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PSYCHOMETRIC EVALUATION OF THE BASIC PSYCHOLOGICAL NEEDS IN EXERCISE SCALE IN COMMUNITY EXERCISE PROGRAMS: A CROSS-VALIDATION APPROACH

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Abstract: The Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos & Michailidou, 2006) is a domain-specific self-report instrument designed to assess the extent to which the needs for autonomy, competence, and relatedness are fulfilled in exercise. The structural and predictive validity of BPNES responses were evaluated among community exercise program participants together with the extent to which the responses were measurement invariant across the community and the private fitness contexts. A sample of 851 participants attending community exercise programs and two samples totaling 1012 participants attending private fitness centers were used. The results supported the hypothesized dimensionality, internal consistency, and predictive validity of the BPNES among community-program exercise participants, as well as the partial metric invariance, partial measurement error invariance and partial scalar invariance of BPNES responses across the exercise contexts.

Key words: Generalizability, Measurement invariance, Self-determination theory.

An important question in both exercise and health psychology has been why people exercise (Dishman, 1994). A number of theoretical models of behavioral change applicable to exercise participation (Buckworth & Dishman, 2002) have been proposed that allow for identification of specific factors related to initiation of exercise as well as adherence to it. Such models include the Health Belief Model (Becker & Maiman, 1975), the Theory of Reasoned Action (Fishbein & Ajzen, 1975; Godin, 1994), the

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Theory of Planned Behavior (Ajzen & Madden, 1986; Godin, 1994), Self-efficacy Theory (Bandura, 1977; McAuley, Pena, & Jerome, 2001), the Transtheoretical Model (Prochaska & DiClemente, 1983; Marcus, Rossi, Selby, Niaura, & Abrams, 1992) and Self-determination Theory (SDT, Deci & Ryan, 1985, 2000; Ryan & Deci, 2000, 2002; Vallerand, 2001). Determinants of physical activity include demographic factors such as education, gender and socioeconomic status; psychological factors such as enjoyment of exercise, expectation of health benefits, self-efficacy, and self-schemata for exercise; behavioral attributes such as activity history, processes of change, and skills for coping with barriers; and social factors such as physician influence and social support from friends, spouse, and exercise instructor (Buckworth & Dishman, 2002).

The SDT has received considerable attention in the area of exercise promotion (Frederick & Ryan, 1993; Mullan & Markland, 1997; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997; Wilson & Rodgers, 2004). SDT describes the conditions under which different motives for action evolve and the resulting consequences of such motives. That is, the degree to which the social context fulfills the person's needs for autonomy, competence, and relatedness impacts on the quality of the person's motivation and psychological health. The need for autonomy refers to the desire of individuals to be the origin of their own behavior (Deci & Ryan, 1985). The need for competence reflects one's desire to interact effectively with one's environment and to experience opportunities to exercise and express one's capacities. This need is fulfilled when individuals experience the sense of producing desired outcomes and preventing undesirable ones (Deci & Ryan, 1985). The need for relatedness reflects feeling connected with significant others, cared for, and belonging into a given social milieu (Ryan, 1993). According to Deci and Ryan (2000), studying these needs is important because they give goals their psychological potence and determine which regulatory processes direct people's goal pursuits. Fulfillment of these innate needs underpins intrinsically motivated behavior and the internalization of extrinsically motivated behavior that in turn may lead to positive motivational outcomes such as concentration in exercise, exercise enjoyment, attitude and intention for exercise involvement (see Brickell, Chatzisarantis, & Pretty, 2006; Hagger, Chatzisarantis, & Harris, 2006; Vallerand, 2001; Vallerand & Rousseau, 2001). In line with the Hierarchical Model of Intrinsic and Extrinsic Motivation (HMIEM: Vallerand, 1997, 2001), the degree to which these

needs are fulfilled or impeded is determined by a multitude of factors worth studying to gain a better understanding of the determinants of exercise behavior through an intrinsic/extrinsic motivation perspective.

The Basic Psychological Needs in Exercise Scale (BPNES, Vlachopoulos & Michailidou, 2006) is a self-report instrument designed to assess individual differences in the extent to which the innate psychological needs for autonomy, competence, and relatedness are fulfilled in exercise. In line with Vallerand's (1997, 2001) hierarchical conceptualization of motivation, the three needs and types of motivation are conceptualized at three levels, that is, the global or personality level, the context or life-domain level, and the situational level positing top-down and bottom-up influences between these levels. Motivation at higher levels may influence motivation in lower levels while the reverse is also true. According to Ryan (1995) differences in the degree to which the three needs are fulfilled between domains may lead to differences in integration within individuals. Both Ryan (1995) and Vallerand (1997) have emphasized the importance of domain-specific motivation research and consequently the use of context-specific scales to explain and predict behavior accurately in different domains.

The BPNES comprises 12 items divided into three subscales representing the factors of autonomy, competence, and relatedness with four items in each subscale. Participants are asked to indicate the degree to which each of the needs is fulfilled in exercise. Responses are provided on a 5-point Likert scale ranging from 1 ("Totally disagree") to 5 ("Very strongly agree"). Vlachopoulos and Michailidou (2006) have provided satisfactory initial evidence for the structural validity of the BPNES responses through confirmatory factor analysis (CFA) on a sample of exercise participants different from the calibration sample used. In addition, they provided evidence of discriminant validity through demonstrating that the 3-factor BPNES CFA model was a statistical improvement over alternative 1-factor and 2-factor CFA models representing combinations of the BPNES factors. Further, evidence of generalizability validity was obtained through demonstrating factorial invariance across the calibration and the validation samples of private fitness centers exercise participants. The internal consistency indices were greater than .80 whereas test-retest reliability over 4 weeks demonstrated intra-class correlation coefficients greater than .90 for all three subscales. Predictive validity was also demonstrated through the use of latent variable

structural equation models significantly predicting frequency of concentration, levels of enjoyment/interest, attitude toward exercise, intention for continued exercise involvement, and internal locus of control from the three need constructs. Finally, BPNES responses were found to be largely unaffected by socially desirable responding and specifically the tendency for impression management.

In contrast to the large number of individuals attending organized exercise programs in private fitness centers, an equally large number of individuals attend organized exercise programs in community-based fitness centers. A distinguishing characteristic between these two contexts is that for the former participants, payment for using the facilities and abiding to payment-related contract rules constitute a major factor that may influence the participants' motivational processes for exercise involvement; in contrast, for the latter participants, this factor may be considered either negligible or even non-existent owing to either the extremely low cost or no cost of using community-based exercise facilities. Further, community exercise participants may select the community programs either because they are near to their residence or have an opportunity to exercise in a more homogeneous group. In line with this argument, McElroy (2002) holds that communities are more than geographic locations. Rather, a community includes a culture with values, norms, and attachments to the community as a whole and at the same time among its parts. A community is viewed as more than a grouping of people who have different common goals. It is viewed as a living organism, with interactive systems of relationships between people and their organizational structures (McElroy, 2002).

Given (a) that validation is an ongoing process requiring evidence collected from a number of sources and samples to determine the psychometric merit of an instrument (Messick, 1995), (b) that the community exercise context differs from the private fitness context, and (c) that evidence supporting the validity of the BPNES responses has emerged only from exercise participants attending private fitness centers (Vlachopoulos & Michailidou, 2006), this study was designed to extend the applicability of the BPNES into the community exercise context. Specifically, select psychometric properties of the BPNES responses were examined together with the extent to which the factor structure of the BPNES is invariant across the community and the private fitness center context.

While in the current exercise and sport psychology literature testing the factorial dimensionality of measures used in the research process has become common practice (Li, 1999; Markland & Ingledew, 1997; Roberts, Treasure, & Balague, 1998; Vlachopoulos & Michailidou, 2006), the examination of the assumption of invariance in measurement models across different samples has been limited (Li et al., 1998; Markland, Emberton, & Tallon, 1997; Standage, Treasure, Duda, & Prusak, 2003). Measurement invariance indicates the extent to which scale responses maintain their meaning across groups (Byrne, 1989). The tenability of measurement invariance is central to psychological measures as group comparison using a measure that is not invariant is worthless (Hoyle & Smith, 1994). That is, a lack of measurement invariance corresponds to comparing "apples and oranges" (Hoyle & Smith, 1994). In addition, meaningful direct group comparisons or pooling test scores across these populations would require evidence that the BPNES scores obtained from participants in these exercise contexts possess an invariant factor structure (Millsap & Kwok, 2004).

Therefore, the goals of the study were (a) to examine the factorial dimensionality of the scale; (b) the internal consistency reliability; (c) the predictive validity of the scale; and (d) the extent to which the factor structure of the BPNES is invariant across community and private fitness centers exercise participants. The hypotheses forwarded were that (a) the 3-factor CFA model would display an adequate fit to the data and a better fit compared to alternative models; (b) the internal consistency indices of the subscales would be greater than .70; (c) in line with findings based on BPNES responses obtained in private fitness centers the outcome variables will be mainly predicted by the need for competence except enjoyment/interest that it will also by predicted by the need for autonomy; and (d) that the BPNES factor structure will emerge invariant across the samples.

METHOD

Participants

Three samples were used in the present study. Sample 1 represented the community exercise context whereas Samples 2 and 3 the private fitness center context. The first sample was used for the psychometric evaluation of the BPNES whereas the second and third samples were employed for

the tests of measurement invariance across the community context and the private fitness context. Samples 2 and 3 were combined into one data set to represent the private fitness context (see below).

Community context exercise participants. Sample 1 (CES) consisted of 851 participants with an age range from 18 to 64 years (M = 34.16, SD = 10.85). There were 216 males (25.4%) and 635 females (74.6%). The participants' exercise experience ranged from a few months to 48 years (M = 7.43, SD = 6.15). The duration of daily exercise participation ranged from 30 min to 240 min (M = 70.55, SD = 24.93). Of the participants 523 (63%) were involved in aerobic type activities, 127 in weight training activities (15.3%), and 143 (17.2%) in both aerobic-type and weight-training whereas 37 (4.5%) did not report the type of activity they were involved in.

Private context exercise participants. Two samples were employed comprising individuals participating in private fitness centers. The first sample (Sample 2) comprised 508 participants from five fitness centers from the area of Thessaloniki, a city in northern Greece. There were 254 males (50%) and 254 females (50%). The participants' age ranged from 18 to 55 years (M = 30.06 yrs., SD = 8.13 yrs.). Their exercise experience ranged from few months to 38 years (M = 8.18 yrs., SD = 7.30 yrs.). They exercised daily for about 1 and 1/2 hours approximately (M = 84.55 min., SD = 29.69 min.) while the maximal reported duration of their daily exercise activity was 4 hours. One hundred and two participants (20.1%) were mainly involved in group-type activities such as aerobics, body pump, tae-bo, and cycling, 313 participants (61.6%) were involved in conventional weight-training activities such as free style weight-lifting and "cardio-theatre", while 93 participants (18.3%) were involved in a combination of the above activities.

The second sample (Sample 3) comprised 504 participants. There were 246 males (48.8%) and 258 females (51.2%) aged between 18 and 65 years (M = 28.92 yrs., SD = 8.45 yrs.). The participants' exercise experience ranged from few months to 45 years (M = 6.88 yrs., SD = 6.91 yrs.). In general, daily exercise involvement ranged from 40 to 240 minutes (M = 85.08, SD = 30.08). Of the participants 109 (21.6%) reported that they participated in aerobic training programs, 280 participants (55.6%) that they were involved in weight training activities, and 108 participants (21.4%) that they were involved in various other activities. The two samples equaled the number of 1012 exercise participants attending private fitness centers.

Comparison of private fitness center samples

To examine the extent to which the two private fitness center samples differed in characteristics such as participants' age, exercise experience, number of days attending exercise classes weekly, and daily time spent exercising, a MANOVA was computed between the two samples (Samples 2 and 3) using the above characteristics as the dependent variables. After a significant multivariate effect, Hotelling's trace = .01, $F(4, 987) = 3.01, p < .05$, the univariate analyses revealed significant effects for both age, $F(1, 990) = 4.68, p < .05, \eta^2 = .005$, and years of exercise experience, $F(1, 990) = 9.98, p < .01, \eta^2 = .010$, but neither for days exercising per week, $F(1, 990) = 0.60, p > .05, \eta^2 = .001$, nor for minutes exercising per exercise session, $F(1, 990) = 0.02, p < .05, \eta^2 = .000$. Despite that the samples differed on age and years of exercise experience, the n^2 effect sizes demonstrated that almost 0% of the age variance, 1% of the exercise experience variance, and 0% of the days and minutes variances were explained by the samples (Vincent, 1995). Hence, it was concluded that the samples did not differ on any of these demographic characteristics. Taking into account that both samples comprised exercise participants attending private fitness centers, the samples were combined into one data set for analysis purposes.

Measurement tools

Basic Psychological Needs in Exercise Scale. The BPNES comprises 12 items developed in Greek (see Appendix) that assess the degree to which the innate needs for autonomy, competence, and relatedness are satisfied in exercise. Each subscale comprised 4 items. Participants were asked to indicate the degree of their agreement with 12 statements providing their responses on a 5-point Likert scale anchored by 1 (Do not agree at all), 2 (Agree a little bit), 3 (Moderately agree), 4 (Strongly agree), and 5 (Very strongly agree). Sample items for Autonomy included "The exercise program I follow is highly compatible with my choices and interests" and "I feel very strongly that the way I exercise fits perfectly the way I prefer to exercise"; For Competence "I feel I have been making a huge progress with regard to the end result I pursue" and "I feel that I can manage with the requirements of the training program I am involved"; and Relatedness "I feel extremely comfortable when being with the other exercise participants" and "I feel that I associate with the other exercise participants in a very friendly way". To examine the predictive validity of the BPNES responses a number of outcome variables were assessed. These were

concentration during exercise, enjoyment/intrinsic interest, attitude toward exercise participation, and intention for continued exercise involvement.

Concentration during exercise. To evaluate the participants' frequency of concentration during their exercise participation, four items were used that were adopted from the Trait Flow Scale (TFS, Jackson, Kimiecik, Ford, & Marsh, 1998). The items assessed the frequency with which participants made particular thoughts during exercise. Following the stem "In general, during my involvement in this activity...", participants were requested to think how often they experienced the following thoughts: "My attention is focused entirely on what I am doing", "It is no effort to keep my mind on what is happening", "I have total concentration", and "I am completely focused on the task at hand". The participants were requested to report the frequency of each thought on the following Likert scale: 1 (Never), 2 (Rarely), 3 (Sometimes), 4 (Often), and 5 (Always). The Cronbach's alpha for the subscale was .87 for the community sample.

Enjoyment-Intrinsic interest. To assess the participants' levels of exercise enjoyment/intrinsic interest, the enjoyment-intrinsic interest subscale of the Intrinsic Motivation Inventory (IMI, McAuley, Duncan, & Tammen, 1989) was used. This subscale has been successfully adapted for the Greek physical education context (Goudas, Dermitzaki, & Bagiatis, 2000) and was adapted for use in exercise. Participants were requested to report the extent of their agreement with 5 items on a Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). Sample items[1] were "I would describe my participation in this activity as very interesting" and "I have a lot of fun when I participate in this activity when I exercise". Cronbach's alpha for the community sample was .77.

Attitude toward exercise. The question "I think that participating in exercise five times per week is..." was used to evaluate the participants' attitude toward exercise participation. The participants provided their responses to 4 bipolar adjectives on a 6-point semantic differential scale (i.e., 1-extremely boring; 6-extremely interesting; see Ajzen & Fishbein, 1980). The adjectives used were "boring-interesting", "harmful-beneficial", "pleasant-unpleasant", and "important-unimportant". Cronbach's alpha for the community sample was .84.

Behavioral intention. To assess the participants' intention for continued exercise participation, the following items were used: "I intend/I will try/I am determined to continue exercising five times per week for the remaining of the

1. The BPNES sample items presented have not been systematically translated from Greek and are presented for conveying to interested nonGreek-speaking readers their meaning.

year" (Ajzen & Fishbein, 1980). The participants provided their responses on a semantic differential scale ranging from 1 (Extremely unlikely) to 6 (Extremely likely). Cronbach's alpha for the community sample was .96.

Procedure

Owing to a lack of a comprehensive list of community fitness centers, convenience sampling was used. Data were collected from community fitness centers in the cities of Thessaloniki and Athens in Greece, thus enhancing the representativeness of the findings. Initially, permission was granted from the fitness center managers to conduct the study. Participants were approached before initiation of their daily exercise class and were requested to participate in the study. Participants were intercepted at the reception area every second individual and data were collected during morning, afternoon and evening classes before initiation of the exercise class. The purpose of the study was explained to them, confidentiality and anonymity were assured, and they were asked to sign an informed consent form for their participation. Then, the questionnaire was completed. Participants were thanked for their participation.

Data analysis

To examine the dimensionality of the BPNES a 3-factor confirmatory factor analysis (CFA) model was computed. The twelve BPNES items were specified to load only onto the factor intended to define, the cross-loadings were fixed to zero, the factor variances were fixed to unity, and the factors were free to correlate. Item residuals were not allowed to correlate. To examine the discriminant validity of the scale, the 3-factor model was compared and contrasted to three 2-factor BPNES CFA models, each one specifying the items of a pair of factors to load onto the same factor. The three models corresponded to all possible pairs of BPNES factors. In addition, it was contrasted to a 1-factor model and a hierarchical CFA model positing a higher-order factor to represent the correlations between the first-order need factors. The alternative models were estimated on Sample 1.

The EQS 5.7 software was used (Bentler, 1995). Both absolute and incremental fit indexes were employed to evaluate model fit (Hoyle & Panter, 1995). The absolute index used was the chi-square statistic to examine the goodness of fit between the data-implied and the model-implied covariance matrices. Because the chi-square statistic is highly sensitive to sample size (Hu

& Bentler, 1995), model fit assessment was complemented by means of incremental fit indexes. These indexes were the Non-normed Fit Index (NNFI) and the Comparative Fit Index (CFI) that assess the degree of improvement of the target model over the model that specifies no covariances. The NNFI assesses the models' improvement over the null model per degree of freedom (Hoyle & Panter, 1995). The CFI may range from 0 to 1 and is relatively unaffected by sample size (Byrne, 1995). NNFI and CFI values greater than .90 indicate a good fit of the model to the data (Hu & Bentler, 1995) whereas values of .95 or greater indicate an excellent fit (Hu & Bentler, 1999). In addition, the RMSEA was employed to examine the differences between the observed and the implied covariance matrices. Values close to .06 or lower indicate an adequate model fit (Hu & Bentler, 1999) whereas .10 is the upper limit (Byrne, 2000).

To examine the predictive validity of the BPNES responses in the community exercise context a number of latent variable structural equation models (SEM, Ullman, 1996) were estimated using the latent need constructs as the predictor variables and each of the outcome measures as the latent dependent variable. Using SEM was justified to examine the unique influence of each of the latent need constructs in predicting the motivational consequences.

To examine the degree of factorial invariance of the BPNES responses across participants attending private and community-based fitness centers the EQS (Bentler, 1995) software was used. A number of multi-group CFA models were tested in line with the order suggested by Cheung and Rensvold (2002): First, the totally non-invariant model testing the hypothesis of configural invariance (Model 1). If this model does not fit the data, then, multi-group models with additional constraints will not fit either (Marsh, 1993). This model tested the hypothesis that BPNES responses representing the different exercise contexts would reflect conceptualization of the need constructs in the same way (Cheung & Rensvold, 2002). Second, a multi-group model with factor loading equality constraints that tested the hypothesis of metric invariance (Model 2), that is, the equivalence of the strength of the item-factor relationships across samples (Cheung & Rensvold, 2002). Meaningful cross-group comparison necessitates metric invariance (Bollen, 1989). Sometimes, the strength of factor loadings may differ across the groups indicating disagreement with regard to the way the construct is manifested (Cheung & Rensvold, 2002). In case that few factor loadings appear non-invariant, cross-group comparison may still be meaningful because few items will not seriously

affect comparison between samples (partial metric invariance: Byrne, Shavelson, & Muthen, 1989; Marsh & Hocevar, 1985). Third, a multi-group model (Model 3) with equality constraints on the residuals of the items found to have invariant factor loadings in Model 2. This model tested the hypothesis that the amount of measurement error of the scale items was the same across exercise contexts. This is the least important hypothesis to test (Bentler, 1995). Fourth, a multi-group model (Model 4) with equality constraints on the intercepts of those items found to have invariant factor loadings in Model 2. This model tested the hypothesis of scalar invariance that is a prerequisite for meaningful cross-group latent mean comparison.

The same overall fit indices used to assess model fit in the single-group CFA models were also used in the multi-sample tests. The most appropriate index to examine differences between the multi-group models is the CFI because it is not affected by sample size and model complexity and is not correlated with overall fit measures (Cheung & Rensvold, 2002). A CFI change smaller than or equal to –0.01 indicates that the null hypothesis of invariance should not be rejected (Cheung & Rensvold, 2002).

RESULTS

Structural validity and internal consistency

The extent of multivariate non-normality of the data was examined using Mardia's (1970) coefficient of multivariate kurtosis. The coefficient was 73.11 for the 12 BPNES items indicating multivariate normality of the data. This value is smaller than the cut-off point of 168 suggested by the formula p(p+2) for estimating the limit of departure from multivariate normality. In this formula, p equals the number of observed variables (Bollen, 1989). Owing to the multivariate normality of the data, the Maximum Likelihood method of estimation was used.

The goodness-of-fit indexes of the 3-factor CFA BPNES model revealed an excellent fit of the model to the data (Table 1). The factor loadings ranged from .59 to .90. The latent factor correlations were .76 between Autonomy and Competence, .63 between Autonomy and Relatedness, and .64 between Competence and Relatedness, all significant at $p < .05$. Chi-square difference tests compared the 3-factor BPNES model with alternative 2-factor CFA models, a 1-factor model and a

Table 1. Goodness-of-fit indexes for the 3-factor and alternative CFA BPNES models among community exercise participants

CFA model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	NNFI	CFI	RMSEA	RMSEA 90% CI
3-factor model	209.87	51	.001	--	--	.971	.977	.061	.052 - .069
Autonomy/competence	600.32	53	.001	390.45*	2	.903	.922	.110	.102 - .118
Autonomy/relatedness	1212.19	53	.001	1002.32*	2	.794	.834	.160	.153 - .168
Competence/relatedness	1211.47	53	.001	1001.60*	2	.794	.834	.160	.152 - .168
1-factor model	1821.24	54	.001	1611.37*	3	.691	.747	.196	.188 - .204
Hierarchical model	209.87	51	.001	0	0	.971	.977	.061	.052 - .069

Note. Chi-square comparisons are performed between the 3-factor model and each one of the alternative models based on Sample 1. $N = 851$, $^*p < .05$.

hierarchical model positing a higher-order factor to represent the relationships between the first-order factors. The comparisons demonstrated that the 3-factor model was a significant improvement over the 2-factor models and the 1-factor model whereas it appeared equivalent to the hierarchical BPNES model (Table 1).

Regarding the hierarchical BPNES model, the second order factor loadings were .868 for autonomy (disturbance = .496; 75% variance explained by the higher order factor), .884 for competence (disturbance = .468; 78% variance explained by the second order factor) and .730 for relatedness (disturbance = .684; 53% variance explained by the second order factor).

The Cronbach's alpha values for the BPNES subscales were .84 for autonomy, .86 for competence, and .92 for relatedness. The Pearson's correlations were .76 between Autonomy and Competence, .63 between Autonomy and Relatedness, and .64 between Competence and Relatedness. The alpha values for the outcome variables were .82 for concentration, .77 for enjoyment/interest, .84 for attitude, and .96 for intention.

Predictive validity

All of the structural equation models displayed a good fit to the data (Table 2). The motivational consequences were concentration, enjoyment/interest, attitude toward exercise, and intention for continued exercise involvement. The results showed that the hypothesis (c) was supported (Table 2). It was the need for competence that played the most important role in predicting the motivational outcomes. Only enjoyment/interest was significantly predicted by all three need constructs.

Table 2. Standardized structural coefficients and goodness-of-fit indexes of SEMs predicting motivational consequences from the need constructs

Structural coefficients and goodness-of-fit indices	Concentration	Enjoyment/interest	Attitude	Intention
Autonomy beta	.11	.34*	.09	.07
Competence beta	.34*	.31*	.33*	.28*
Relatedness beta	.04	.17*	.09	.01
χ^2	299.79	361.46	485.71	259.12
df	98	113	98	84
p	.001	.001	.001	.001
NNFI	.974	.966	.945	.978
CFI	.978	.972	.955	.983
RMSEA	.049	.051	.069	.050
RMSEA 90%CI	.043 - .056	.045 - .057	.063 - .075	.043 - .056
Variance explained	21%	56%	22%	12%

Note. SEMs = structural equation models. Analyses were performed on the community exercise sample (Sample 1: $N = 851$). *$p < .05$.

Measurement invariance

Before proceeding to test the increasingly constrained BPNES measurement invariance models across the community and the private fitness contexts, the factor structure of the BPNES should be established separately for the private fitness context sample as well. Hence, the 3-factor CFA model was tested on the BPNES responses of the 1012 participants attending private fitness centers. The CFA model displayed a good fit to the data (Table 3).

The measurement invariance tests were initiated with the totally non-invariant model (Model 1) that displayed adequate overall fit indexes showing that it may serve as a baseline model for testing models with more restrictions on various sets of parameters (see Table 3). Model 2 tested the hypothesis of invariant item-loadings across the two contexts. Despite the excellent overall fit indexes of the model, the chi-square difference test showed that Model 2 was significantly worse than Model 1 (Table 3). However, the ΔCFI value of 0 demonstrated that the hypothesis of metric invariance should not be rejected (Cheung & Rensvold, 2002). The Lagrange Multiplier test (LM test) showed that the fourth Autonomy item-loading and the first and second Relatedness item-loadings were non-invariant across contexts indicating partial metric invariance. Model 3 examined the extent to which the BPNES item residuals are invariant across contexts (Table 3). Measurement error constraints were added on the items with invariant item-loadings. Model 3 fit the data very well (Table 3). Based on the chi-square difference test, Model 3 appeared significantly worse than

Table 3. Goodness-of-fit indexes for the exercise context measurement invariance models

CFA model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	NNFI	CFI	RMSEA	RMSEA 90% CI
3-factor private context model	149.44	51	.001	--	--	.982	.986	.044	.036 - .052
Multi-sample model 1: Configural invariance	359.30	102	.001	--	--	.976	.982	.037	.033 - .041
Multi-sample model 2: Metric invariance	390.26	114	.001	30.96*[a]	12	.977	.980	.036	.032 - .040
Multi-sample model 3: Measurement error invariance	478.37	120	.001	88.11*[b]	6	.972	.974	.040	.036 - .044
Multi-sample model 4: Scalar invariance	566.10	118	.001	175.84* [b]	4	.964	.968	.045	.041 - .049

Note. Private fitness context group: N = 1012; Community fitness context group: N = 851. [a] model compared with Model 1. [b] model compared with Model 2; *significantly different at $p < .05$.

Model 2 (Table 3). However, the ΔCFI value of -0.01 led to not rejecting the null hypothesis of measurement error invariance. The LM test revealed that the items Autonomy 1, Competence 1 and 2, and Relatedness 3 and 4 displayed non-invariant item residual variances indicating partial measurement error invariance. Model 4 examined the extent to which the equality constraints imposed onto the item intercepts of the items with invariant item-loadings were tenable. The overall fit indexes revealed an excellent fit to the data. Whereas the χ^2 difference test showed that Model 4 was worse than Model 2, the ΔCFI of .01 indicated that this was not true (Table 3). Based on the χ^2 univariate increment associated with each item intercept equality constraint within the LM test, the item intercepts that appeared non-invariant were associated with the Autonomy 1, 2, and 3, Competence 2 and 4, and Relatedness 3 and 4 items. However, the constraints that seriously contributed to the increase of the overall model χ^2 if released, were associated with the Autonomy 1 (χ^2 = 102.60), Autonomy 3 (χ^2 = 11.99), Relatedness 3 (χ^2 = 26.12) and Relatedness 4 (χ^2 = 29.01) items. All of the remaining constraints were associated with negligible χ^2 change values (smaller than 10). These values justify the phenomenon that whereas a number of item intercept equality constraints were found not to hold, the scalar invariance model (Model 4) was not significantly different than the partial metric invariance model (Model 2). Hence, it was concluded that, overall, the scalar invariance hypothesis was not rejected.

With respect to the multi-group model comparisons, the differences reported based on the chi-square difference tests may be influenced by sample size. Following Cheung and Rensvold's (2002) suggestions regarding

the efficiency of the ΔCFI as the most appropriate index to examine multi-group differences, the results supported a lack of difference among all the multi-sample models. The BPNES item loadings based on the multi-sample Model 4 ranged from .54 to .90.

DISCUSSION

Exercise participants attending community-based fitness centers represent a large part of the exercising population in which the study of the psychology of exercise maintenance and dropout is deemed appropriate. Given the ongoing nature of the validation process for newly developed instruments (Marsh, 1997), and the need to accumulate evidence from a number of sources and samples to determine the psychometric merit of an instrument (Messick, 1995), the present study extended the application of the BPNES to community exercise participants. The structural and the predictive validity of the BPNES responses of exercise participants attending community-based fitness centers were examined together with the extent of measurement invariance of BPNES responses across the two contexts.

Structural validity

The structural validity results supported the hypothesized 3-factor structure of the BPNES responses demonstrating strong item-factor relationships. The finding that the 3-factor model was a significant improvement over the alternative 2-factor models supported the distinctiveness between the three need latent factors. Also, the finding that the 3-factor model was significantly better than the 1-factor model demonstrated that the 12 BPNES items are not perceived as indicators of the same construct, as such a conclusion would necessitate an adequate fit of the 1-factor CFA model. Thus, the 12 BPNES items should not be used in computing a single need satisfaction mean score.

The equally good fit of the hierarchical BPNES model with the 3-factor model leaves unanswered questions about whether the three need constructs may be represented by a higher order need construct. From a technical viewpoint, such a finding is justified by the considerable latent factor correlations between the need constructs that result into strong second-order factor loadings, thus, facilitating a good fit of the hierarchical

model. However, SDT theorists posit that each one of the needs plays a distinct and necessary part in optimal development so than none can be neglected without significant negative consequences (Deci & Ryan, 2000). Such a theoretical proposition, justifies assessing the three need constructs as separate constructs rather than using a global latent need score to determine the role of each one of the basic psychological needs in exercise participants' motivational processes. That is, despite the technical representation of the three need constructs by a higher order construct, using the higher order construct is not theoretically justified and is not recommended in research. Further, the internal consistency of the subscales was supported. The results are in agreement with data presented by Vlachopoulos and Michailidou (2006) demonstrating evidence of adequate structural validity of the BPNES responses obtained from participants attending private fitness centers.

Predictive validity

The results of the SEM analyses supported the predictive validity of the BPNES responses. The results were very close to the predictive validity results reported by Vlachopoulos and Michailidou (2006) based on data from private fitness centers. Specifically, the results from the two studies were similar, in that, only the need for competence emerged as a significant predictor of concentration, attitude, and intention. With respect to enjoyment/interest in both studies, both the needs for autonomy and competence emerged as significant predictors; however, in the community exercise context the need for relatedness also played a significant predicting role for this outcome variable. In accord with Elliott, McGregor, and Thrash (2002), the need for competence aims at the experience of pleasure of accomplishment per se, and that the natural urge to seek competence for its own sake is often clearly observed in the form of effectence pursuits. Thus, the fact that the element of accomplishment is central to exercise may justify the central role of the need for competence in the motivational processes of exercise participants. This is in agreement with a number of studies demonstrating that interest/enjoyment and competence motives have proven major determinants of adherence to exercise and more effective predictors than body-related motives (Frederick-Recascino, 2002). The implication of the present finding for practitioners is the importance of providing an exercise environment appropriately designed to fulfill the

participants' need for competence. Behaviors that support competence and may be implemented in organized exercise programs include removing barriers to efficient performance, agreeing on achievable goals, providing optimal challenges, allowing regular constructive feedback, not offering too much negative feedback at once, and allowing the person time to address one's mistakes whenever possible (Baard, 2002). Exercise-applicable behaviors supportive of autonomy include allowing choice in the activity selected to achieve a goal or in the level of difficulty a task will be performed, permitting failure, trying to understand the participants' perspective, providing feedback in a non-controlling manner, using an assertive rather than a controlling communication style, and using rewards as affirmation of progress and efficient task performance (Baard, 2002).

The finding that the need for relatedness predicted significantly enjoyment/interest in the community exercise context independent of the needs for competence and autonomy may alert us to its motivational significance for this particular context. This may indicate that an additional reason for exercise participation in the community fitness centers in contrast to participation in private fitness centers may be the desire for social interaction and a sense of belonging. This finding is in line with the characteristics of the community discussed by McElroy (2002). Hence, researchers may study the possible differential significance of the need for relatedness for the motivational dynamics of exercise participants across the private and the community exercise contexts. Relatedness-supportive behaviors of the exercise instructor may include being easily accessible to all of the exercise participants and not encouraging competition but rather setting reward structures that promote cooperation (Baard, 2002).

Measurement invariance

The present findings provided considerable support for the measurement invariance properties of the BPNES responses across exercise participants in the private and the community exercise contexts. Support for the configural model (Model 1) indicated that for both samples the same set of items was found to be associated with the same constructs or put differently the samples did attach the same meaning to the constructs assessed by the BPNES (Cheung & Rensvold, 2002).

With respect to the metric invariance properties of the scale responses, partial metric invariance was supported as nine out of the twelve item

loadings appeared to be invariant across exercise contexts. The non-invariant items were the Autonomy 4 "I feel very strongly that I have the opportunity to make choices with respect to the way I exercise", the Relatedness 1 "I feel extremely comfortable when being with the other exercise participants", and Relatedness 2 "I feel that I associate with the other exercise participants in a very friendly way" item-loadings. The equivalence of the item-factor relationships across exercise contexts demonstrated that the constructs were manifested in the same way across the samples (Cheung & Rensvold, 2002) or in other words demonstrated the same scale intervals across groups (Steenkamp & Baumgartner, 1998). When metric invariance holds, the observed item differences are indicative of similar cross-group differences in the underlying construct (Steenkamp & Baumgartner, 1998). Equivalence of factor loadings across the samples is a prerequisite for meaningful and valid cross-group comparisons (Bollen, 1989). The few non-invariant item loadings may be attributed to the differential exercise experience of the participants across the exercise contexts.

Regarding the measurement error invariance hypothesis the multi-sample model displayed a good fit to the data. Out of the nine item-residuals constrained to be equal based on the invariant item loadings five appeared non-invariant. Hence, the measurement error invariance hypothesis was partially supported (partial measurement error invariance). However, this hypothesis is the least important hypothesis to test in factorial invariance analyses (Marsh, 1993). In general, not all of the BPNES items assessed the constructs of interest with the same degree of measurement error or put differently, displayed the same quality as indicators of the innate psychological need constructs across the exercise contexts (Cheung & Rensvold, 2002).

The scalar invariance multi-sample model was also supported. The constraints with the greatest impact onto the increase of the overall model χ^2 value, if released, were those associated with Autonomy 1 and 3 and Relatedness 3 and 4. Invariance of the item intercepts is necessary for comparing latent means because it demonstrates the same operational definition, i.e., identical intervals and zero points of the scale items across the samples (Cheung & Rensvold, 2002). When scalar equivalence does not hold, latent means cannot be compared because the cross-group differences in the latent means may be confounded with the scale and the origin of the latent variable (Cheung & Rensvold, 2002). The present measurement invariance findings supported valid cross-group comparisons at the latent

mean level and/or pooling BPNES scores across the private fitness context and the community exercise context.

Overall, the present findings are in agreement with previous research supporting the construct validity of BPNES responses with participants attending private fitness centers (Vlachopoulos & Michailidou, 2006) where the dimensionality of the scale responses, the distinctiveness of the need factors, the internal consistency, and the predictive aspect of the BPNES scores' validity were supported. The present results extend the evidence base supporting the construct validity of the BPNES to exercise participants attending community-based exercise programs highlighting its appropriateness in testing theoretical propositions offered by SDT in this exercise context.

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APPENDIX

Η Κλίμακα των Βασικών Ψυχολογικών Αναγκών στην Άσκηση [The Basic Psychological Needs in Exercise Scale (BPNES)]

Οδηγίες: Οι προτάσεις που ακολουθούν αναφέρονται γενικά στην εμπειρία σας σε αυτό το χώρο άσκησης και όχι σε κάποια συγκεκριμένη προπόνηση. Χρησιμοποιώντας την παρακάτω κλίμακα 1-5, παρακαλούμε σημειώστε κατά πόσο συμφωνείτε με τις προτάσεις αυτές βάζοντας σε κύκλο έναν αριθμό για κάθε μία πρόταση.

Σε αυτό το χώρο άσκησης...	**Δε συμφωνώ καθόλου**	**Συμφωνώ λίγο**	**Συμφωνώ μέτρια**	**Συμφωνώ πολύ**	**Συμφωνώ πάρα πολύ**
1. Αισθάνομαι ότι έχω πολύ μεγάλη πρόοδο σε σχέση με το αποτέλεσμα που θέλω να πετύχω	1	2	3	4	5
2. Αισθάνομαι πάρα πολύ άνετα όσον αφορά τις σχέσεις μου με τους άλλους ασκούμενους	1	2	3	4	5
3. Ο τρόπος που γυμνάζομαι συμφωνεί απόλυτα με τις επιλογές μου και τα ενδιαφέροντά μου	1	2	3	4	5
4. Νιώθω ότι εκτελώ πολύ αποτελεσματικά τις ασκήσεις του προγράμματος που ακολουθώ	1	2	3	4	5
5.Οι σχέσεις μου με τους άλλους ασκούμενους είναι πάρα πολύ φιλικές	1	2	3	4	5
6. Νιώθω πάρα πολύ έντονα ότι ο τρόπος που γυμνάζομαι είναι και ο τρόπος που θα ήθελα	1	2	3	4	5
7. Αισθάνομαι ότι η άσκηση είναι μία δραστηριότητα στην οποία τα πηγαίνω πάρα πολύ καλά	1	2	3	4	5
8. Αισθάνομαι ότι έχω άριστη επικοινωνία με τους άλλους ασκούμενους	1	2	3	4	5
9. Αισθάνομαι ότι ο τρόπος που ασκούμαι με εκφράζει απόλυτα	1	2	3	4	5
10. Ανταποκρίνομαι με πολύ μεγάλη άνεση στις απαιτήσεις του προγράμματος που ακολουθώ	1	2	3	4	5
11. Οι σχέσεις μου με τους άλλους ασκούμενους είναι πάρα πολύ οικείες	1	2	3	4	5
12. Αισθάνομαι πάρα πολύ έντονα ότι έχω τη δυνατότητα να κάνω επιλογές σχετικά με τον τρόπο που γυμνάζομαι	1	2	3	4	5

Κλειδί απαντήσεων: Αυτονομία: 3, 6, 9, 12. Ικανότητα: 1, 4, 7, 10. Σχέση με άλλους: 2, 5, 8, 11