Variety support and exercise adherence behavior: Experimental and mediating effects

Abstract

The purpose of this study was to examine the extent to which the provision of variety (i.e., variety support) is related to exercise behavior among physically inactive adults and the extent to which the 'experience of variety' mediates those effects. One hundred and twenty one inactive university students were randomly assigned to follow a high or low variety support exercise program for six weeks. Assessments were conducted at baseline, 3-weeks and 6-weeks. Participants in the high variety support condition displayed higher levels of adherence to the exercise program than those in the low variety support condition (F (1, 116) = 5.55, p = .02, η_p^2= .05) and the relationship between variety support and adherence was mediated by perceived variety (β = .16, p < .01). Exercise-related variety support holds potential to be an efficacious method for facilitating greater exercise adherence behaviors of previously inactive people by fostering perceptions of variety.

Keywords*:* diverse, physical activity, resistance training, mediation, perceived variety

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Researchers and public health agencies have consistently identified that the vast majority of North American adults are physically inactive (i.e., Centers for Disease Control and Prevention, 2014; Colley et al., 2011) and that physical inactivity is linked to an increased risk for numerous causes of morbidity (and mortality) such as cardiovascular disease and some types of cancer (World Health Organization [WHO], 2009). To address the public health concern ensuing from this global physical inactivity pandemic (Hallal et al., 2012), there have been calls to develop efficacious exercise intervention strategies (Mâsse et al., 2011; WHO, 2007).

One intervention strategy that holds potential for influencing individuals' exercise behavior relates to the provision of variety (e.g., Juvancic-Heltzel et al., 2013). Variety refers to the experience of an assortment or alternation of (novel and familiar) tasks, actions, and opportunities (cf. Juvancic-Heltzel et al., 2013; Sheldon & Lyubomirsky, 2012; Sylvester et al., 2014a). Variety has been examined as both a feature of an activity or environment (i.e., *variety support*; e.g., Lyubomirsky & Layous, 2013), and as an experience (i.e., one's *felt experience*; e.g., Sylvester et al., 2014a). Variety support refers to the manner in which activities, behaviors, and opportunities are structured to facilitate (or thwart) the experience of variety, whereas the experience of variety refers to the extent to which a person feels as though they experience an assortment of tasks, actions, and opportunities. In the present investigation, we focus on both variety support and the experience of variety in the context of exercise.

In previous work, Glaros and Janelle (2001) found that participants who varied their use of aerobic exercise equipment every fortnight for eight weeks adhered to their exercise program more so than participants who did the same aerobic exercise each session. In addition, Juvancic-Heltzel and colleagues (2013) found that participants who encountered greater variety support in a single bout of exercise (i.e., the opportunity to use ten versus two pieces of equipment) spent more time exercising and performed a greater number of repetitions. In these studies the authors structured exercise-related variety support by prescribing variation both between sessions (i.e., changing the mode of exercise from one session to another; Glaros & Janelle, 2001) and within a session (i.e., offering a greater number of exercises in a single bout; Juvancic-Heltzel et al., 2013). Furthermore, Dimmock Jackson, Podlog, and Magaraggia (2013) provided variety support within a single exercise by instructing participants that the second half of a cycling task would require different resources and would be experienced differently than in the first half. Although these studies provide insight in terms of how to structure exercise-related variety support (e.g., Dimmock et al., 2013), and the subsequent effect on exercise behavior (i.e., Glaros & Janelle, 2001; Juvancic-Heltzel et al., 2013), these studies examined exercise-related variety support using atheoretical approaches which limits researchers understanding of the process through which (i.e., why/how) interventionists can change exercise behavior (Rothman, 2004).

One theory that provides insight in terms of the extent to which (and manner through which) various contextual factors lead to exercise behavior (i.e., through psychological experiences) is self-determination theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2002). Embedded within SDT, Ryan and Deci (2002) posit that people have universal and innate basic psychological needs for competence, relatedness, and autonomy, and the extent to which these needs are supported in one's social environment leads to subsequent behavior (through the intermediary role of autonomous motivation). Competence refers to feeling capable and effective in one's environment (Ryan & Deci, 2002; White, 1959), relatedness refers to feeling connected to others (Baumeister & Leary, 1995; Ryan & Deci, 2002), and autonomy refers to feelings of self-governance, and volition in one's choices and behaviors (deCharms, 1968; Ryan & Deci, 2002).

In their conception of SDT, Ryan and Deci (2002) theorized that in any given context, the way in which that context is structured will influence downstream psychological variables and subsequent behavior. While there is mounting empirical evidence supporting the notion that fostering satisfaction of the needs for competence, relatedness, and autonomy in exercise (through social support) leads to exercise behavior (e.g., Teixeira et al., 2012), Sheldon (2011) noted that a lack of research examining alternative/additional psychological experiences that may support adaptive behavior (in addition to satisfaction of the needs for competence, relatedness and autonomy advanced within SDT) is a limitation in the extant SDT literature, and one that should be empirically examined.

The experience of variety may operate as a salient and unique psychological experience worth investigating from an SDT perspective. In the context of exercise, previous work has found that perceived variety is empirically distinct from perceptions of competence, relatedness, and autonomy (Sylvester et al., 2014a). Moreover, perceptions of variety (in addition to satisfaction of basic psychological needs for competence, autonomy, and relatedness) predict variance in indices of exercise-related well-being (e.g., Sylvester et al., 2014a), motivation and exercise behavior (Sylvester et al., 2014b). One of the notable limitations of the studies by Sylvester and colleagues (2014a, 2014b), however, is that they used observational (i.e., non-experimental) designs, which substantively limits inferences of causality. Drawing from the work of Sylvester et al. (2014a, 2014b), theorizing from the perspective of SDT (Ryan & Deci, 2002), as well as observations by Sheldon (2011), the diversity (or invariance) of exercises that one engages in (i.e., exercise-related variety support), may act to facilitate the subsequent experience of variety in exercise, which in turn could have substantive implications for exercise behavior.

Thus, in the present study, we sought to examine the effects of experimentally manipulated variety support in a resistance exercise program in relation to exercise adherence behavior, while first examining the extent to which variety support is differentially related to the experience of variety, when considered in comparison to perceptions of competence, relatedness, and autonomy.

This initial step was designed to provide evidence of discriminant validity, whereby we hypothesized that the provision of variety support in the context of exercise would result in changes in perceived variety, but not in perceived competence, relatedness, and autonomy. Beyond this manipulation check, the main purpose of the study was to examine the effects of variety support in relation to exercise behavior and whether the experience of variety in exercise mediates those effects. This line of enquiry was designed to shed light on whether perceived variety acts as a psychological experience (cf. Sheldon, 2011) that influences (and explains the relationship between variety support and) exercise behavior. Based on Ryan and Deci's (2002) conceptual framework and previous research (e.g., Glaros & Janelle, 2001; Juvancic-Heltzel et al., 2013; Sylvester et al., 2014a, 2014b), we hypothesized that exercise-related variety support would foster perceptions of variety (but not satisfaction of the needs for competence, relatedness, and autonomy) in exercise, as well as exercise adherence behavior. Furthermore, we hypothesized that the relationship between variety support and exercise adherence behavior would be mediated through perceived variety.

Methods

Participants

Following ethical approval from the first author's institutional research ethics board, a sample of university students (n = 144) between the ages of 17 and 38 years old were recruited to participate in the study. To be eligible, participants had to (a) be currently enrolled as a university student, (b) be between the ages of 17 and 40 years old, (c) be able to read and converse in English, (d) report no health risks that would interfere with exercise (as identified by responses to the Physical Activity Readiness Questionnaire for Everyone; PARQ+, Warburton et al., 2011), and (e) be classified as physically inactive (i.e., report two or fewer bouts, of at least 20 minutes, of moderate to vigorous exercise in a typical week; cf. Wilcox et al., 1999).

The final sample (N = 121) was comprised of 87 females (M_{age} = 20.87 years; SD_{age} = 3.09 years) and 34 males (M_{age} = 21.88 years; SD_{age} = 3.57 years). The sample was ethnically diverse, as most participants self-identified as Chinese (n = 43; 35.5%), White (n = 32; 26.4%), multi-racial (n = 17; 14.1%), or Korean (n = 9; 7.4%). Most participants lived on their own off-campus (n = 43; 35.5%), in an on-campus residence (n = 38; 31.4%), or with family (n = 35; 28.9%) and reported being in their third (n = 36; 29.8%), first (n = 32; 26.4%), second (n = 28; 23.1%), or fourth (n = 20; 16.5%) year of university.

Procedure

This study was conducted at a university fitness centre in British Columbia, Canada. Participants attended an introductory session where they were briefed on the study protocol (e.g., that they could drop-in to complete the exercise program at their convenience) and asked to provide written informed consent. They subsequently provided baseline data and were then randomly assigned (through a random number generator) to either a high variety support (HVS) or low variety support (LVS) exercise program (i.e., condition). Participants were blinded to the program conditions. Trained research assistants and employees (i.e., Certified Personal Trainers) at the fitness centre supervised the exercise sessions and monitored participants for safety and technique.

All participants were given the same exercise protocol instructions with regard to exercise frequency, duration, and intensity (e.g., three 1-hour training sessions per week) and both exercise programs were designed to target upper and lower body muscle groups (e.g., chest, legs). To control for volume and intensity, following a warm-up consisting of aerobic exercise, dynamic stretching, and a light set for each exercise, participants were instructed to perform sets of 10 repetitions (of each prescribed exercise) at a selected weight such that a consecutive repetition (i.e., >10) would not be possible without compromising proper technique. As such, to maintain the same relative intensity between participants, the absolute resistance for each given exercise was individually tailored. Participants were provided with an exercise booklet (available from the first author upon request) that had a printed copy of their exercise program as well as information about the study protocol and exercise techniques. The booklet remained at the exercise facility throughout the study for participants to follow their assigned program and record their attendance. Participants were asked to abstain from other strength-training exercise programs over the course of the study (to avoid compromising internal validity). Finally, participants in both conditions completed measures of exercise-related perceived variety and the psychological needs at two time points (i.e., at baseline prior to commencing the exercise program, and at the end of week three (Time 2)) as part of the experimental pretest-midtest-posttest control group design. Those who received LVS served as the control group in this study.

Intervention

The exercise programs were designed to be as identical as possible with the exception of the level of variety support that was provided. Participants in each condition performed the same number of exercise sets and repetitions, at the same relative intensity. The volume of exercise (i.e., 160 total repetitions) was equal for both conditions and was consistent with procedures developed by Sparkes and Behm (2010) who outlined the provision of resistance exercise programs for previously inactive adults within a university setting. The rest intervals (i.e., one-minute) between exercises and sets were also identical for each group. In the HVS condition, however, participants completed varied resistance-based exercises (using machine weights, free weights, and one's own body weight) during each session, while participants in the LVS condition completed the same exercises each session. To foster the experience of variety in exercise, participants in the HVS group engaged in an exercise program designed to (a) alternate exercises between sessions (cf. Glaros & Janelle, 2001), (b) include more diverse exercises within each session (while holding the total number of sets and repetitions in each session equal with the LVS group; cf. Juvancic-Heltzel et al., 2013), and (c) vary within individual exercises by incorporating modifications (cf. Dimmock et al., 2013). Those in the HVS condition had unique combinations of eight exercises to perform each session (two sets of each exercise), which was expected to consistently support the experience of variety throughout the study, while those in the LVS condition repeated the same four exercises each session (four sets of each exercise).

Sample Size Determination

G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) software was used to conduct an a priori power analysis to determine the total sample size necessary for this study. The sample size was selected based on our primary research question regarding the extent to which experimentally manipulated variety support in the context of a resistance exercise program leads to exercise adherence behavior in a sample of physically inactive adults. We used G*power (Faul et al., 2007) to determine that an ANCOVA with $\alpha = .05$, a moderate effect size ($\eta^2 = .06$) based on Glaros and Janelle (2001) and Juvancic-Heltzel et al. (2013), and a conservative power estimate ($\beta = .80$) requires a sample of N = 128. To answer our second research question regarding the extent to which the experience of variety mediates that relationship, we used a single mediation model with a latent variable of the mediator (with the independent variable operationalized as an observed variable reflecting the two experimental conditions and the dependent variable as an observed measure of attendance). For structural equation modeling (SEM), several researchers suggest at least 5 or 10 observations per estimated parameter (Bentler & Chou, 1987; Bollen, 1989); 10 parameters were estimated in our mediation model (i.e., using a conservative approach based on these recommendations, a sample of 100 was required). Others have provided more omnibus recommendations for sample size estimates with SEM, such as suggesting samples of at least 200 (Kline, 2005). However, sample size depends on many factors such as the size of the model (e.g., number of parameters) and the estimated size of effects, with researchers also recently advocating that sample size estimates for SEM models can be smaller in instances with less measurement error (e.g., Wolf, Harrington, Clark, & Miller, 2013). We reduced the risk of Type 1 error by creating a latent variable (to reduce measurement error) and used bootstrapping procedures to estimate indirect effects (Preacher & Hayes, 2008). Bootstrapping analysis is recommended to test for mediation with small sample sizes (e.g., Fritz & MacKinnon, 2007; Shrout & Bolger, 2002). When taken together, our a priori sample of n= 144 was deemed appropriate to address both our primary (effects of variety support on physical activity) and secondary (mediation) research questions, while accounting for modest attrition (final sample n = 121).

Measures

Perceived variety in exercise. Perceived variety in exercise was assessed using the five-item Perceived Variety in Exercise (PVE) questionnaire (Sylvester et al., 2014a). Items on the PVE questionnaire are anchored on a six-point Likert-type rating scale with responses ranging from 1 (*False*) to 6 (*True*). Higher scores reflect greater levels of perceived variety in exercise. In their original instrument development work, Sylvester et al. (2014a) reported ordinal composite reliability (Zumbo et al., 2007) of PVE scores to be .97. In the current study, ordinal composite reliability of the PVE scores was .91 at Time 1 and .94 at Time 2.

Basic psychological needs satisfaction. The Psychological Needs Satisfaction in Exercise (PNSE) questionnaire (Wilson et al., 2006) was used to measure the satisfaction of the needs for competence, relatedness, and autonomy in the context of exercise. The PNSE is an 18-item instrument with each of the three psychological needs measured using six items. Responses to each item are anchored on a scale that ranges from 1 (*False*) to 6 (*True*). Higher scores reflect greater satisfaction of the needs for (perceived) competence, relatedness, and autonomy in exercise. Structural and criterion validity of scores derived from an adult population regarding each subscale of the PNSE was initially reported by Wilson et al. (2006). In the current study, ordinal composite reliability was found to be $\geq .87$ for each of the psychological needs at both Time 1 and Time 2 (see Table 1).

Exercise behavior. Exercise behavior was operationalized as the percentage of recorded adherence to the exercise program over the six-week period. For each exercise session the participants attended (up to 18 sessions over six-weeks), they recorded whether they completed the prescribed exercises in their exercise booklets. Adherence was calculated as a percentage of sessions completed (i.e., total number of sessions completed, divided by the maximum number of sessions (i.e., 18), and multiplied by 100). This variable was used as the dependent measure of exercise behavior.

Exercise behavior at baseline (i.e., Time 1) was measured using the Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985). The GLTEQ is comprised of 3-items that assess the frequency of mild, moderate, and strenuous leisure-time exercise behavior enduring at least 15 minutes per session in a typical week. A score was calculated using the formula [(Mild x 3) + (Moderate × 5) + (Strenuous × 9)] to produce weekly estimates of leisure-time exercise, with higher scores reflecting higher levels of energy expenditure (Godin, 2011). Godin and Shephard (1985) reported support for the validity evidence of adult's GLTEQ scores in the form of positive correlations with estimates of cardiorespiratory fitness (i.e., VO_2max) and negative correlations with body fat scores. Score stability has been examined through test-retest reliability coefficients, which have been found to range from .24 to .96 (Godin & Shephard, 1985; Jacobs et al., 1993).

Data Analysis

In line with our study objective to examine the efficacy of exercise-related variety support on exercise program adherence, participants who attended at least one exercise session (i.e., received the variety support) were included in the analysis. Prior to the main analyses, descriptive data were obtained and Little's chi-square test (Little, 1988) was conducted to examine any potential patterns of missing data using.

Next, to examine whether exercise-related variety support differentially leads to the experience of variety, and/or satisfaction of the needs for competence, relatedness, and autonomy in exercise, we examined a latent variable multivariate analysis of covariance (LVMANCOVA) using *Mplus* 6.11 software. The latent model was utilized to (a) treat the PVE and PNSE data as ordinal, (b) reduce potential bias from measurement error, (c) estimate the model simultaneously and therefore reduce the risk of Type 1 error, and (d) provide sufficient degrees of freedom in the model. Weighted least squares mean and variance-adjusted (WLSMV) method of estimation was used to account for the ordered categorical nature of the Likert-type response scale scores (Finney & DiStefano, 2006). To model ordinal data, a polychoric correlation matrix is considered to be the best option when there are less than seven response options (cf. Beauducel & Herzberg, 2006). Missing data were estimated using all of the available data via the WLSMV algorithm within *Mplus* 6.11.

Based on recommendations by Brown (2006), Hu and Bentler (1999), and Marsh, Hau, and Wen (2004), goodness of fit for the model was assessed using the χ^2 goodness of fit index, the comparative fit index (CFI), Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA). CFI and TLI values greater than .90, and RMSEA values less than .08 were considered to indicate good model-data fit, whereas CFI and TLI values greater than .95, and RMSEA values less than .06 were considered to indicate excellent fit (cf. Hu & Bentler, 1998, 1999). In addition to fit indices, we examined the reliability of the scores through composite reliability (CR) where scores from each item are individually weighted in the composite load (see Bollen, 1989; Fornell & Larcker, 1981). Ordinal composite reliability is based on the polychoric correlation matrix and was assessed to account for the Likert-type response format used in the PVE and PNSE measures (Zumbo et al., 2007).

The LVMANCOVA was used to examine whether exercise-related variety support influenced perceptions of variety, competence, relatedness, and/or autonomy in exercise at Time 2, controlling for within-person (baseline) scores of perceived variety, competence, relatedness, and autonomy in exercise at Time 1. The experimental condition was the independent variable, while latent variables were constructed using multiple categorical items regarding perceived variety (five items), satisfaction of the needs for competence (six items), relatedness (six items), and autonomy (six items). Time 2 scores of perceived variety, competence, relatedness, and autonomy in exercise were the dependent variables, and baseline scores of those variables at Time 1 were specified as covariates.

On the basis of the finding that the intervention resulted in changes in perceived variety, but not the three psychological needs (see Results section), we subsequently conducted an analysis of covariance (ANCOVA) to assess whether there were differences in adherence to the exercise program based on the provision of (high or low) exercise-related variety support. To examine this research question, the experimental condition was specified as the independent variable, scores of exercise program adherence over the six-week intervention was specified as the dependent variable, and gender and baseline scores of exercise behavior at Time 1 were specified as covariates. Exercise adherence behavior was operationalized as an observed variable.

Finally, through a structural equation model we examined whether receiving exercise-related variety support explains variance in adherence to the six-week exercise program, through the mediating role of perceived variety in exercise (measured at Time 2). To examine the full range of adherence scores, we included participants who either completed or dropped out of the intervention at any time (i.e., before or after Time 2 data collection). For those participants who had dropped out of the study before we measured their perceived variety in exercise at Time 2, we imputed the last value obtained from those participants as a conservative estimate (i.e., no manipulation) of the participant's perceived variety in exercise (cf. intention-to-treat analysis recommendations; Unnebrink, & Windeler, 2001). Specifically, we used scores of perceived variety in exercise available from Time 2 ($n = 88$) as the mediator, but if the participant had dropped out of the study by this point, we carried forward their score from Time 1 ($n = 33$; $n_{HVS} = 13$; $n_{LVS} = 20$) to retain their adherence data in the model.

In line with Rucker, Preacher, Tormala, and Petty's (2011) recommendations for testing mediation, the main outcome of interest was the indirect effect of exercise-related variety support on exercise program adherence through perceived variety in exercise. The indirect effect was estimated using Preacher and Hayes' (2008) bootstrapping procedure ($k = 5000$ samples) to construct bias corrected 95% confidence intervals (CIs). Bootstrapping is a non-parametric resampling procedure recommended for estimating indirect effects and CIs, and to optimize statistical power (Preacher & Hayes, 2008).

Results

Of the 144 people who attended the baseline appointment, 121 participants received the exercise-related variety support manipulation (i.e., $n_{HVS} = 58$; $n_{LVS} = 63$) by attending at least one exercise session, and were subsequently included in the analyses. Examination of Little's (1988) test indicated that missing data were Missing Completely at Random (MCAR), χ^2 (502) = 519.20, $p = .289$.

Descriptive statistics for exercise adherence were as follows: $M = 56.80\%$; $SD = 30.71$; skewness = -.144 ($SE = .220$); kurtosis = -1.304 ($SE = .437$). Results from the LVMANCOVA showed that overall, the model had good fit, χ^2 (1015) = 1292.24, $p < .00$, CFI = .96, TLI = .96, RMSEA = .06. Correlations and CR values for the study variables are presented in Table 1. In the LVMANCOVA (see Table 2), after statistically controlling for baseline scores of exercise-related perceived variety, competence, relatedness, and autonomy, there was a statistically significant intervention effect on perceived variety ($\beta = .47$, $p < .001$), but not perceived competence ($\beta = .05$, $p > .05$), relatedness ($\beta = -.04$, $p > .05$), or autonomy ($\beta = .03$, $p > .05$) at Time 2.

An ANCOVA was then conducted to examine potential differences between exercise-related variety support conditions with regard to exercise program adherence, after statistically controlling for gender and baseline scores of exercise behavior as covariates. There was a significant intervention effect on adherence to the program $F(1, 116) = 5.55$, $p = .02$, $\eta_p^2 = .05$, after statistically controlling for gender $F(1, 116) = 0.01$, $p > .05$, $\eta_p^2 = .00$, and exercise behavior at Time 1 $F(1, 116) = 0.05$, $p > .05$, $\eta_p^2 = .00$. Participants who received high variety support had greater exercise adherence than those who received low variety support, M_{HVS} = 64.22%, SD = 30.99; M_{LVS} = 50.89%, SD = 28.80 (see Figure 1). That is, on average participants in the high variety support group completed 11.56 exercise sessions, whereas participants in the low variety support group completed only 9.16 exercise sessions, on average (out of 18).

Finally, we examined whether perceived variety in exercise mediated the relationship between exercise-related variety support and adherence to the exercise program, after statistically controlling for gender and baseline scores of exercise behavior. Overall, the model had excellent fit, χ^2 (23) = 21.56, $p = .55$, CFI = 1.00, TLI = 1.00, RMSEA = .00. In the structural model, exercise-related variety support positively predicted variance in perceived variety in exercise at Time 2 ($\beta = .43$, $p < .001$), which subsequently predicted variance in adherence to the six-week exercise program ($\beta = .37$, $p = .001$; see Figure 2 and Table 3). Neither exercise behavior at Time 1 ($\beta = -.02$, $p > .05$), or gender ($\beta = .01$, $p > .05$), was found to be a statistically significant covariate of exercise adherence behavior over the course of the six-week program. The indirect effect was found to be significant for the relationship between exercise-related variety support and adherence to the program, through perceived variety in exercise ($\beta = .16$, $p < .01$). After statistically controlling for the effects of perceived variety (i.e., the mediator), the direct effect of variety support in relation to exercise adherence was non-significant ($\beta = .07$, $p > .05$), which provided evidence of mediation.

Discussion

The purpose of this study was to examine the extent to which experimentally manipulated variety support in the context of a resistance exercise program leads to the experience of variety (when examined alongside satisfaction of the three psychological needs embedded within SDT; Ryan & Deci, 2002), and exercise adherence behavior in a sample of physically inactive adults. We also sought to examine whether the relationship between variety support and exercise adherence behavior is mediated by perceived variety. The results showed that receiving high (compared to low) exercise-related variety support led to higher perceived variety in exercise, but not satisfaction of the needs for competence, relatedness, or autonomy, three-weeks later. Furthermore, higher variety support led to an increase in exercise adherence behavior over the course of six-weeks and the relationship between variety support and exercise adherence was mediated by perceptions of variety.

The positive effects of variety support on exercise adherence behavior are consistent with findings reported by Glaros and Janelle (2001) who found evidence that providing variety support (i.e., switching the mode of exercise in an aerobic exercise program every two-weeks) leads to improved exercise adherence when compared to thwarting variety support (i.e., by prescribing only one mode of aerobic exercise for eight weeks). Adherence rates in the current study were similar to those reported by Glaros and Janelle (2001), as participants in the high and low variety support conditions in the current study attended 64% and 51% of exercise sessions respectively, compared to 63% and 54% in Glaros and Janelle's (2001) study. The results of our study substantively extend this work by explicating a mechanism through which variety support fosters improvements in exercise behavior. Specifically, from an SDT perspective, Deci and Ryan (2002) posit that satisfaction of the needs for competence, relatedness, and autonomy represent the most salient psychological experiences (i.e., needs) through which well-being, motivation and achievement behavior are supported. The results of the current study provide experimental evidence in support of the contention that perceived variety may act as an *additional psychological experience* (cf. Sheldon, 2011; Sylvester et al, 2014a, 2014b) that might bring about improved exercise behavior. Indeed, these findings may have theoretical implications, as the experience of variety may be an additional type of positive experience (beyond satisfaction of the three basic psychological needs within SDT) that is involved in supporting adherence behavior.

Although the mediation analysis provides valuable insight regarding how and why the intervention had an effect on exercise adherence, plausible additional explanations exist and should be noted. For example, researchers have found empirical evidence that perceptions of variety explain the prospective relationship between perceived variety in exercise and exercise behavior through the mediating role of autonomous motivation (i.e., Sylvester et al., 2014b). Although we did not test an extended multiple mediation model that also included autonomous motivation (e.g., interest/enjoyment inherent within an activity; Ryan & Deci, 2002), future research is warranted that examines the following sequence: exercise-related variety support→ perceived variety in exercise → autonomous motivation toward exercise → exercise behavior. It is also entirely possible that the *absence of variety* (in the LVS condition) may have resulted in reduced adherence via other (physical/physiological) mechanisms. Because our sample was comprised of non-exercisers, we recognized the importance of buffering against factors such as delayed onset muscle soreness (DOMS; Smith, 1992), and we did so by following a three-days-per-week resistance exercise program protocol that was previously conducted with inactive adults within a university setting (Sparkes & Behm, 2010). However, it is entirely possible that participants in this study may have experienced different levels of muscle soreness based on the condition to which they were assigned (due to the specificity of exercises), that in turn may have differentially contributed to their motivation and attendance of subsequent sessions. When taken together, although perceptions of variety were found to mediate the effects of variety support in relation to exercise adherence, other mechanisms warrant greater scrutiny in future research.

Nevertheless, from an applied perspective, the results of this study suggest that the provision of a varied exercise program may be an efficacious intervention strategy for those concerned with health promotion that can influence exercise adherence behavior. In this study, we successfully manipulated the experience of variety through three modalities, namely, varying the exercise activities between sessions (i.e., from bout to bout), within sessions (i.e., prescribing eight versus two exercise activities), as well as prescribing variation within the exercises (e.g., progressions). Within the current research it was not our aim to elucidate the relative importance of each discrete (i.e., micro) method of providing variety support, and instead took a more macro approach to maximizing variety in the HVS condition by operationalizing variety support between sessions, within sessions, and within exercises. Nevertheless, we certainly recognize that in future work it would be particularly informative for researchers to disentangle the unique effects of each method of variety support in their own right.

While the experimental design and the mediation analysis are notable strengths of the study, limitations should also be acknowledged. Specifically, the mediation results should be interpreted with some caution due to the fact that some participants dropped out of the study during the first three-weeks (n = 33). As a conservative approach, we used intent-to-treat analytic procedures (cf. Unnebrink, & Windeler, 2001), by carrying forward the Time 1 scores of the mediator for those participants. Although such an approach is preferable to listwise deletion (Unnebrink & Windeler, 2001), we recognize that dropout from any intervention study represents a challenge to internal validity of a study's findings (Shadish et al., 2002). A second limitation corresponds to the relative short-term nature of the exercise program. Although we used a prospective experimental design, and found significant effects with regard to the efficacy of providing variety support in facilitating exercise behavior over time, it should be noted that the program was limited to six weeks. Given that sustained participation is required to achieve sufficient health outcomes (Physical Activity Guidelines Advisory Committee, 2008), future research is required to examine the efficacy of such (varied) exercise programs over a much longer period of time (i.e., six months or more).

Additionally, caution should be exercised in generalizing the findings beyond physically inactive adults. Although inactive adults represent an important population for intervention (Centers for Disease Control and Prevention, 2014), in future, researchers are encouraged to examine the external validity of variety support as a means of intervention in relation to physical activity adherence behaviors with other populations and in different contexts (e.g., physical education in schools, community exercise programs, adherence to rehabilitation protocols). Finally, while the present study sought to examine a psychological mediator (perceived variety) of the relations between variety support and exercise adherence, future work should also examine potential *moderators* (i.e., boundary conditions) that might interact with variety support in relation to supporting physical achievement outcomes. Such moderators might include variables such as age (children versus adults) and dose of variety. For example, an obvious question is *how much variety* is optimal to support exercise adherence?

Summary

In conclusion, the provision of exercise-related variety support was found to result in improved levels of exercise adherence among a sample of inactive university students, when compared to those who took part in a low variety support exercise program. Furthermore, participants' perceptions of 'felt' variety acted as the psychological mechanism that drove this effect. When taken together the results point to the potential utility of variety support as an efficacious strategy for supporting exercise behavior, with further research now required to examine the long-term (≥ 6 months) effects of this intervention strategy in supporting health-enhancing physical activity, potential moderators, as well as the external validity of this approach with other populations and in different contexts.

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Table 1. Correlations and Reliability Estimates of Study Variables

Variable	CR	1	2	3	4	5	6	7	8	9	10	11
1. Variety Support		--										
2. Variety-T1	.91	-.02	--									
3. Competence-T1	.94	-.08	.67*	--								
4. Relatedness-T1	.92	-.11	.49*	.54*	--							
5. Autonomy-T1	.87	-.09	.52*	.59*	.47*	--						
6. Variety-T2	.94	.42*	.56*	.37*	.27*	.29*	--					
7. Competence-T2	.94	.05	.46*	.68*	.37*	.40*	.60*	--				
8. Relatedness-T2	.95	-.03	.20	.21	.40*	.19	.23	.40*	--			
9. Autonomy-T2	.94	.03	.36*	.41*	.33*	.69*	.58*	.64*	.17	--		
10. Exercise Behavior-T1		-.12	.11	.09	-.07	.17	-.08	.06	.07	-.04	--	
11. Exercise Adherence		.20*	.02	.01	.02	.13	.39*	.19*	.25*	.01	-.05	--

Note. CR = composite reliability; T1 = Time 1; T2 = Time 2. *$p < .05$.

Table 2. Intervention Effects on Perceived Variety, Competence, Relatedness, and Autonomy

Variables	Standardized Estimates	Unstandardized Estimates	*SE*	Bootstrapped 95% Confidence Interval
Effects of Variety Support on:				
Perceived Variety (T2)	.474	.897	.177	**[.668, 1.338]**
Competence (T2)	.053	.085	.179	[-.228, .458]
Relatedness (T2)	-.036	-.056	.161	[-.341, .321]
Autonomy (T2)	.028	.034	.128	[-.233, .282]

Note: Boldface confidence intervals do not contain 0. T2 = Time 2.

Table 3. Direct and Indirect Effects of Variety Support, Covariates, and Perceived Variety on Exercise Adherence

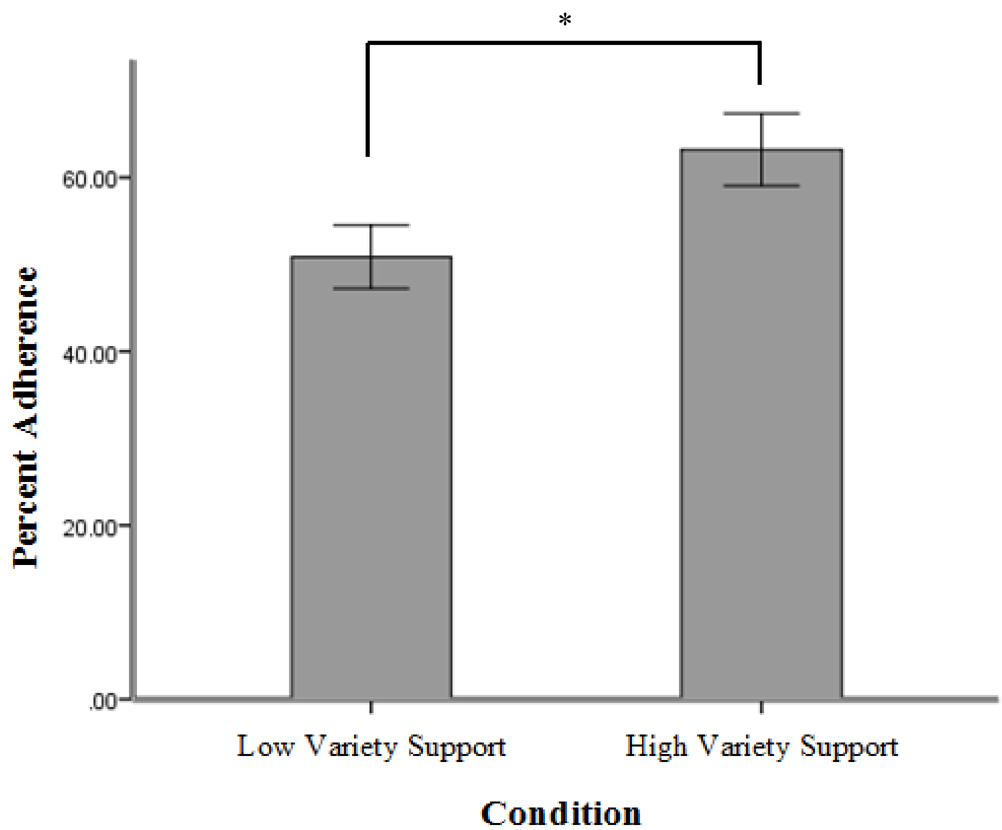
Variables	Standardized Estimates	Unstandardized Estimates	*SE*	Bootstrapped 95% Confidence Interval
Direct Effects on Exercise Adherence				
Variety Support	.065	3.918	5.408	[-6.568, 14.332]
Perceived Variety (T2)	.365	11.460	3.250	**[5.481, 18.251]**
Exercise Behavior (T1)	-.019	-.029	.204	[-.247, .465]
Gender	.010	.673	6.118	[-11.285, 12.775]
Direct Effect on Perceived Variety				
Variety Support	.425	.821	.181	**[.461, 1.166]**
Indirect Effect of Variety Support on Exercise Adherence				
Perceived Variety (T2)	.155	9.405	3.120	**[4.421, 17.246]**

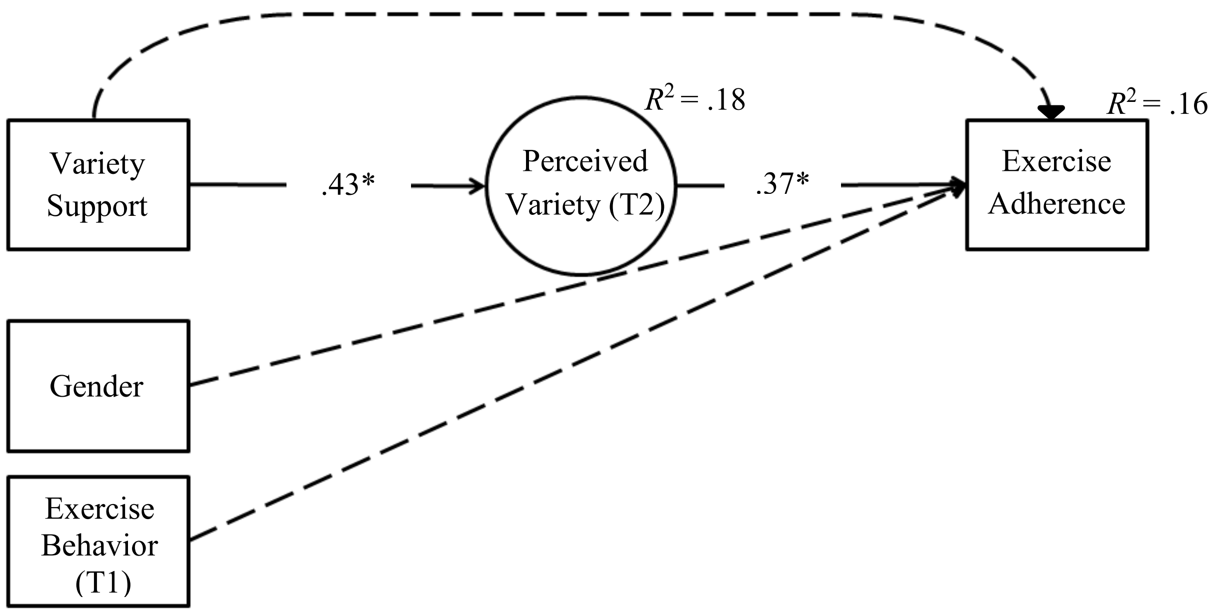
Note: Boldface confidence intervals do not contain 0. T1 = Time 1; T2 = Time 2.

Figure Captions

Figure 1. Dependent variable scores after controlling for gender and exercise behavior at Time 1. Estimated marginal means are reported (i.e., the mean values at post-test include controlling for pre-test measures). Bars denote standard errors. * $p < .01$.

Figure 2. Path diagram of the relationships between exercise-related variety support (i.e., condition) and exercise adherence via perceived variety in exercise at Time 2 (T2) after controlling for gender and exercise behavior at Time 1 (T1) as covariates. Solid lines represent standardized significant path coefficients and dashed lines represent non-significant path coefficients. * $p < .01$.


*
Percent Adherence
60.00
40.00
20.00
.00
Low Variety Support
High Variety Support
Condition


Variety Support
.43*
Perceived Variety (T2)
R^2 = .18
.37*
Exercise Adherence
R^2 = .16
Gender
Exercise Behavior (T1)