

# Predicting exercise motivation and exercise behavior: A moderated mediation model testing the interaction between perceived exercise variety and basic psychological needs satisfaction

Benjamin D. Sylvester<sup>a,\*,1</sup>, Thomas Curran<sup>b,1</sup>, Martyn Standage<sup>b,1</sup>, Catherine M. Sabiston<sup>a,1</sup>, Mark R. Beauchamp<sup>c,1</sup>

<sup>a</sup> University of Toronto, Canada

<sup>b</sup> University of Bath, United Kingdom

<sup>c</sup> The University of British Columbia, Canada

## ARTICLE INFO

### Keywords:

Physical activity  
Self-determination theory  
Motivation  
Variety

## ABSTRACT

**Objectives:** Perceived variety in exercise predicts exercise behavior through autonomous motivation. However, psychological need satisfaction (viz. for competence, autonomy, and relatedness) may moderate the relationship between perceived variety in exercise and exercise behavior (through autonomous motivation). The purpose of the present study was to examine whether the satisfaction of the basic psychological needs in exercise contexts moderates the mediating role of autonomous exercise motivation in the relationship between perceived variety in exercise and exercise behavior.

**Design:** Cross-sectional.

**Method:** Adults ( $N = 499$ ) completed an online questionnaire to measure the study variables. Associations were examined using structural equation modeling.

**Results:** Psychological need satisfaction moderated the positive indirect relationship between perceived exercise variety and self-reported exercise behavior (via autonomous motivation) such that perceived variety was associated with exercise behavior when psychological need satisfaction scores were lower than average.

**Conclusions:** Based on these findings, perceived exercise variety may act as a compensatory source of motivation when psychological need satisfaction is low. In addition to attempting to foster need-supportive exercise contexts, it may be particularly important for exercise promotion specialists to foster the experience of variety among individuals who have lower psychological need satisfaction.

## 1. Introduction

Engaging in regular exercise is associated with physical and psychological benefits, such as improved muscular and cardiorespiratory function and decreased risk of stress-related illness (World Health Organization, 2010). Yet, most adults do not accrue enough exercise to gain these health benefits (Ding et al., 2016). To better understand how levels of adult exercise behavior might be enhanced, various frameworks have been used to identify salient antecedents (e.g., Rimer & Viswanath, 2015; Standage & Ryan, 2012; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Here, multiple contributors operating at different

levels of influence including social (e.g., support), biological (e.g., genes), demographic (e.g., age), and psychological (e.g., motivation) have been identified as influential antecedents to exercise behavior (see Bauman et al., 2012; Teixeira et al., 2012). One potentially significant antecedent of exercise behavior that has received relatively scant attention in the literature to date is perceived variety (Sylvester et al., 2016). In the current study, we examine the relationship between perceived exercise variety and exercise behavior and provide an empirical test of the theoretical mechanisms that underlie this relationship.

\* Corresponding author. Faculty of Kinesiology & Physical Education, University of Toronto, 55 Harbord Street, Toronto, M5S 2W6, Canada.

E-mail address: [ben.sylvester@utoronto.ca](mailto:ben.sylvester@utoronto.ca) (B.D. Sylvester).

<sup>1</sup> Benjamin Sylvester and Catherine Sabiston are with the Faculty of Kinesiology and Physical Education, The University of Toronto, Canada. Thomas Curran and Martyn Standage are with the Centre for Motivation and Health Behaviour Change, Department for Health, University of Bath, England. Mark Beauchamp is with the School of Kinesiology, The University of British Columbia, Canada. This research was supported by a post-doctoral research fellowship awarded to Benjamin Sylvester by the Social Sciences and Humanities Research Council of Canada, by the Canada Research Chairs program which supports Catherine Sabiston, as well as a career investigator award from the Michael Smith Foundation for Health Research awarded to Mark Beauchamp.

### 1.1. Exercise variety

Researchers have conceptualized variety as the range of tasks and actions that people engage in within a given context (Sheldon & Lyubomirsky, 2012). Variety has been operationalized as a modifiable feature of the environment (e.g., the range of equipment available to use; Juvancic-Heltzel, Glickman, & Barkley, 2013), social context (e.g., diverse tasks structured sequentially; Lyubomirsky & Layous, 2013), and as a subjective perception (i.e., a felt experience; Sylvester, Standage, Dowd et al., 2014). Subjective perceptions of variety are instrumental to understand how the objective environment influences behavior (i.e., through interpretation and evaluation; Pintrich, 2003; Sylvester et al., 2016), and encapsulate the extent to which people feel they experience an array of tasks, actions, and opportunities in a certain context (Sylvester, Standage, Dowd et al., 2014). That is, doing diverse types of exercise such as aerobic, resistance, and flexibility training may foster the felt experience and perception that one engages in a variety of exercise activities.

Self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2002; 2017) provides a useful framework for examining potential links between perceived exercise variety and exercise behavior. Within SDT, it is posited that people have three universal and innate basic psychological needs which, when satisfied, lead to behavioral integration, proactivity, wellness, and optimal functioning (Ryan & Deci, 2002). These psychological needs are for autonomy (i.e., feeling as though one is the causal agent of his or her decisions and behaviors; deCharms, 1968), competence (i.e., feeling confident and capable regarding challenging tasks; White, 1959), and relatedness (i.e., feeling close and connected to people; Baumeister & Leary, 1995). The basic psychological needs are often examined as a unified concept since the satisfaction of all three is necessary for psychological health and wellness (cf. Ryan & Deci, 2000a, 2017). Further, when all three basic psychological needs are satisfied, people have the psychological nutrients required to experience more integrated and autonomous forms of motivation (Ryan & Deci, 2000b). When people engage in exercise activities through integrated sources of motivation they identify with and personally value the outcomes of their engagement – resulting in higher quality exercise behavior (Teixeira et al., 2012).

Perceptions of exercise variety have also been shown to be positively associated with indices of autonomous exercise motivation and exercise behavior (Dimmock, Jackson, Podlong, & Magaraggia, 2013; Juvancic-Heltzel et al., 2013). For example, Dimmock et al. (2013) found that those who expected to experience variety in an exercise session reported greater interest, more enjoyment, and had an increased internal locus of causality compared to those who expected monotony. Similarly, Juvancic-Heltzel et al. (2013) found that providing ten as opposed to two options of equipment to use in a single exercise session resulted in an increased amount of time allocated by participants to exercise as well as a greater volume of work performed. Extending this work, Sylvester, Standage, Ark et al. (2014) found that perceived exercise variety was positively associated with exercise behavior via autonomous exercise motivation when examined alongside perceived autonomy, competence, and relatedness in exercise. The findings from this study provide insight into the relative predictive ability of these constructs in relation to exercise motivation and exercise behavior (Sylvester, Standage, Ark et al., 2014). Through experimental work, Sylvester et al. (2016) demonstrated that perceptions of variety in exercise mediated the relationship between the objective provision of variety (i.e., *variety support*) and exercise adherence in a resistance exercise program. Further, when participants subsequently perceived greater variety they also had greater exercise program engagement (relative to participants in a low variety support comparison exercise program). This body of research points to the important effects of perceived and objective variety in relation to exercise behavior among adults. However, beyond unique effects of variety and psychological need satisfaction on exercise behavior, there is also some supposition

that the relationship between variety and psychological need satisfaction is interactional (Axtell & Parker, 2003).

### 1.2. Interaction of exercise variety with psychological need satisfaction

Across occupational contexts, Axtell and Parker (2003) found that increasing task variety in one's job, without also increasing one's autonomy can have detrimental consequences regarding confidence towards productivity. Further, Merbah and Meulemans (2011) note that in motor learning contexts, increasing variety (i.e., random versus blocked practice schedules) for people who are low in perceived competence, results in slower learning. Finally, without relatedness, increasing the variety of activities one engages in may inhibit the opportunity to build friendships within a given activity (i.e., spending less time together in a single activity; cf. Markiewicz & Doyle, 2016). Hence, higher levels of variety may have detrimental effects on adaptive outcomes when psychological needs for autonomy, competence, and relatedness are not satisfied. For example, in exercise contexts, if someone is not feeling autonomous, competent, or socially connected to others (i.e., is having a poor quality exercise experience) then adding variety to their exercise may have no effect, or even a negative effect, on autonomous motivation and behavior. Conversely, it is possible that variety only contributes to improved motivation and physical activity behavior if, and when, the needs within SDT are supported. Based on SDT and empirical work (e.g., Axtell & Parker, 2003), greater perceived variety in exercise tasks may only lead to high-quality forms of exercise motivation and behavioral engagement in the presence of the satisfaction of autonomy, competence, and relatedness.

### 1.3. The present study

The purpose of the present study was to examine whether satisfaction of the basic psychological needs in exercise contexts moderates the mediating role of autonomous exercise motivation in the relationship between perceived variety in exercise and exercise behavior. Based on previous research findings (e.g., Axtell & Parker, 2003; Juvancic-Heltzel et al., 2013; Sylvester, Standage, Ark et al., 2014) and theory (Ryan & Deci, 2002), we hypothesized that: (i) perceived variety in exercise would be positively associated with exercise behavior; (ii) the positive relationship between perceived variety and exercise behavior would be mediated by autonomous motivation; and (iii) satisfaction of the basic psychological needs would moderate the mediated effect, such that the positive mediation of perceived variety in exercise on exercise behavior by autonomous exercise motivation would be significant at high but not low psychological need satisfaction.

## 2. Methods

### 2.1. Participants and procedures

After receiving ethical approval from a large university institutional review board, community adults were informed of the study through posters (e.g., at community centers), online postings, and verbal invitations (e.g., at community exercise classes), and invited to e-mail the first author if they were interested in participating. To increase variability in our sample, all adults who could speak and write in English were eligible and targeted to invite participation. An online questionnaire including items about demographic information, as well as perceived variety in exercise, basic psychological need satisfaction in exercise, behavioral regulations (i.e., to measure autonomous motivation) in exercise, and exercise behavior, was emailed to consenting participants.

### 2.2. Measures

**Perceived variety in exercise.** The Perceived Variety in Exercise

(PVE) questionnaire (Sylvester, Standage, Dowd et al., 2014) was used to assess exercise variety. Participants were asked to “Please answer the following questions by considering how you typically feel while you are exercising”. The questionnaire includes 5 items such as “I feel like my exercise program is varied” and are anchored on a 6-point Likert-type rating scale with response options from 1 (False) to 6 (True). A latent variable was created in Mplus with higher scores represent higher perceptions of variety.

**Basic psychological need satisfaction.** The Psychological Need Satisfaction in Exercise (PNSE) questionnaire (Wilson, Rogers, Rodgers, & Wild, 2006) was used to assess satisfaction of the participants’ psychological needs for competence (i.e., 6-items; e.g., “I feel capable of completing exercises that are challenging to me”), relatedness (i.e., 6-items; e.g., “I feel connected to the people who I interact with while we exercise together”), and autonomy (i.e., 6-items; e.g., “I feel free to exercise in my own way”) in the context of exercise. Response options for the 18 items ranged from 1 (False) to 6 (True). In the current study, the scores were combined to create latent scores representing satisfaction of the needs for competence, relatedness, and autonomy. Subsequently, the latent scores from each of the three needs were integrated to create a higher order latent variable representing psychological need satisfaction, with higher scores representing higher need satisfaction (see Curran, Hill, & Niemiec, 2013; Ryan & Deci, 2000a).

**Autonomous motivation.** The Behavioral Regulations in Exercise Questionnaire-2R (BREQ-2R; Wilson, Rodgers, Loitz, & Scime, 2006) was used to assess autonomous exercise motivation. Items were scored on a 5-point Likert scale ranging from 0 (Not true for me) to 4 (Very true for me). Higher scores represent higher quality autonomous motivation. Consistent with tenets within SDT (Deci & Ryan, 2008), and previous research (e.g., Barbeau, Sweet, & Fortier, 2009), autonomous motivation was operationalized as the composite of the 12 items within the BREQ-2R reflecting intrinsic regulation, integrated regulation, and identified regulation. In the current study we created latent scores representing each of the three subscales (i.e., intrinsic regulation, 4-items; integrated regulation, 4-items; and identified regulation 4-items) and then integrated the three subscales into a single latent variable representing autonomous motivation (e.g., Barbeau et al., 2009).

**Exercise behavior.** The Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985) was used to measure exercise behavior. The GLTEQ includes 3 items regarding the frequency of mild, moderate, and strenuous exercise lasting at least 15 min per session, in a typical week. Godin (2011) suggested that only moderate and strenuous intensity exercise behavior contribute to health and therefore mild activity was not included and weekly estimates of leisure-time exercise were calculated using the formula [(Moderate  $\times$  5) + (Strenuous  $\times$  9)]. The calculated score was a continuous variable of energy expenditure (i.e., metabolic units) used as an estimate of typical weekly exercise behavior.

### 2.3. Data analysis

Latent moderated structural equation modeling (LMS) was conducted in Mplus (version 8; Muthén & Muthén, 2007) to test our focal hypotheses (Cheung & Lau, 2017). As LMS does not produce indices of absolute model fit, we initially confirmed that our measurement model – containing the latent study variables (i.e., autonomous motivation, psychological need satisfaction, and variety) fit the data well (step 1: Assessment of the measurement model). Conventional standards were employed to assess fit of the measurement model and deemed acceptable if CFI and TLI  $\geq$  .90 and RMSEA and SRMR  $\leq$  .10 (Marsh, Hau, & Wen, 2004). Next, interactions among the predictor latent variables (i.e., psychological need satisfaction and variety) were added to the latent moderated structural equation model that contained the latent mediator (i.e., autonomous motivation) and observed criterion (i.e., exercise behavior) so that the index of moderated mediation could be calculated (step 2: Latent variable moderated mediation). Finally, the

conditional indirect effect of variety on exercise behavior through autonomous motivation was estimated at low ( $-2 SD$ ,  $-1 SD$ ), mean, and high ( $+1 SD$ ,  $+2 SD$ ) levels of psychological need satisfaction (step 3: Probing the conditional indirect effect). All manifest variables were standardized prior to analysis to put them on a common scale. Path estimates and conditional indirect effects were evaluated using bias corrected confidence intervals based on 5000 bootstrap resamples with replacement (Hayes, 2015).

## 3. Results

Participants ( $N = 521$ ) were a convenient sample of adults aged 18–81 years.<sup>2</sup> On average, participants reported being single (51.1%) or married/common law (43.6%); White (76.0%), completed at least a college diploma or university degree (72.7%), had full or part-time employment (64.3%), and had an annual household income less than \$100,000 (75.1%).

### 3.1. Preliminary analyses

A missing value analysis revealed that there were 491 complete cases and 30 incomplete cases. Of the incomplete cases, 11 cases had more than 10% of items missing and were removed from the dataset (Tabachnick & Fidell, 2007). Missing values for the remaining cases with incomplete data were imputed using the Expectation Maximization algorithm at the variable level (Cole, 2008). Following imputation, in accordance with the recommendations of Osborne (2013), univariate and multivariate outliers ( $p < .001$ ) were removed from the dataset ( $n = 11$ ). Although this process resulted in data that were approximately univariate normal, estimates of multivariate kurtosis (Mardia’s normalised coefficient = 1.27,  $p > .05$ ) indicated the data remained multivariate asymmetrical. Accordingly, and in line with LMS, we employed a bootstrapping procedure that drew 5000 replication samples. Bias corrected confidence intervals associated with the correlations and regression coefficients are those derived from the standard errors of this bootstrapping procedure. This data screening and cleaning procedure yielded a final sample of 499 (323 females;  $M_{age} = 34.09$  years;  $SD_{age} = 13.27$  years, and 175 males;  $M_{age} = 33.43$  years;  $SD_{age} = 12.84$  years;  $n = 1$  did not report gender). On average, participants were classified as active ( $M = 38.08$ ;  $SD = 21.11$  metabolic units; Godin, 2011).

### 3.2. Primary analyses

**Step 1: Assessment of the measurement model.** The measurement model consisted of three inter-correlated latent factors. Subscales were used as measured variables for psychological need satisfaction (three indicators; autonomy, competence, and relatedness) and autonomous motivation (three indicators; identified regulation, integrated regulation, and intrinsic motivation). Items were used as the measured variables for variety (five indicators). A correlation between residual

<sup>2</sup> The data reported in the present study is part of a larger program of research designed to examine the effects of perceived variety in exercise contexts. Research on item development, and reliability and validity evidence of scores derived from the PVE questionnaire was previously published in Sylvester, Standage, Dowd et al. (2014) and included data on perceived variety, competence, relatedness, and autonomy in exercise collected at Time 1 and data on exercise-related well-being at Time 2 (i.e., 6 week later). In a follow-up study, we examined Time 1 scores of perceived variety, competence, relatedness, and autonomy in exercise, in relation to Time 2 scores of autonomous and controlled motivation in exercise, and exercise behavior (Sylvester, Standage, Ark et al., 2014). In the current study, we examined a tertiary research question using scores of perceived variety in relation to autonomous motivation and exercise behavior at various levels of basic psychological need satisfaction (i.e., comprised of perceived autonomy, competence, and relatedness scores) in exercise contexts. All variables were measured at Time 1. None of the data on autonomous motivation and exercise behavior at Time 1 were included in previous publications (cf. Sylvester, Standage, Ark et al., 2014; Sylvester, Standage, Dowd et al., 2014).

**Table 1**  
Error-free correlations and composite reliabilities for latent variables and exercise behavior.

Variable	1	2	3	4
1. Variety	.95			
2. Psychological Need Satisfaction	.54**	.63		
3. Autonomous Motivation	.50**	.75**	.86	
4. Exercise Behavior	.29**	.38**	.44**	–

Note. Overall sample ( $N = 499$ ). Correlations for variety, psychological need satisfaction, and autonomous motivation are error-free. \*\* $p < .01$ . Estimates of composite reliability are reported along the diagonal.

terms for variety items 1 (“I feel like I engage in a variety of exercises”) and 2 (“I feel like I try a range of exercises”) was included in the measurement model on empirical grounds, because a chi-square difference test indicated a significant improvement in fit with it added:  $\Delta\chi^2[1] = 216.40, p < .001$ .

All standardized factor loadings for the measured variables on their latent factors were significant (psychological need satisfaction  $\lambda$  range = .38 to .88; autonomous motivation  $\lambda$  range = .76 to .85; variety  $\lambda$  range = .84 to .96). Furthermore, composite reliability of the latent factors ranged from  $\rho = .63$  to  $\rho = .95$  (psychological need satisfaction  $\rho = .63$ ; autonomous motivation  $\rho = .86$ ; variety  $\rho = .95$ ). The measurement model exhibited an acceptable fit to the data:  $\chi^2 = 206.89$  (40),  $p < .001$ ;  $\chi^2/df = 2.74$ ; TLI = .95; CFI = .96; SRMR = .05; RMSEA = .09 (90% CI = .08 to .10), and the error-free correlations between all latent factors were significant and in the expected positive directions (see Table 1).

**Step 2: Latent variable moderated mediation.** Following assessment of the measurement model, we turned to tests of moderated mediation. Here, we included our observed exercise behavior variable and the latent interaction term between variety and psychological need satisfaction to the measurement model and applied the relevant moderated and mediated structural paths (see Fig. 1). Table 2 contains the standard errors,  $t$  values,  $p$  values, and 95% bias corrected confidence intervals (95% BCCI) from 5000 bootstrap iterations. Results showed that regression coefficient  $a_3$  of the latent interaction term for variety and psychological need satisfaction on autonomous motivation was  $-.13$ , 95% BCCI  $[-.27, -.02]$ , and regression coefficient  $b$  of autonomous motivation on exercise behavior was .46, 95% BCCI  $[.33, .60]$ . The regression coefficient  $c'$ , of variety on exercise behavior was .12, 95% BCCI  $[-.00, .24]$ . Of special note, the estimated index of moderated mediation  $a_3b$  was  $-.06$ , 95% BCCI  $[-.12, -.01]$ .

**Step 3: Probing the conditional indirect effect.** Next, we used estimates from the latent variable moderated mediation model to calculate the conditional indirect effect of variety on exercise behavior at various levels of psychological need satisfaction (Preacher, Rucker, & Hayes, 2007). The conditional indirect effect of variety on exercise behavior for the model in Fig. 1 is  $(a_1 + a_3W)b_1$ . We substituted five

levels of psychological need satisfaction in the equation that defines the conditional indirect effect, as follows: (a) mean plus two standard deviations, (b) mean plus one standard deviation, (c) mean, (d) mean minus one standard deviation, and (e) mean minus two standard deviations. The conditional indirect effects at various levels of the moderator are reported in Table 3.

Results show that when psychological need satisfaction was at the mean (.05, 95% BCCI  $[-.01, .11]$ ), one standard deviation above the mean ( $-.00$ , 95% BCCI  $[-.08, .07]$ ), and two standard deviations above the mean ( $-.05$ , 95% BCCI  $[-.16, .05]$ ), the indirect effect of variety on exercise behavior was not significant. However, when psychological need satisfaction was one standard deviation below the mean (.10, 95% BCCI  $[.03, .18]$ ) and two standard deviations below the mean (.15, 95% BCCI  $[.06, .27]$ ), the indirect effect of variety on exercise behavior was significant. These results imply that variety indirectly predicts exercise behavior via autonomous motivation when psychological need satisfaction is low.

**4. Discussion**

In this study, we sought to examine the extent to which basic psychological need satisfaction in exercise moderates the relationship between perceived exercise variety and exercise behavior (via autonomous exercise motivation). We found support for our hypotheses that (i) perceived variety in exercise was positively associated with self-reported exercise behavior, (ii) the positive association between perceived exercise variety and reported exercise behavior was mediated by autonomous exercise motivation, and (iii) the satisfaction of the basic psychological needs in exercise moderated this mediated pathway. However, the direction of the moderating association was contrary to our hypothesis. Overall, perceptions of variety in exercise were positively associated with both autonomous exercise motivation and exercise behavior when scores of basic psychological need satisfaction in exercise were low (i.e., below the mean).

Finding support for our hypotheses regarding a positive relationship between perceived variety in exercise and exercise behavior, and the mediating role of autonomous exercise motivation, is consistent with previous research (e.g., Sylvester, Standage, Ark et al., 2014). Yet, finding a synergistic relationship between perceived variety and psychological need satisfaction in the association between perceived variety and exercise behavior (via autonomous motivation) extends previous work in a number of ways. Despite evidence that variety in workplace settings may not be adaptive in the absence of autonomy, competence, or relatedness (e.g., Axtell & Parker, 2003), in the context of exercise, when scores of psychological need satisfaction were low, there was a stronger relationship between perceived variety in exercise and exercise behavior (via autonomous motivation). One potential explanation for the compensatory role of perceived variety relates to the equifinal principle of basic psychological needs within SDT (Deci &

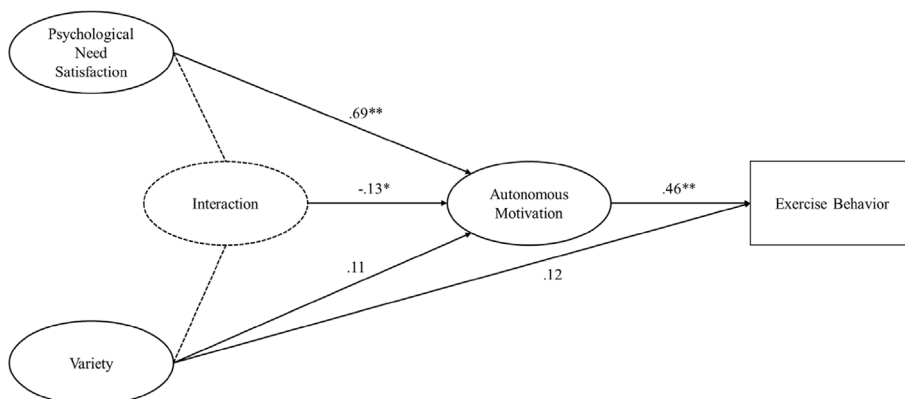


Fig. 1. Results from the latent variable moderated mediation model of exercise behavior. \*\* $p < .01$ , \* $p < .05$ .

**Table 2**  
Estimated model effects and bias-corrected confidence intervals.

	Effect	Std Err	t Value	Norm p	95% BCLL	95% BCUL
Variety on Autonomous Motivation ( $a_1$ )	.11	.07	1.64	.10	-.03	.23
PNS on Autonomous Motivation ( $a_2$ )	.69	.12	5.95	< .001	.50	.97
Interaction on Autonomous Motivation ( $a_3$ )	-.13	.06	-2.22	.03	-.27	-.02
Variety on Exercise Behavior ( $c'$ )	.12	.06	1.90	.06	-.00	.24
Autonomous Motivation on Exercise Behavior ( $b$ )	.46	.07	6.83	< .001	.33	.60
Index of Moderated Mediation ( $a_3b$ )	-.06	.03	-2.17	.03	-.12	-.01

Note: PNS = psychological need satisfaction; Std Err = estimated standard error; norm  $p = p$  value under the assumption of normal distribution; BCLL = lower limit of bias-corrected bootstrap confidence interval; BCUL = upper limit of bias-corrected bootstrap confidence interval.

**Table 3**  
Moderated mediation effect of variety on exercise behavior at various values of psychological need satisfaction.

	$(a_1 + a_3W)b_1$	SE (Boot)	95% BCLL	95% BCUL
+2 $SD_{PNS}$	-.05	.05	-.16	.05
+1 $SD_{PNS}$	-.00	.04	-.08	.07
Mean $_{PNS}$	.05	.03	-.01	.11
-1 $SD_{PNS}$	.10	.04	.03	.18
-2 $SD_{PNS}$	.15	.05	.06	.27

Note. The conditional indirect association is calculated by  $(a_1 + a_3W)b_1$ , where  $a_1$  is the path from variety to autonomous motivation,  $a_3$  is the path from the interaction of variety with basic psychological need satisfaction to autonomous motivation,  $W$  is the value of basic psychological need satisfaction, and  $b_1$  is the path from autonomous motivation to exercise behavior. SE = standard error; BCLL = bias-corrected bootstrap confidence interval lower limit; BCUL = bias-corrected bootstrap confidence interval upper limit.

Ryan, 2000). Specifically, people are growth oriented and have an innate propensity to have their basic psychological needs satisfied (Ryan & Deci, 2002; 2017). When psychological needs are not satisfied, people persistently seek to devise ways to have their needs met. Perhaps when needs are not satisfied, variety (akin to change) has a stronger relationship with exercise behavior via autonomous motivation because a change in activity diverts interest/attention in the short term (e.g., a distraction) and offers (more) potential to have one's psychological needs satisfied. Alternatively, it is possible that the effects of experiencing variety are different in exercise settings to those in the workplace. Indeed, it is possible that in exercise settings, the experience of variety may operate as a compensatory mechanism that can (to some extent) alleviate inhibitory effects from the three basic needs not being met, but in workplace settings may simply compound any deleterious effects that result when those same needs are not met (cf. Axtell & Parker, 2003). Future work examining the potential for a compensatory mechanism of perceived variety is required. Taking the current findings and those of Axtell and Parker (2003) into account, researchers would do well to examine this potential relationship within and across settings.

Within SDT, it is proposed that adaptive outcomes result from all three basic psychological needs being satisfied (Ryan & Deci, 2017). Therefore, perceptions of variety in exercise were expected to be positively associated with autonomous motivation and exercise behavior in the presence of basic psychological need satisfaction. In contrast, we found an indirect relationship between perceived variety and exercise behavior (via autonomous motivation) when individuals felt that their basic psychological need satisfaction was lower than average in exercise contexts (i.e., experiencing variety may be a compensatory mechanism). While Deci and Ryan (2000) discuss the role of negative compensatory mechanisms (e.g., extrinsic aspirations) within SDT, the experience of variety in exercise may be a positive compensatory mechanism that could, in the short-term, somewhat mitigate deleterious associations when psychological needs are not satisfied. In spite of the robust theoretical foundation and a cogent body of empirical research supporting the relationships between psychological need satisfaction, autonomous motivation, and exercise behavior (Standage & Ryan,

2012; Teixeira et al., 2012), Sheldon (2011) highlighted the potential for other types of positive experiences to explain variation in desired outcomes (Sheldon, Boehm, & Lyubomirsky, 2012). The experience of variety may be one such experience that is associated with autonomous motivation and exercise behavior (cf. Sylvester, Standage, Ark et al., 2014; Sylvester et al., 2016).

Dimmock et al. (2013) provide insight into the role of interest as a possible short-term mechanism to explain the moderated pathway between perceived variety and autonomous motivation. In their study, Dimmock and colleagues found that participants who possessed lower levels of intrinsic motivation towards exercise (a less optimal psychological state similar to low psychological need satisfaction) were interested in the exercise activity when they expected to experience variety (compared to those who did not expect variety). The authors concluded that people with high intrinsic motivation towards exercise may be more proficient at self-regulating interest, whereas those with low levels of intrinsic motivation might benefit from variety in the task. Dimmock et al.'s (2013) findings support the notion that in the short term, variety can foster interest in the activity when psychological conditions are maladaptive. Despite the authors not including basic psychological need satisfaction in their analysis, their study does provide insight into the role of variety on interest in a psychologically depleted state.

Consistent with previous research, the experience of variety in exercise was positively associated with exercise behavior (Sylvester, Standage, Ark et al., 2014). However, the direct association between perceived variety and exercise behavior was not statistically significant after controlling for the interaction between perceived variety and psychological need satisfaction. Thus, the interaction effect may take precedence over interpreting the main effect of perceived variety and exercise behavior. Previously, researchers did not take a potential interaction effect between perceived variety and the psychological needs into account when explaining exercise behavior (Sylvester et al., 2016).

With regard to applied implications of this study, the highest levels of exercise behavior may be associated with high feelings of competence, autonomy and relatedness and high perceptions of variety. However, when satisfaction of the psychological needs are lower (compared to higher), the experience of variety is associated with exercise behavior via autonomous motivation. While the current study included a broad sample of adults, one group that may especially benefit from experiencing variety in exercise are those lacking a sense of competence, autonomy, or relatedness. Because the association between perceptions of variety and exercise behavior (via autonomous motivation) was stronger when psychological need satisfaction was lower than average, it is possible that experiencing variety is a strategy for mitigating suboptimal exercise experiences characterized by unsatisfied psychological needs. That is, experiencing variety may help foster autonomous motivation and exercise behavior when one's psychological needs are not satisfied. However, research is needed to test the extent to which these associations are causal.

If these findings are replicated, experiencing variety in exercise may be a valuable recommendation for adults to achieve increased autonomous motivation and behavior and buffer against unsatisfied

psychological needs. While the current research provides insight into the relationships between these variables, to make robust inferences, researchers need to examine potential causal pathways using causal designs (i.e., experimental). Finding that the relationship between the experience of variety and exercise behavior (via autonomous motivation) was moderated by psychological need satisfaction has implications for both exercise psychology researchers, and practitioners. Researchers might want to take variety into account when testing theory-driven models of exercise behavior (via autonomous motivation), as well as practitioners who use SDT principles to promote autonomous motivation and exercise behavior. In the context of these findings, the aim would be to provide need-supportive experiences along with the provision of variety within such environments. To harness the use of variety in applied settings, researchers may want to examine factors that could influence perceptions of variety in exercise such as exercise history (e.g., experience) and skill level, or social factors such as exercising with a variety of people (with various ability levels), in various locations.

#### 4.1. Limitations

In spite of the theoretical and applied implications of this study, there are several noteworthy limitations. The factor loadings and composite reliability estimate of the psychological need satisfaction latent variable scores indicate that findings should be interpreted with some caution. The cross-sectional nature of the data introduces common method variance/bias and prevents inferences of causality. Therefore, researchers are encouraged to interpret the results as representing patterns of association, not causal relationships. Research is warranted to examine the proposed conditional process model using longitudinal and experimental research designs to examine the temporal precedence and causal nature of the proposed relationships. Furthermore, the cross-sectional design also precludes the testing of time-relevant premises within SDT. Specifically, Ryan and Deci (2002) contend that long-term undermining of basic psychological need satisfaction will lead to ill-being, alienation and/or passive engagement. Researchers may wish to examine whether experiencing variety mitigates/buffers against ill effects in exercise contexts over time. Another limitation stems from data being exclusively collected in the context of exercise. Research is needed to confirm whether current findings are generalizable to global and situational levels, as well as other contexts (e.g., academics, relationships, business, and sport). Caution is warranted regarding generalizing findings to contexts other than exercise, as the interaction between perceived variety and basic psychological need satisfaction may differ under diverse contexts (cf. Axtell & Parker, 2003). Future research could address this issue by determining the conditions under which perceived variety and basic psychological need satisfaction interact, and what form such interactions might take under different conditions.

In conclusion, the experience of variety in exercise was associated with higher levels of exercise behavior, and variance in autonomous motivation mediates this association. The relationship between perceived variety and exercise behavior (via autonomous motivation) was moderated by basic psychological need satisfaction. These findings underscore the potential that the experience of variety in exercise holds to improve autonomous motivation and exercise behavior when people do not feel fully volitional in their exercise participation, feel like they could not be more competent at exercise, or feel like they could connect more with their exercise companions.

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