA = physical activity.

spective. Furthermore, this study used SDT constructs to better explain why changes in physical activity occur during this period of development. Results showed that, on average, students demonstrated a small decline in identified regulation and physical activity, and a small increase in introjected regulation and amotivation. The hypothesized model fit the data well; however, not all paths were as expected. Competence was positively associated with both forms of autonomous motivation, autonomy was negatively associated with external regulation only, and relatedness was positively associated with identified, introjected, and external regulations. Intrinsic motivation was the only significant predictor of physical activity. When direct paths between psychological needs and physical activity were added, the model fit significantly better, with significant direct relationships of both perceived competence and relatedness to physical activity.

Decreased identified regulation suggests a lower interest in, or priority given, to physical activity on entering university. This finding is consistent with the findings of Strong et al. (2008) where students reported low priority for physical activity despite controlling for free time, exercise self-efficacy, positive outcome expectations for exercise, and desire to exercise more. Students' motivation to be physically active in order to avoid feeling guilt or shame (i.e., introjections) and their lack of intention (i.e., amotivation) regarding physical activity increased slightly between high school and university. Introjection has been shown to be a fairly good regulator of physical activity (Gillison, Osborn, Standage, & Skevington, 2009); however, increasing levels of amotivation likely

puts students at risk for decreasing physical activity levels in university. Amotivation can stem from multiple sources, including perceived lack of contingency between behavior and desirable outcomes, the perception that one is not competent to engage in the behavior, or a lack of value for the behavior (Ryan & Deci, 2007). Therefore, increased amotivation could reflect less identification with physical activity in a new context. However, the complexity of amotivation lends itself to multiple interpretations and warrants further work to clarify the interpretation of this finding.

The overall pattern of findings suggests that there is a decline in the value and importance placed on physical activity, but an increase in feelings of guilt and shame associated with not being physically active. This pattern is an example of a shift from relatively more autonomous motivation to more controlled motivation, and could speak to the change in the role and form of physical activity for some students. Those who played sports in high school may have identified as an athlete, and sports likely comprised a major source of physical activity. However, relatively few high school athletes will play sports at the university level in the U.S. (National Collegiate Athletic Association, 2012). It is not surprising that the value of physical activity will change if the role of physical activity changes. This motivational shift is supported by research identifying high school athletes' disengagement from or loss of sport associated with problems with adjustment to university (Lubker & Etzel, 2007), decreased vigorous physical activity, and lower levels of athletic identity (Downs & Ashton, 2011). At the same time, it makes sense that during this time of transition in value and identity, one will feel shame and guilt associated with physical activity, which comprised a highly salient behavior in the past. Consideration of how past physical activity experiences shape future motivation and behavior could be tested in future research.

Although there was a small decline in physical activity behavior across the transition to university, supporting our hypothesis, physical activity levels demonstrated a moderate degree of stability. This pattern indicates that some individuals do less physical activity, but there are also some whose activity levels remain the same or increase on entering university. Thus, there are substantial individual differences in physical activity change across the transition to university that could be at least partly explained by changes in motivation regulations. In line with our hypotheses, intrinsic motivation positively predicted physical activity after controlling for past physical activity. However, no other motivation regulations predicted physical activity. These findings support past work showing that self-determined regulations are the strongest and most consistent predictors of physical activity-related constructs, whereas the predictive utility of non–self-determined regulations is inconsistent (e.g., Ullrich-French & Cox, 2009). The sporadic associations between non–self-determined regulations and physical activity behavior may be due to the multidimensional nature of motivation according to SDT. For example, research findings suggest that the non-self-determined regulations are a negative predictor of physical activity behavior only when self-determined forms of motivation are low (see Ullrich-French & Cox, 2009). A person-centered approach to examine patterns of motivation regulations would be a valuable addition to future research on college student physical activity motivation.

Finally, there was mixed support for the hypothesis that satisfaction of the psychological needs for competence, autonomy, and relatedness would positively predict self-determined motivation regulations across the university transition in line with SDT. Only perceived competence (intrinsic motivation and identified regulation) and relatedness (identified regulation) positively predicted self-determined motivation regulations after controlling for past levels of these regulations. Perceived competence is considered highly salient to both motivation and behavior and is a consistently strong predictor of self-determined motivation (Conroy, Elliot, & Coatsworth, 2007). Furthermore, the salience of perceived competence, over the other psychological needs, to self-determined motivation supports other recent research examining university students (Ullrich-French et al., 2011) as well as physical education students (Taylor, Ntoumanis, Standage, & Spray, 2010). The direct effect of competence on physical activity supports the interpretation that this psychological need is a potent contributor to exercise behavior. This is a common finding that competence directly predicts and is most salient

to behavioral outcomes (e.g., Taylor et al., 2010). The significant indirect effect remained with the addition of the direct path, suggesting that competence is partially mediated by intrinsic motivation and contributes in multiple ways to physical activity behavior. This finding provides partial support for the mediating role of motivation regulations in the relationship between need satisfaction and physical activity behavior. Additionally, this pattern is not inconsistent with BPNT (Ryan & Deci, 2007), which proposes a direct relationship between psychological needs and indices of well-being. Furthermore, it parallels recent research that has demonstrated that fulfillment of psychological needs mediates the relationship between physical activity and well-being (Mack et al., 2012).

We found that relatedness perceptions positively predicted external regulation, which poses some interesting theoretical questions. Research on adolescents in the physical domain has identified relatedness as an important psychological need, demonstrating that it is positively associated with self-determined motivation (e.g., Cox & Williams, 2008), supporting SDT tenets. However, in the present study, increased feelings of social connection were also linked with increased feelings of external pressure to participate in physical activity. One possible interpretation of this finding that is consistent with SDT is that the relatedness need is likely more relevant to the internalization process; that is, relatedness may contribute to long-term patterns but can be more inconsistent in associations with short-term outcomes (Wilson & Rogers, 2007). As Wilson and Rogers (2007) have pointed out, when all psychological needs are included, empirical evidence suggests that perceived relatedness may be more salient to the external regulation of behavior. An additional consideration, according to SDT, is that need satisfaction is a dynamic process, sensitive to context (Deci & Ryan, 2002). It is reasonable to speculate that in a relatively new environment, feeling a sense of belonging and connection could foster a greater awareness of the social setting and thereby trigger initial feelings of social pressure as one adapts to the new context that may over time be internalized as value for the activity; however, clearly more work is needed to understand this finding. It should be noted that external regulation was low for most participants and the "detrimental" effects of feeling socially connected may not be practically significant. The direct negative relationship between relatedness and physical activity suggest that at least in the short term this may be the case. It would be interesting to determine whether these relationships hold over time (i.e., as one gets further from the initial transition point).

Several practical implications emerge from the findings. It is clearly important to foster self-determined motives for physical activity not only during the high school years, but also specifically across the transition to university. University environments can also help deter the decline in autonomous motivation by placing greater value on the importance of physical activity and providing a variety of ways that one can fit activity into a busy schedule. Care should be taken not to induce feelings of guilt or shame. Rather, the focus should be on helping individuals link personally meaningful activities to their lifestyle. Adolescent attitudes about physical activity (i.e., caring about physical activities) have been found to predict behavior up to 10 years later (Graham, Sirard, & Neumark-Sztainer, 2011). Such an emphasis on internalizing the meaning and importance of physical activity may be particularly important during this developmental time period.

Another key practical implication is to intentionally support feelings of physical competence and autonomy, each of which affords both psychological and behavioral benefits. The university transition may promote feelings of pressure and doubt, as students move from being the big fish in the little pond as high school seniors, to the little fish in the large university pond. Creating opportunities for students to learn new skills or activities in a low pressure environment could help foster autonomy and competence and thereby reduce the chance of negative effects owing to potential "upward" comparison to their past high school context or to a more select peer group of university students (see Marsh et al., 2008). In other words, developing new skills and activities at the university level can provide opportunities for students to develop physical activity patterns without the threat to their self-esteem that making comparisons to their past context may induce (see Corcoran, Crusius, & Mussweiler, 2011 for a review of Festinger's Social Comparison Theory). Sport activities may provide a good opportunity

for skill development and are linked with more autonomous motives for university students compared with more traditional exercise-based physical activity (Kilpatrick, Herbert, & Bartholomew, 2005). In particular, intergroup competition (e.g., both cooperative/social- *and* competitive/skill-based) may be especially facilitative of autonomous motivation (Tauer & Harackiewicz, 2004).

There are study limitations that deserve mention. The first is the use of a convenience and self-selecting sample. A larger representation of university students would provide a more representative picture of the transition to university. There was an overrepresentation of female students in the study, though when examined as a covariate gender did not appear to play an influential role in predicting motivation or behavior. It should be noted that the inclusion of more time points would allow us to examine the stability of motivation and behavior over time. Unfortunately, integrated regulation was not included in the measure used in the current study, which captures assimilation of an activity within one's sense of self. The inclusion of this regulation will be helpful in the future to better understand the unique roles of value and identity. In addition, inclusion of more objective and detailed measures of physical activity behavior would greatly enhance our understanding of how need satisfaction and motivation regulations influence specific behaviors. For example, certain regulations may be better predictors of the frequency of physical activity whereas others may relate more closely to the intensity of activity. Similarly, the mode of activity may also be important to consider (i.e., sport, exercise, recreation; Kilpatrick et al., 2005). Another valuable future direction for this work is to consider a person-centered approach taking into account different profiles or combinations of motivational characteristics and behavior.

Conclusions

Physical activity is clearly a difficult behavior to sustain over time. Using a prospective design, we identified that some reasons for participating in physical activity decline across the transition to university, with substantial variability in physical activity behavior patterns. Future research using a longer prospective design examining trajectories of change will be helpful in understanding long-term behavior patterns. Behavior likely fluctuates across the university experience, and thus inclusion of data both before university as well as across the whole university experience would provide a clearer picture of the pathways to persistent lifestyle physical activity patterns. How physical activity fits among other lifestyle choices may be examined by considering associations with other health-related behaviors (e.g., substance use, sleep, diet) and identifying profiles or patterns of risk or resilience. Based on the findings of the current study, health advocates are encouraged to provide a variety of physical activity experiences to both high school and university students that can foster perceptions of competence and autonomy and thereby help students give greater priority to physical activity pursuits.

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