



Psychological need satisfaction and thwarting: A test of Basic Psychological Needs Theory in physical activity contexts[☆]

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ABSTRACT

Objectives: To test Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2002) to determine if psychological need thwarting experienced when physically active contributes to the understanding of well-being and ill-being.

Design/method: Participants ($N = 155$, 67.70% female, $M_{\text{age}} = 37.46$ years; $SD_{\text{age}} = 19.89$ years) completed assessments of psychological need satisfaction and thwarting, subjective vitality and positive/negative affect during separate testing sessions separated by 6 months.

Results: Scores from the modified version of the Psychological Need Thwarting Scale (PNTS-PA; Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011) demonstrated discriminant evidence of validity, evidence of internal structure and minimal error variance. Changes in psychological need satisfaction positively predicted positive affect ($R^2 = .16$, $p < .05$), subjective vitality ($R^2 = .13$, $p < .05$) and negatively predicted negative affect ($R^2 = .12$, $p < .05$). Additional regression analyses revealed that changes in psychological need thwarting predicted negative affect ($\Delta R^2 = .11$, $p < .05$), but not positive affect ($\Delta R^2 = .01$, $p > .05$) or subjective vitality ($\Delta R^2 = .04$, $p > .05$) beyond contributions made by psychological need satisfaction.

Conclusions: Overall, these results extend the potential utility of the PNTS-PA as an instrument for use with BPNT beyond sport and support Deci and Ryan's (2002) contentions regarding the critical role of psychological need thwarting.

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Introduction

Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2002) holds considerable appeal for understanding the relationship between the social contextual environment and a person's well-being and ill-being. Within BPNT, Deci and Ryan posit that humans are active, growth-oriented organisms who strive for opportunities to fulfill key psychological needs. When these key psychological needs

are fulfilled, optimal psychological well-being should ensue. While researchers in sport and exercise psychology have tested BPNT in terms of well-being (Adie, Duda, & Ntoumanis, 2012; Gunnell, Mack, Wilson, & Adachi, 2011; Wilson, Longley, Muon, Rodgers, & Murray, 2006), very few investigations have examined the undermining effect of psychological need thwarting (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011). Deci and Ryan (2000) suggest that persistent thwarting of innate psychological needs has the potential to lead to a host of negative outcomes such as compensatory activity or need substitutes, non-self-determined regulatory styles and rigid behavior. The primary aim of this paper is to test BPNT to determine if psychological need thwarting in physical activity contributes to the understanding of well-being and ill-being.

As conceptualized in BPNT, humans have fundamental psychological needs for competence, autonomy and relatedness (Deci & Ryan, 2002). Competence refers to a feeling that one can successfully complete optimally challenging tasks (Deci & Ryan). Autonomy refers to a sense of volition over behavior or feelings of self-governance, whereas relatedness refers to experiences of

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meaningful connections or belonging with others (Deci & Ryan). According to Deci and Ryan, fulfillment of these key psychological needs within a given context contributes to optimal growth, integrity and well-being whereas psychological need thwarting will lead to greater fragmentation and ill-being (Deci & Ryan).

Investigators working with BPNT have found evidence to support Deci and Ryan's (2002) assertions regarding psychological need satisfaction and well-being across a broad spectrum of physical activity contexts (see Ng et al., 2012; Ryan, Williams, Patrick, & Deci, 2009; Wilson, Mack, Gunnell, Oster, & Gregson, 2008). Cross-sectional (McDonough & Crocker, 2007; Sebire, Standage, & Vansteenkiste, 2009) and prospective (Rahman, Thøgersen-Ntoumani, Thatcher, & Doust, 2011; Wilson, Longley, et al., 2006) investigations have generally revealed that perceived psychological need satisfaction is positively associated with well-being and negatively associated with ill-being. Finally, researchers have supported theoretical tenets that psychological needs experienced in physical activity have an overall direct relationship on well-being (Gunnell et al., 2011; Mack et al., 2012). Despite these findings, some researchers have noted mixed results with regard to the unique contribution of each psychological need (Gunnell et al., 2011; Mack et al., 2012; McDonough & Crocker, 2007). Together, psychological need satisfaction appears to contribute to well-being, yet further research is needed to understand why certain psychological need satisfactions often emerge as independent contributors when each psychological need is expected to contribute independently to well-being (Deci & Ryan, 2000; Sheldon, Elliot, Kim, & Kasser, 2001). It is possible that in different contexts (e.g., physical activity or exercise) fulfillment of certain psychological needs may play a more distal or salient role, as has been suggested by previous researchers (Deci & Ryan, 2000; McDonough & Crocker, 2007). While the role of perceived need satisfaction has been tested, few investigators have tested assertions made by Deci and Ryan within BPNT about psychological need thwarting in sport or exercise contexts.

According to Ryan and Deci (2000), the framework set forth within BPNT addresses not only issues germane to personal growth and well-being, but also the "...undermining, alienating, and pathogenic effects of need thwarting contexts" (p. 319). Psychological need thwarting is conceptualized as "the perception that need satisfactions are being obstructed or actively frustrated within a given context" (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011, p. 5). Low scores on psychological need satisfaction may not indicate that needs are thwarted, but may suggest that an individual is unsatisfied with the degree to which needs are being met (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani). In other words, psychological need thwarting is concerned with an active process and not simply the lack of psychological need satisfaction. Competence thwarting occurs when a person is made to feel ineffective or is in an environment that is demeaning of their ability (Vansteenkiste, Niemiec, & Soenens, 2010). Autonomy thwarting is described as being in a controlling environment and relatedness thwarting occurs within cold and neglectful environments (Vansteenkiste et al., 2010). For example, a runner may not feel as though his/her psychological need for competence is being met if he/she does not feel effective in his/her running. Conversely, a runner may experience active need thwarting if his/her running partner is overly demeaning of his/her ability.

Until recently, there was no instrument available designed to measure psychological need thwarting in line with BPNT (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011). Because such an instrument did not exist, many researchers simply equated lack of psychological need satisfaction with psychological need thwarting; however, researchers have documented concerns with using measures of psychological need satisfaction as

predictors of negative affect (McDonough & Crocker, 2007) because existing measures of psychological need satisfaction are measured with positively worded items (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011). Supporting this contention, researchers in sport (Adie et al., 2012) and physical activity (Mack et al., 2012) noted that a lack of need satisfaction did not predict ill-being. To make sense of these aberrant findings, Bartholomew and colleagues (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011) argued that need satisfaction and need thwarting can co-occur in a given context and, over time, could differentially contribute to the prediction of negative outcomes. In other words, the anomalous finding reported in existing research could be attributable to not measuring active psychological need thwarting, and simply equating a lack of psychological need satisfaction with the presence of psychological need thwarting. In order to initiate a more detailed examination of psychological need thwarting, Bartholomew et al. developed the Psychological Need Thwarting Scale (PNTS; Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011). The PNTS represents the first instrument designed within the framework of BPNT to capture feelings of active thwarting specific to competence, autonomy, and relatedness needs.

Since the development of the PNTS, investigators have been quick to examine the importance of psychological need thwarting in sport (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011; Bartholomew, Ntoumanis, Ryan, Bosch, & Thøgersen-Ntoumani, 2011; Belaguer et al., 2012; Mallison & Hill, 2011; Stebbings, Taylor, Spray, & Ntoumanis, 2012). Results of these investigations indicated that psychological need thwarting predicted emotional and physical exhaustion (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011), depression, disordered eating (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011) and burnout (Belaguer et al., 2012). Perfectionistic concerns have been associated with higher levels of psychological need thwarting in junior sport participants (Mallison & Hill, 2011). Daily fluctuations in psychological need satisfaction and thwarting predicted corresponding daily fluctuations in well-being and ill-being, respectively, in athletes (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011). Psychological need thwarting in coaches has also been associated with ill-being (Stebbing et al., 2012). Furthermore, psychological need thwarting mediated the relationship between the social environment and ill-being (Belaguer et al., 2012). Collectively, results of these studies indicate that considering the role of psychological need thwarting in sport could further our understanding of the mechanisms contributing to ill-being beyond simply the lack of psychological need satisfaction, rendering further study of psychological need thwarting a viable avenue for research (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011).

Justification for the proposed research

The purpose of this study was to test BPNT by examining if the concept of psychological need thwarting experienced when engaged in physical activity adds to the understanding of mechanisms that contribute to well-being and ill-being. An examination of existing literature yields at least three reasons justifying continued investigation in this area: (1) psychological need thwarting has not been directly examined in more general physical activity contexts, (2) it is unclear if examining psychological need thwarting enhances BPNT's predictive utility with reference to indices of ill-being and well-being, and (3) to determine the utility of the original PNTS items for assessing these psychological mechanisms in contexts other than sport.

The first justification for this research concerns the contextual domain of interest. To date, investigators examining psychological

need thwarting have focused mainly on sport. Ryan (1995) has argued that researchers should investigate different domains in order to understand how a particular theory functions across contexts. Domains represent specific contexts in which different influences may be operating and influencing the satisfaction (or thwarting) of innate psychological needs. Researchers have established that psychological need thwarting contributes to ill-being in sport, yet sport represents merely a fraction of the plausible behaviors that comprise the domain of physical activity (Bouchard, Blair, & Haskell, 2007). One limitation to using the term ‘sport’ or ‘exercise’ is that it may exclude various forms of physical activity that individuals engage in on a daily basis (e.g., gardening, walking). The benefit of using this broad/global perspective of physical activity is that it is more inclusive. More global domains of physical activity could provide a context in which individuals experience controlling conditions (e.g., from fitness instructors, physicians, or significant others who do not understand physical activity decisions or perspectives).

Second, given the contentions regarding the negative role psychological need thwarting may play in different domains (Deci & Ryan, 2000; Ryan & Deci, 2000), the inclusion of psychological need thwarting constructs may assist researchers attempting to explain ill-being outcomes such as negative affect or exercise dependency related to physical activity engagement. An important next step is to determine if the concept of psychological need thwarting enhances our understanding of well-being and ill-being beyond the contributions made by psychological need satisfaction. Theories are created and used in order to disentangle complex human behavior and provide a parsimonious explanation (Green et al., 1994). If the concept of psychological need thwarting experienced in physical activity does not explain additional variance in well-being or ill-being outcomes above existing constructs housed within BPNT, it may not be a useful avenue for researchers to pursue.

Finally, to our knowledge, there is only one instrument (the PNTS) to date that directly measures psychological need thwarting; however, it was created specifically for use within the confines of sport. Researchers have argued that when instruments have been modified from their original format a rigorous examination of score validity is warranted to ensure that the modifications have not impeded the interpretability of item scores (Gunnell, Wilson, Zumbo, Mack, & Crocker, 2012; Hagger & Chatzisarantis, 2009) to determine if the instrument can, or should be modified to alternative contexts. Score reliability and validity are critical for interpreting the meaningfulness of the inferences made from the data (Messick, 1995).

To examine the main purpose, a longitudinal, two-wave design over six months was adopted. Based on previous research (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011) and theory (Deci & Ryan, 2002), it was hypothesized that: (a) changes in psychological need satisfaction would positively predict well-being and, (b) changes in psychological need thwarting would predict additional variance in ill-being but not well-being beyond satisfying key psychological needs. Prior to testing the main hypothesis, the merit of modifying the instrument to make it applicable for global physical activity contexts where people engage in various different forms of physical activity other than just sport will be examined. Score validity for the modified PNTS will be scrutinized using a hypothesis-testing approach within the validity framework set forth by The Standards for Educational and Psychological Testing (*The Standards*; AERA, APA, & NCME, 1999). Specifically, the internal structure of scores from the modified PNTS will be examined. Second, discriminant evidence (Campbell & Fiske, 1959) based on scores from the PNTS and scores from a measure of psychological need satisfaction will be examined. Finally, estimates of

reliability will be assessed to determine the amount of error variance associated with scores from the modified PNTS.

Methods

Participants

Participants ($N = 155$, 67.70% female) were a sample of adults 17 years or older. At time 1, the participants were on average 37.46 years old ($SD = 19.89$; Range = 17–97) with an average body mass index (BMI) of 23.45 kg/m^2 ($SD = 3.55$). Participants’ marital status was as follows: single/never married (50.3%), married (40.60%), separated/divorced (5.20%) or widowed (3.9%). The majority of participants were White (83.20%). Participants’ highest educational attainment was a university/college degree (43.90%), high school diploma (36.10%), graduate degree (18.70%) or some high school (1.30%). At time 1, most of the participants reported that they were regularly active for more than 6 months preceding data collection (87.60%; Mullan & Markland, 1997). Following Godin’s (2011) recommendations using self-reported estimates of physical activity behavior,¹ participants were classified as ‘active’ at both time 1 ($M = 42.56$ units, $SD = 27.77$)² and time 2 ($M = 45.55$ units, $SD = 32.39$).

Measures

Psychological need satisfaction

Participants completed a modified version of the Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006) designed to capture feelings of competence, autonomy, and relatedness felt during physical activity (PNSE-PA; Gunnell et al., 2012). The original PNSE is an 18-item instrument that assesses fulfillment of psychological needs derived from exercise participation in line with BPNT (Deci & Ryan, 2002). Two modifications were made to the original version of the PNSE for the purpose of this study. Both modifications were made by replacing the word “exercise” with “physical activity” in all instances. First, the instructional stem was modified to read as follows: “please answer the following questions by considering how you typically feel when you engage in physical activity”. Second, individual PNSE items were modified and used in the PNSE-PA in line with previous research (Gunnell et al., 2012). An example of this modification is as follows: “I feel confident I can do even the most challenging physical activities”. Participants were asked to rate each item from 1 (*false*) to 6 (*true*). Initial validity and reliability for scores of the PNSE-PA have been demonstrated in the form of internal structure, weak invariance across formats and populations, composite reliability, average variance extracted and coefficient alpha $\geq .72$ (Gunnell et al., 2012; Mack et al., 2012).

Psychological need thwarting

Participants completed a modified version of the Psychological Need Thwarting Scale (PNTS; Bartholomew, Ntoumanis, Ryan, &

¹ Physical activity was measured with the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985). The LTEQ assesses the amount of mild, moderate and strenuous physical activity typically performed in an average week. Following the stem “During a typical 7-Day period (a week), how many times on average do you do the following kinds of exercise for more than 15 min during your free time”, participants record a number for mild, moderate and strenuous. Physical activity unit scores were calculated based on the formula [(Strenuous*9) + (Moderate*5)] (Godin, 2011).

² One person was deleted from this calculation because he/she had indicated he/she had performed 100 bouts of mild, moderate and strenuous physical activity in a typical week.

Thøgersen-Ntoumani, 2011). The original PNTS was designed to assess the degree of psychological need thwarting felt by athletes during sport. Two modifications were made to the original PNTS. First the stem was modified to read as follows: “considering your physical activity, please indicate how much you agree or disagree with each statement”. Second, individual PNTS items were modified in the same manner as the PNSE. An example of this modification is as follows: “I feel prevented from making choices with regard to the way I engage in physical activity.” Participants rated each item on a scale of 1 (*strongly disagree*) to 7 (*strongly agree*). The modified PNTS will be referred to as PNTS-PA for the remainder of this paper. Evidence of internal structure (factor structure, gender, sport type and competitive experience invariance), predictive evidence of validity and composite reliability $> .67$ has been found for scores of the PNTS-PA (Bartholomew Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011).

Well-being and ill-being

Subjective vitality and positive affect served as markers of well-being. Negative affect served as a marker of ill-being.³ Participants completed a modified version of the Subjective Vitality Scale (SVS; Ryan & Frederick, 1997) to assess feelings of vitality and energy felt when engaged in physical activity. Following the stem, “please respond to each of the following statements by indicating the degree to which the statement is true for you when engaged in physical activity”, participants rated each item using a scale of 1 (*not true*) to 7 (*very true*). Positive and negative affect were assessed with a modified version of the short 10-item Positive and Negative Affect Schedule (PANAS; Mackinnon et al., 1999; Watson, Tellegen, & Clark, 1988). The following stem oriented participants to the items: “This scale contains a number of words describing different feelings and emotions. Indicate to what extent you generally feel this way when you engage in physical activity.” Participants rated each item on a scale of 1 (*very slightly or not at all*) to 5 (*extremely*). The SVS and PANAS have been widely used in sport and exercise psychology research, with evidence of score reliability and validity demonstrated across investigations (e.g., Adie et al., 2012; McDonough & Crocker, 2007; Wilson, Longley, et al., 2006).

Data collection

After obtaining ethical approval to conduct the study, a sample of people over the age of 17 was recruited through the use of recruitment posters, online announcements, and snowball sampling. After providing informed consent, participants completed two identical online questionnaires containing the instruments described above, separated by a period of ~6 months.

Data analysis

Individual cases were deleted if scores for $>50.00\%$ of the subscale were missing (Hawthorne & Elliott, 2005). When $\leq 50.00\%$ missing data were evident, within person median substitution was employed. Five multivariate outliers were detected with Mahalanobis distances (Tabachnick & Fidell, 2007). Visual inspection

³ Negative affect has typically been conceptualized as part of the well-being tradition because it is contained within the definition of subjective well-being (Ryan & Deci, 2001). However, researchers have found strong evidence to suggest that positive and negative affect are two distinct non-overlapping measures (Watson, Clark, & Tellegen, 1988). Researchers in exercise psychology have utilized negative affect as an indicator of ill-being (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011; Mack et al., 2012; McDonough & Crocker, 2007; Stebbings et al., 2012; Wilson, Longley, et al., 2006) and corroborated previous findings with regard to the small correlation between positive and negative affect.

indicated that the outliers had a greater increase in negative affect, decrease in autonomy satisfaction and increase in competence, autonomy and relatedness thwarting compared with the majority of the sample classified as non-outliers. The outliers in this investigation were deemed to be an unintentionally and unknowingly included subpopulation⁴ and were not deleted from the analysis because they represent legitimate observations (Liu & Zumbo, 2012).

Data analysis proceeded in the following order: First, following data screening, descriptive statistics and Pearson bivariate correlations and intraclass correlations between time points (ρ) were assessed. Second, confirmatory factor analyses (CFA) using polychoric correlation matrices and Weighted Least Squares Estimation were conducted using MPlus 7.0 for scores reported with each instrument at time 1 and time 2 setting the variance of the latent factors to 1.00 for the purposes of model identification. Model fit was assessed with a combination of fit indices (Kline, 2005). A Comparative Fit Index (CFI) and Tucker Lewis Index (TLI) close to or above .95 (Hu & Bentler, 1999) in conjunction with a Root Mean Square Error of Approximation value close to or below .06, respectively, were deemed indicative of acceptable model fit (Hu & Bentler, 1999). Finally, estimates of ordinal composite reliability (Raykov, 1997) were calculated using information from the CFA analyses.

Fifth, to address the primary aim of this study, hierarchical regression analyses were calculated using the residual approach (Zumbo, 1999). First, robust (least trimmed squares [LTS]; Rousseeuw, 1984) residualized change scores using SPlus software (Insightful Corporation, 2007) were calculated. Robust procedures can be a useful way of dealing with outliers and their influence on the standard errors of the sample mean (Liu & Zumbo, 2012; Wilcox, 2012; Zumbo, 1999). Next, hierarchical regression analyses were calculated with the LTS residual scores in SPSS 20. Separate hierarchical regression models were calculated for each dependent variable. Collinearity diagnostics were examined to inspect the presence of multicollinearity using guidelines outlined by Tabachnick and Fidell (2007; VIF < 2.07 , condition index < 30 along with < 2 variables with variance proportion $> .50$ per dimension). Robust residual change scores for competence, autonomy and relatedness satisfaction were entered into block 1. Next, robust residual change scores for competence, autonomy and relatedness thwarting were entered into block 2. If more than one variable was statistically significant, a Relative Pratt Index (RPI or d) was calculated using the formula $(\beta^*r)/R^2$, where β denotes the standardized beta coefficient, r denotes the bivariate correlation between the predictor and the outcome variable, and R^2 denotes the model R^2 (Thomas, Hughes, & Zumbo, 1998). The RPI therefore represents the proportion of variance attributed to each variable in each model and can be used to determine predictor importance. A variable is meaningful if its d value is greater than $1/(2 * \text{the number of predictors})$ (Thomas, 1992).

Results

Preliminary analysis, score reliability and validity

Sample descriptive statistics are provided in Table 1. Demonstrating change, individual differences from time 1 to time 2 (simple change score) ranged from -4.50 to 5.25 . Intraclass correlation coefficients ranged from .62 to .84 (see Table 1). Estimates

⁴ Liu and Zumbo (2012) described a case of outliers termed unintentionally and unknowingly included subpopulations. This type of outlier occurs when the researcher unknowingly recruits some people who were not from the target population, thus creating a subpopulation. Results of the main analysis (R^2 and ΔR^2) without the subpopulation mirrored the results presented herein and can be obtained from the first author upon request.

Table 1
Descriptive statistics, score reliability and intraclass correlations.

	Time 1		Time 2		ICC
	Mean (SD)	ρ_c	Mean (SD)	ρ_c	
Subjective vitality	5.45 (.98)	.90	5.48 (.96)	.90	.84*
Positive affect	3.79 (.68)	.87	3.85 (.65)	.87	.79*
Negative affect	1.30 (.43)	.86	1.32 (.53)	.91	.62*
PNSE-PA-competence	4.75 (.96)	.95	4.76 (.97)	.96	.79*
PNSE-PA-autonomy	5.30 (.84)	.96	5.33 (.83)	.97	.72*
PNSE-PA-relatedness	4.59 (1.13)	.96	4.58 (1.10)	.96	.84*
PNTS-PA-competence	1.88 (1.11)	.93	1.95 (1.21)	.93	.78*
PNTS-PA-autonomy	1.76 (1.08)	.93	1.75 (.97)	.90	.79*
PNTS-PA-relatedness	1.70 (.91)	.91	1.73 (.95)	.89	.75*

Note. * $p < .05$. SD = Standard Deviation; ρ_c = ordinal composite reliability; PNSE-PA-competence = perceived competence satisfaction, PNSE-PA-autonomy = perceived autonomy satisfaction, PNSE-PA-relatedness = perceived relatedness satisfaction; PNTS-PA-competence = perceived competence thwarting, PNTS-PA-autonomy = perceived autonomy thwarting, PNTS-PA-relatedness = perceived relatedness thwarting; ICC = intraclass correlation.

of ordinal composite reliability $\geq .87$ were noted for scores per instrument/subscale at time 1 and 2 (see Table 1). Results of the CFA's provide evidence for the factor structure of PNTS-PA responses and all instruments used (see Table 2); however, the latent inter-factor correlations between psychological need thwarting variables were high (Φ 's range from .85 to .96; see Table 3). Item factor loadings for PNTS-PA and PNSE-PA responses across both time points were $\geq .60$ (see Table 3).

Cross-sectional correlations

At the cross-sectional level, bivariate correlations between feelings of psychological need satisfaction and perceptions of psychological need thwarting were negative and small-to-moderate, supporting the validity of PNTS-PA scores based on discriminant evidence (r 's = $-.05$ to $-.62$; see Table 4). Psychological need satisfaction was positively correlated with positive affect and subjective vitality (r 's = $.18$ – $.51$) and negatively correlated with negative affect (r 's = $-.18$ to $-.38$). Psychological need thwarting was negatively correlated with subjective vitality and positive affect (r 's = $-.14$ to $-.33$) and positively correlated with negative affect (r 's = $.38$ – $.62$; see Table 4).

Table 2
Results of confirmatory factor analyses.

	χ^2	df	CFI	TLI	RMSEA (90% CI)
Time 1					
SVS	54.06*	14	.98	.97	.14 (.10–.18)
PANAS	80.81*	34	.95	.94	.09 (.07–.12)
PNSE-PA	399.94* ^a	132	.97	.97	.11 (.10–.13)
PNTS-PA	131.93*	51	.99	.98	.10 (.08–.12)
Time 2					
SVS	65.55*	14	.97	.96	.15 (.12–.19)
PANAS	52.96*	34	.98	.98	.06 (.02–.09)
PNSE-PA	328.63*	132	.99	.98	.10 (.09–.11)
PNTS-PA	128.83*	51	.98	.98	.10 (.08–.12)

Note. χ^2 = chi-square, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, * $p < .05$. SVS = Subjective Vitality Scale; PANAS = Positive and Negative Affect Schedule; PNSE-PA = Psychological Need Satisfaction in Exercise Scale modified to physical activity; PNTS-PA = Psychological Need Thwarting Scale modified to physical activity.

^a When the CFA analysis was calculated for the PNSE-PA at time one, Mplus produced a warning that item 11 (I feel free to choose which physical activities I participate in) and 12 (I feel like I am the one who decides what physical activity I do) were correlated at .99. An additional analysis was calculated with item 11 removed and model fit only changed slightly ($\chi^2 = 365.70$, $df = 116$, $p < .05$, $CFI = .97$, $TLI = .97$, $RMSEA = .12$ [.10–.13]). Therefore, for the purposes of the main analysis, which used composite scores, items 11 and 12 were left in the PNSE-PA at time 1.

Correlations of change scores

Correlations between changes in psychological need satisfaction and psychological need thwarting were negative and small providing additional support for the validity of scores from the PNTS-PA based on discriminant evidence (r 's = $.05$ to $-.26$). Correlations between changes in psychological need thwarting and negative affect were positive (r 's = $.26$ – $.38$). No statistically significant correlation was found between changes in psychological need thwarting variables and subjective vitality and positive affect. Changes in psychological need satisfaction variables were positively related to subjective vitality and positive affect (r 's = $.15$ – $.33$). Changes in autonomy satisfaction were negatively correlated with negative affect ($r = -.34$). Intercorrelations between need thwarting variables (r 's = $.35$ – $.60$) and need satisfaction (r 's = $.32$ – $.47$) were small-to-moderate. Changes in positive affect were associated with changes in subjective vitality ($r = .36$, $p < .05$) but not negative affect ($r = -.01$, $p > .05$). Changes in negative affect were not significantly related to changes in subjective vitality ($r = -.03$, $p > .05$).

Main analysis

Collinearity analyses for each regression model indicated that the assumption of multicollinearity was not violated. To test the first study hypothesis, changes in psychological need satisfaction were entered in block 1 of the hierarchical regression analyses (see Table 5). Changes in psychological need satisfaction predicted subjective vitality ($R^2 = .13$, $p < .05$), positive affect ($R^2 = .16$, $p < .05$), and negative affect ($R^2 = .12$, $p < .05$). Changes in competence made a meaningful but not statistical contribution ($d = .34$) to subjective vitality while changes in relatedness satisfaction made a meaningful and statistical ($\beta = .26$, $d = .64$) contribution to subjective vitality. Changes in competence ($\beta = .24$, $d = .45$) and relatedness ($\beta = .27$, $d = .56$) satisfaction predicted positive affect. Changes in autonomy satisfaction ($\beta = -.40$) negatively predicted negative affect. Testing the second study hypothesis, changes in psychological need thwarting did not account for additional variation in subjective vitality or positive affect ($p > .05$; see Table 5). Changes in psychological need thwarting accounted for additional variation in negative affect ($\Delta R^2 = .11$, $p < .05$) beyond contributions made by psychological need satisfaction. Autonomy thwarting ($\beta = .23$, $d = .38$) and autonomy satisfaction ($\beta = -.29$, $d = .43$) emerged as predictors of negative affect. Changes in competence thwarting also made a meaningful contribution to negative affect ($d = .19$) and changes in relatedness thwarting approached meaningfulness ($d = .05$).

A suppressor variable is identified using the RPI when a predictor variable has little to no correlation with an outcome variable alone, yet in the presence of other variables, contributes to the model, therefore yielding a d value that is appreciably smaller than others in the model despite a similar magnitude in standardized betas (Thomas et al., 1998). Examination of the d values in each regression model indicated that relatedness thwarting ($r = .09$, $p > .05$, $\beta = .20$, $p < .05$) and competence thwarting ($r = -.05$, $p > .05$, $\beta = .22$, $p < .05$) may be suppressor variables in the regression model predicting subjective vitality.⁵

⁵ At the request of an anonymous reviewer, we calculated composite scores (averages) for need satisfaction and need thwarting subscales. Results mirrored the main analyses and indicated that the composite psychological need thwarting variable contributed to the prediction of negative affect ($\Delta R^2 = .09$, $p < .05$) but not vitality ($\Delta R^2 = .01$, $p > .05$) or positive affect ($\Delta R^2 = .02$, $p > .05$) above the composite psychological need satisfaction variable.

Table 3
Item factor loadings, standard errors and residuals for the PNTS-PA and PNSE-PA.

Subscale and item	Time 1		Time 2	
	Factor loading (SE)	Residual	Factor loading	Residual
PNTS-PA-competence thwarting				
There are situations where I am made to feel inadequate	.89 (.02)	.21	.83 (.03)	.31
I feel inadequate because I am not given opportunities to fulfill my potential	.88 (.03)	.23	.88 (.03)	.23
Situations occur in which I am made to feel incapable	.86 (.02)	.26	.88 (.02)	.22
There are times when I am told things that make me feel incompetent	.87 (.03)	.25	.92 (.02)	.15
PNTS-PA-autonomy thwarting				
I feel prevented from making choices with regard to the way I engage in physical activity	.75 (.04)	.43	.77 (.04)	.41
I feel pushed to behave in certain ways	.92 (.02)	.16	.82 (.03)	.32
I feel under pressure to agree with the physical activity regime I am provided	.92 (.02)	.15	.85 (.03)	.29
I feel forced to follow physical activity decisions made for me	.93 (.02)	.14	.87 (.04)	.25
PNTS-PA-relatedness thwarting				
I feel other people dislike me	.91 (.02)	.17	.88 (.03)	.23
I feel others can be dismissive of me	.86 (.03)	.26	.89 (.03)	.20
I feel I am rejected by those around me	.93 (.02)	.14	.90 (.03)	.19
I feel that other people are envious when I achieve success	.70 (.04)	.52	.60 (.05)	.64
PNSE-PA-competence satisfaction				
I feel that I am able to complete physical activities that are personally challenging	.83 (.03)	.31	.87 (.02)	.24
I feel confident I can do even the most challenging physical activities	.90 (.02)	.20	.93 (.01)	.14
I feel confident in my ability to perform physical activities that personally challenge me	.88 (.02)	.22	.90 (.02)	.20
I feel good about the way I am able to complete challenging physical activities	.81 (.03)	.35	.90 (.02)	.19
I feel like I am capable of doing even the most challenging physical activities	.89 (.02)	.21	.90 (.02)	.18
I feel capable of completing physical activities that are challenging to me	.93 (.02)	.14	.91 (.02)	.17
PNSE-PA-autonomy satisfaction				
I feel like I am in charge of my physical activity program decisions	.98 (.02)	.04	.91 (.02)	.18
I feel free to make my own physical activity program decisions	.88 (.02)	.22	.88 (.02)	.22
I feel free to do physical activity in my own way	.82 (.03)	.33	.83 (.03)	.30
I feel like I have a say in choosing the physical activities that I do	.97 (.01)	.06	.96 (.01)	.08
I feel free to choose which physical activities I participate in	.90 (.03)	.19	.99 (.01)	.02
I feel like I am the one who decide what physical activities I do	.89 (.02)	.21	.97 (.01)	.07
PNSE-PA-relatedness satisfaction				
I feel attached to my physical activity companions because they accept me for who I am	.89 (.02)	.21	.86 (.03)	.27
I feel I share a common bond with people who are important to me when we do physical activity together	.84 (.03)	.29	.89 (.02)	.20
I feel close to my physical activity companions who appreciate how difficult physical activity can be	.87 (.02)	.25	.89 (.02)	.22
I feel a sense of camaraderie with my physical activity companions because we do physical activity for the same reason	.91 (.02)	.17	.88 (.02)	.22
I feel connected to the people who I interact with while we do physical activity together	.93 (.02)	.13	.94 (.01)	.11
I feel like I get along well with other people who I interact with while we do physical activity together	.91 (.02)	.17	.91 (.02)	.18

PNTS-PA time 1: $\Phi_{\text{PNTS-PAcomp.PNTS-PAaut}} = .96$, $\Phi_{\text{PNTS-PAcomp.PNTS-PArel}} = .95$, $\Phi_{\text{PNTS-PArel.PNTS-PAaut}} = .85$, all p 's < .05.

PNTS-PA time 2: $\Phi_{\text{PNTS-PAcomp.PNTS-PAaut}} = .93$, $\Phi_{\text{PNTS-PAcomp.PNTS-PArel}} = .91$, $\Phi_{\text{PNTS-PArel.PNTS-PAaut}} = .86$, all p 's < .05.

PNSE-PA time 1: $\Phi_{\text{PNSE-PAcomp.PNSE-PAaut}} = .68$, $\Phi_{\text{PNSE-PAcomp.PNSE-PArel}} = .64$, $\Phi_{\text{PNSE-PArel.PNSE-PAaut}} = .52$, all p 's < .05.

PNSE-PA time 2: $\Phi_{\text{PNSE-PAcomp.PNSE-PAaut}} = .61$, $\Phi_{\text{PNSE-PAcomp.PNSE-PArel}} = .63$, $\Phi_{\text{PNSE-PArel.PNSE-PAaut}} = .46$, all p 's < .05.

Note: factor loading values are standardized. SE = standard errors of the factor loading. Φ = latent inter-factor correlation.

Discussion

The primary purpose of this paper was to test BPNT to determine if psychological need thwarting advances Deci and Ryan's (2002) predictions about well-being and ill-being in physical activity contexts. The findings supported both of the hypotheses that (a) psychological need satisfaction would predict well-being and (b) psychological need thwarting would predict additional variance beyond psychological need satisfaction when predicting ill-

being but not well-being. Results also indicated the tenability of PNTS-PA scores based on estimates of ordinal composite reliability, and score validity based on internal structure, and discriminate evidence; however CFA results indicated that psychological need thwarting latent factors were highly inter-correlated. Overall, the results of these analyses indicated that Deci and Ryan's contentions regarding psychological need thwarting enhance the predictive utility of BPNT with regard to ill-being in physical activity contexts.

Table 4
Bivariate correlations at time 1 and time 2.

	1	2	3	4	5	6	7	8	9
1. Subjective vitality	–	.64*	–.10	.44*	.23*	.49*	–.19*	–.16*	–.08
2. Positive affect	.67*	–	.01	.50*	.18*	.48*	–.07	–.14*	.01
3. Negative affect	–.30*	–.17*	–	–.18*	–.38*	–.07	.61*	.62*	.42*
4. PNSE-PA-competence	.47*	.51*	–.27*	–	.52*	.55*	–.26*	–.27*	–.09
5. PNSE-PA-autonomy	.49*	.42*	–.35*	.57*	–	.32*	–.58*	–.62*	–.37*
6. PNSE-PA-relatedness	.40*	.46*	–.21*	.59*	.40*	–	–.13	–.08	–.05
7. PNTS-PA-competence	–.33*	–.23*	.51*	–.37*	–.53*	–.19*	–	.78*	.72*
8. PNTS-PA-autonomy	–.22*	–.11	.38*	–.24*	–.54*	–.10	.83*	–	.62*
9. PNTS-PA-relatedness	–.23*	–.16*	.43*	–.16*	–.33*	–.10	.76*	.62*	–

Note. * $p < .05$; PNSE-PA-competence = perceived competence satisfaction, PNSE-PA-autonomy = perceived autonomy satisfaction, PNSE-PA-relatedness = perceived relatedness satisfaction; PNTS-PA-competence = perceived competence thwarting, PNTS-PA-autonomy = perceived autonomy thwarting, PNTS-PA-relatedness = perceived relatedness thwarting. The lower diagonal contains time 1 correlations and the upper diagonal contains time 2 correlations.

Score validity and reliability of the PNTS-PA

Estimates of score reliability revealed that scores from the modified PNTS-PA were associated with minimal error variances. Validity evidence based on internal structure and discriminant evidence for scores of the PNTS-PA was also found. CFA analysis supported the factor structure of scores from the PNTS-PA. In other words, the 12 items comprising the PNTS-PA loaded on to their respective latent variables of competence, autonomy and relatedness thwarting; however, the latent factors of competence, autonomy and relatedness thwarting demonstrated high inter-factor correlations not found in previous research (Bartholomew Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011). We calculated a second-order CFA, yet the solution was inadmissible due to a high negative residual variance that could have been caused by small sample size, the use non-normal estimators, or a small number of indicators per latent factor (Brown, 2006). Alternatively, Marsh et al. (2009) recommended the use of exploratory structural equation modeling (ESEM) to reduce inter-factor correlations caused by many small item cross-loadings. Continued examination of the dimensionality of the PNTS-PA with larger sample sizes and using techniques such as ESEM represents an important avenue for future research.

Results of the correlation analyses between scores of the PNSE-PA and PNTS-PA were small-to-moderate, supporting the validity of scores based on discriminant evidence (Campbell & Fiske, 1959). This finding also supports contentions that need thwarting cannot be directly equated with a lack of need satisfaction (Bartholomew Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011). Based on these findings, it seems reasonable to suggest that researchers refrain from referring to a lack of need satisfaction as evidence of need

thwarting. Given that validity is conceptualized as an ongoing process, it is prudent that future researchers who wish to use the PNTS-PA continue to provide evidence of score validity and reliability.

Psychological needs thwarting and well-being and ill-being

Consistent with previous research (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011) and extending beyond sport contexts, psychological need thwarting contributed to the prediction of ill-being beyond the simple lack of need satisfaction. Researchers who are interested in examining negative outcomes associated with physical activity (e.g., negative affect, social physique anxiety, and exercise dependency) may wish to include assessments of psychological need thwarting to determine if psychological need thwarting is one of the reasons physical activity could be associated with negative outcomes. With reference to the role of individual psychological needs, Deci and Ryan (2000) contend that fulfillment of all three psychological needs is independently important for understanding well-being and ill-being. Results of the analyses reveal that only changes in autonomy satisfaction and autonomy thwarting independently contributed to the prediction of ill-being. Consequently, if a person was engaging in activity due to active coercion or he/she felt that his/her need for autonomy was not being satisfied, he/she was more likely to experience ill-being over time. Changes in competence and relatedness thwarting did not emerge as significant independent predictors of ill-being, although the RPI revealed that changes in competence thwarting contributed a meaningful amount of variance and relatedness thwarting approached a meaningful amount of variance to explaining ill-being.

Table 5
Hierarchical regression analysis based on robust residual change score.

	Negative affect					Positive affect					Subjective vitality				
	β	r	d	R^2	ΔR^2	β	r	d	R^2	ΔR	β	r	d	R^2	ΔR^2
Model 1				.12*					.16*					.13*	
PNSE-PA-competence	.08	–.09	–			.24*	.30*	.45 ^a			.17	.26*	.34 ^a		
PNSE-PA-autonomy	–.40*	–.34*	–			–.05	.15*	–.05			.02	.19*	.03		
PNSE-PA-relatedness	.07	–.03	–			.27*	.33*	.56 ^a			.26*	.32*	.64 ^a		
Model 2				.23*	.11*				.17*	.01				.17*	.04
PNSE-PA-competence	.10	–.09	–.04			.24*	.30*	.42 ^a			.19*	.26*	.29 ^a		
PNSE-PA-autonomy	–.29*	–.34*	.43 ^a			–.05	.15*	–.04			.04	.19*	.04		
PNSE-PA-relatedness	.03	–.03	0			.28*	.33*	.54 ^a			.26*	.32*	.49 ^a		
PNTS-PA-competence	.12	.36*	.19 ^a			–.11	–.05	.03			–.22*	–.05	.06		
PNTS-PA-autonomy	.23*	.28*	.38 ^a			.02	–.04	0			.13	.03	.02		
PNTS-PA-relatedness	.05	.26*	.05			.11	–.04	–.03			.20*	.09	.11 ^a		

Note. β = standardized beta weight, r = simple bivariate correlation, d = Relative Pratt Index (RPI), * $p < .05$.

^a Meaningful predictor (model 1 d cutoff = .17, model 2 d cutoff = .08); PNSE-PA-competence = perceived competence satisfaction, PNSE-PA-autonomy = perceived autonomy satisfaction, PNSE-PA-relatedness = perceived relatedness satisfaction; PNTS-PA-competence = perceived competence thwarting, PNTS-PA-autonomy = perceived autonomy thwarting, PNTS-PA-relatedness = perceived relatedness thwarting.

Although changes in psychological need thwarting contributed to the prediction of ill-being, it did not account for variation in the prediction of well-being. In physical activity contexts, need thwarting events should diminish subjective vitality (Ryan et al., 2009). While the cross-sectional correlations in the present investigation and previous cross-sectional findings support this claim (Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011; Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011), change score analyses do not. It seems as though need thwarting is negatively related to well-being at one time point, yet changes in need thwarting do not predict changes in well-being. One study has noted that among exercise initiators, controlled forms of self-regulation do not change very much whereas self-determined forms increase faster (Rodgers, Hall, Duncan, Pearson, & Milne, 2010). In this investigation, many of the participants were in the maintenance stage of physical activity. It is possible that the participants had internalized the behavior and therefore there was not enough variation over time in psychological need thwarting and well-being to find a significant effect. Future researchers should examine the dynamic nature of need thwarting in individuals who are initiating physical activity behaviors, as it may have implications for public health.

Psychological need satisfaction and well-being and ill-being

In a review article on psychological need fulfillment in exercise contexts, Wilson et al. (2008) found that relatedness consistently had the lowest magnitude of relationship with indices of well-being. Indeed, investigators often find that relatedness does not individually predict outcomes such as well-being when competence and autonomy needs are in the same equation (Gunnell et al., 2011; McDonough & Crocker, 2007; Wilson, Longley, et al., 2006). This investigation found that changes in perceived relatedness satisfaction positively predicted well-being. There are several possible explanations for these atypical findings across studies. Variations associated with the contribution of perceived relatedness to well-being could stem from instruments used (Wilson & Bengoechea, 2010), different samples used (McDonough & Crocker, 2007), or the research design (cross-section vs. longitudinal). Alternatively, it is possible that many of the participants in this investigation were involved in sport, a context in which relatedness often emerges as a significant predictor of well-being over time (Adie et al., 2012; Reinboth & Duda, 2006). Future research should query the different social contexts in which individuals engage in physical activity, in order to elucidate the complex relationship between psychological need satisfaction and well-being over time. Future research should cross-validate the role of relatedness over time in relation to well-being in physical activity.

In exercise (Wilson et al., 2008) and physical activity (Gunnell et al., 2011; Mack et al., 2012) contexts, perceived competence typically emerges as a salient predictor of well-being. In this investigation, perceived changes in satisfaction of competence emerged as a significant and meaningful contributor to well-being. This suggests that individuals who had a positive increase in the fulfillment of competence had an associated positive increase in well-being. Change in autonomy did not emerge as a significant predictor of well-being. This is consistent with previous research findings based on change analysis in sport contexts (Adie et al., 2012). At the bivariate correlation level, changes in autonomy satisfaction were significantly associated with well-being. Another possible explanation concerns the assessment of perceived autonomy. It has been suggested that the PNSE assesses the decisional aspect of autonomy and not the affective aspect (McDonough & Crocker, 2007; Wilson, Longley, et al., 2006; Wilson, Rogers, et al., 2006). It is possible that if the PNSE captured the affective

component, autonomy could have emerged as a significant contributor of well-being. More research is needed to understand the role of perceived autonomy in relation to well-being in physical activity contexts.

Limitations and future directions

A limitation of this investigation is that aspects of social environment (e.g., autonomy supportive or controlling) were not considered. Future research should include assessments about the social environment in physical activity in order to understand how different environments relate to psychological need satisfaction or thwarting. It is possible that certain physical activities (e.g., fitness classes with a leader, weight loss programs, or physician prescribed activity) relate differentially to need satisfaction and thwarting. Another limitation is that the data were collected via self-reported measures that were adapted to physical activity contexts. While this study did provide evidence of score reliability and validity for all instruments used, validation is an ongoing process (Messick, 1995). Future researchers should carefully consider properties of score reliability and validity for all instruments. Moreover, the analyses were conducted on a relatively small sample with a large age range and caution should be warranted when interpreting the results, especially those of the CFA's. Investigators may wish to use larger samples with a more restrictive age, or more diverse populations (e.g., regular exercisers, special populations etc.). It would be interesting to examine growth modeling with data collected at more than two time points to determine within person and between person variations in psychological need satisfaction and thwarting related to well-being and ill-being. Researchers should include alternative measures of ill-being such as depression, exhaustion or exercise dependency. Finally, it would be interesting to examine the mediational role of psychological need thwarting in the relationship between physical activity and ill-being.

Conclusion

Results of this study support Deci and Ryan's claims made within BPNT. It is the thwarting of psychological needs that predicts ill-being, not simply the lack of need satisfaction. A secondary finding was that scores from the PNTS-PA appeared to demonstrate discriminant evidence of validity, evidence of internal structure and minimal error variance. The PNTS-PA may be useful for assessing perceptions of psychological need thwarting in physical activity. Examining psychological need thwarting in physical activity contexts appears to have merit, above and beyond examining psychological need satisfaction when examining ill-being.

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