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The Basic Psychological Need Satisfaction and Frustration Scale in Exercise (BPNSFS-E): Validity, Reliability, and Gender Invariance in Portuguese Exercisers

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Abstract

The aim of this study was to translate and validate the Basic Psychological Need Satisfaction and Frustration Scale for Portuguese exercisers. In addition, we sought to analyze gender invariance. We collected data from two independent samples of Portuguese respondents—a calibration sample with 316 participants and a validation sample with 632 participants. Results from confirmatory factor analysis supported the original six-factor model in both the calibration sample, $\chi^2(237) = 471.814$, $\chi^2/df = 1.99$; B–S $p < .001$, Comparative Fit Index = .935, Tucker–Lewis Index = .924, standard mean root square residual = .047, root mean square error of approximation = .057 (90% confidence interval = [.050, .065]), and the validation sample, $\chi^2(237) = 571.796$, $\chi^2/df = 2.41$; B–S $p < .001$, Comparative Fit Index = .948, Tucker–Lewis Index = .940, standard mean root square residual = .038, root mean square error of approximation = .047 (90% confidence interval = [.042, .052]). Moreover, our analysis revealed acceptable internal consistency, convergent and

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discriminant validity of the translated version, and invariance between the two samples and between genders as differences across latent means showed that magnitude effects were trivial between samples and between male and female exercisers. These results support the use of the adapted scale among both male and female exercisers.

Keywords
self-determination theory, basic psychological needs, measurement invariance, latent means, exercise

Introduction

Although it is widely accepted that regular exercise offers health benefits, 46% of Europeans are physically inactive (Eurobarometer, 2018). Awareness of exercise health benefits seems insufficient for changing sedentary behaviors. According to the literature (e.g., Edmunds, Ntoumanis, & Duda, 2008; Rodrigues et al., 2018), motivation plays a major role when it comes to exercise participation (Radel et al., 2017), and it has a significant impact on exercise enjoyment (Murcia, Román, Galindo, Alonso, & González-Cutre, 2008). [AQ1] Motivational factors partly depend on whether basic psychological needs (BPNs; R. Ryan & Deci, 2017) are satisfied or frustrated. Therefore, it is crucial to understand how BPNs influence motivation in exercisers' behavior, making it equally important to measure BPN accurately for exercisers in various countries. Thus, the aim of this study was to translate and validate a measurement scale for BPN based on self-determination theory (SDT; Deci & Ryan, 1985) to analyze basic psychological need satisfaction and frustration among Portuguese exercisers.

SDT and Basic Psychological Needs in Exercise

SDT (Deci & Ryan, 1985) is the most relevant theoretical framework for understanding human behavior, and it has been used to assess exercise-related outcomes (Thogersen-Ntoumani, Shepherd, Ntoumanis, & Wagenmakers, 2015; Teixeira et al., 2012). [AQ2] This macrotheory states that the BPNs of autonomy, competence, and relatedness are innate to all human beings regardless of race, gender, and cultural background, and BPNs are responsible for how someone regulates his/her motivation toward a behavior (B. Chen et al., 2015; R. Ryan & Deci, 2017). According to Deci and Ryan (2000), autonomy satisfaction refers to an individual's need to control his/her own behavior while enjoying freedom during interactions with the environment. Competence satisfaction involves feeling effective and capable of improving and mastering new skills (B. Chen et al., 2015). Relatedness satisfaction consists of a person's need to develop emotional connections and affective interactions with others (Vansteenkiste & Ryan, 2013). Satisfaction of the three BPNs carries several

positive outcomes by contributing to one's physical and psychological development (Deci & Ryan, 2000).

On the other hand, individuals can also experience BPN frustration. Autonomy frustration involves feelings of being controlled by external or self-imposed pressures (B. Chen et al., 2015). Competence frustration refers to self-doubt in one's capacity to act efficiently (Cordeiro, Paixão, Lens, Lacante, & Luyckx, 2016). Frustration of relatedness is associated with social exclusion and feelings of loneliness (Bartholomew, Ntoumanis, Ryan, & Thogersen-Ntoumani, 2011). **[AQ3]** When individuals perceive their BPNs to be frustrated, they experience feelings of ill-being, enhancing the likelihood of exercise dropout behavior (Edmunds et al., 2008).

It is important to distinguish between low levels of BPN satisfaction (or dissatisfaction) and outright frustration. Low levels of satisfaction are not necessarily indicators of high levels frustration; rather, they may simply suggest that the person is not satisfied with how his/her needs are being met (Bartholomew et al., 2011). That is, BPN's frustration is an active process and more significant than the mere absence of satisfaction (Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013). Moreover, difficulties exercisers experience executing a certain exercise may not indicate competence frustration but, rather, low competence satisfaction. In contrast, exercisers who receive negative feedback from exercise professionals about their exercise technique might experience competence frustration. Differences between needs satisfaction and frustration may result from how the social environment interacts with the individual and how the individual experiences those interactions (Vansteenkiste & Ryan, 2013). This theoretical construct is hard to operationalize, as there is no clear evidence as to whether the participant's experienced feeling is of frustration or low satisfaction toward the same need.

According to SDT, BPN satisfaction predicts more autonomous forms of motivation (labeled as identified regulation, integrated regulation and intrinsic motivation), with intrinsic motivation being the prototype of optimal self-determined behavior in which the individual performs the behavior volitionally (R. Ryan & Deci, 2017), ultimately leading to a higher likelihood of maintaining the behavior over the long run (Ng, Ntoumanis, Thogersen-Ntoumani, Stott, & Hindle, 2013). In addition, BPN satisfaction have been associated with enjoyment (Monteiro, Pelletier, Moutão, & Cid, 2018; Murcia et al., 2008). On the other hand, it is likely that BPN frustration is related to more controlled forms of motivation (labeled as external regulation and introjected regulation), leading to higher levels of dropout behavior (R. Ryan & Deci, 2017; Teixeira, Silva, & Palmeira, 2018). Past research (e.g., B. Chen et al., 2015; Longo, Alcaraz-Ibánez, & Sicillia, 2018) has shown that the frustration of basic psychological needs negatively impacts different behavioral and emotional outcomes, such as satisfaction with life, subjective vitality, and burnout.

Although BPN satisfaction is well described in the literature, BPN frustration based on the SDT framework has only recently been explored empirically.

Bartholomew et al. (2011) developed the Psychological Need Thwarting Scale to analyze only BPN frustration in respondents' first participation in sports. As this scale displayed good consistency and predictive validity, other authors have also used it (Gunnel et al., 2013; Ng et al., 2013). These studies showed that there is a difference between low levels of BPN satisfaction and high levels of BPN frustration.

Later, B. Chen et al. (2015) developed the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) based on two studies, one with a sample of 324 Chinese adolescents and 359 Belgian adolescents, and another with a sample of 1,051 university students drawn from four nations (298 Americans, 309 Chinese, 200 Dutch, and 244 Peruvians). This multidimensional scale simultaneously assesses both BPN satisfaction and BPN frustration simplifying the applicability process (i.e., one scale assessing all six needs), showing good internal consistency and cultural invariance among participants from all four countries. This scale was successfully translated into Italian with an adult population (Costa et al., 2018) and into Portuguese with a college population (Cordeiro et al., 2016).

Gender Differences in the Exercise Context

SDT research has assumed that BPN constructs can be applied to human beings universally, with no differences across age, gender, and ethnicity (Ryan & Deci, 2000). **[AQ4]** These needs have seemed to be important predictors of motivational regulations universally. However, few studies have compared BPN satisfaction (and none have compared BPN frustration) between genders in the exercise context. Only Vlachopoulos (2008) demonstrated that male and female exercisers experienced BPN satisfaction similarly. More studies are needed to further our understanding of how male and female exercisers from different cultural backgrounds experience BPN satisfaction and especially BPN frustration.

Current Research

In this study, we aimed to translate and validate the Basic Psychological Need Satisfaction and Frustration Scale for Portuguese exercisers. In addition, we also sought to analyze nomological validity with behavioral regulations and enjoyment and to analyze presumed gender invariance. According to the literature, BPN constructs are assumed to be universal in their influence on human motivation (Deci & Ryan, 2000), and several studies have supported this view (e.g., B. Chen et al., 2015; Teixeira et al., 2012). Although Cordeiro et al. (2016) validated the BPNSFS Portuguese version in college students, their scale was not adapted for, nor applicable to, exercisers. In addition, they did not measure temporal stability or invariance between groups, two important analyses to

support instrument validity (Chen, 2008). [AQ5] M. Ryan (1995) suggested that SDT research should be conducted within specific cultural contexts and argued that scales validated in one context should not be used in another prior to proper cross-cultural validation. Accordingly, M. Ryan (1995) called for the development and use of adequate questionnaires developed specifically for each given context. This view was also highlighted by Teixeira et al. (2018) when applying the original BPNSFS English version to 153 Portuguese exercisers. Following good exploratory factor analysis indicators, Teixeira et al. (2018) suggested that this instrument should undergo proper validation. In addition, considering the difference between BPN satisfaction and frustration constructs, B. Chen et al. (2015) reported the need for additional evidence in other contexts in order to demonstrate the universal application of this broad tool for assessing both BPN satisfaction and BPN frustration in all human beings. Furthermore, neither nomological validity nor gender invariance has been analyzed among Portuguese respondents. Thus, we examined the psychometric properties of the adapted Portuguese scale in exercise settings, including its reliability, construct-related validity (i.e., convergent and discriminant), and nomological validity with behavioral or motivational regulations and enjoyment. In addition, we used a multigroup analysis to assess measurement invariance according to gender.

Method

Participants

We utilized two independent participant samples in this study. The first sample (calibration sample) was composed of 316 adult Portuguese respondents (145 males and 171 females) who exercised regularly at a gym. They were aged 18 to 69 years ($M = 32.47$, standard deviation [SD] $= 10.41$), with exercise experience that ranged from 6 to 420 months ($M = 54.47$, $SD = 54.70$). Their weekly attendance at the gym was between 2 and 8 times ($M = 2.97$, $SD = 0.98$), and their exercise sessions lasted 45 to 90 minutes ($M = 60.21$, $SD = 17.42$). With regard to exercise activities performed, 11% had personal training sessions, 34.4% were engaged in recreational bodybuilding, and 54.6% attended fitness group classes. The second sample (validation sample) was composed of 642 Portuguese adults attending a gym or an academy (287 males and 345 females), aged 18 to 73 years ($M = 34.10$, $SD = 11.57$) with exercise experience ranging from 6 to 480 months ($M = 68.41$, $SD = 48.91$). Their weekly exercise frequency was between 2 and 8 times ($M = 3.52$, $SD = 1.29$), and their exercise sessions lasted 45 to 90 minutes ($M = 62.93$, $SD = 16.14$). With regard to exercise activities performed, 9.8% had personal training sessions, 46.2% were engaged in recreational bodybuilding, and 44.0% attended group classes. The inclusion criteria for this study were (a) aged older than 18 years, (b) registered in

Portuguese gyms or academies for at least 6 months, and (c) regular exercise (≥2 times per week).

Procedure

The study protocol was approved by the university ethics committee. We recruited the two samples from different gyms in order to evaluate the reliability of the test. We first contacted the technical directors of several gyms in Portugal and explained the objectives of the study, acquiring their approval to proceed. All exercisers were then contacted directly during different time periods; and all of them gave their informed written consent to participate in this study before completing the questionnaire. Time taken to complete the questionnaire was approximately 15 minutes. Twelve months after collecting data from the calibration sample, we collected data from the validation sample, obtaining their consent to participate in the same fashion as described earlier.

One approach to addressing problems associated with model fitting is to perform a cross-validation strategy, whereby the final model derived from post hoc analyses is tested on a second sample from the same population. As such, in this study, the first sample represented a group on which we calibrated the initially hypothesized model and conducted post hoc analyses to attain a well-fitting model. Once this final model was determined, we tested the validity of its structure with participants in the second sample. The data collection period for both the calibration and the validation sample was over 6 months.

Measures

Basic Psychological Need Satisfaction and Frustration Scale. Participants completed the BPNSFS (B. Chen et al., 2015), translated into Portuguese (see later). This scale assesses the respondent's perceived BPN satisfaction or BPN frustration. It is multidimensional and is divided into six factors: autonomy satisfaction, competence satisfaction, relatedness, autonomy frustration, competence frustration, and relatedness frustration. The scale is composed of 24 items, six for each construct. For its validation in the exercise context, see the translation procedures described later. The participants indicated their agreement to each item through a 5-point Likert-type scale with response choices that that varied between 1 (*totally disagree*) and 5 (*totally agree*). Previous studies support the use of this scale (B. Chen et al., 2015; Teixeira et al., 2018). Internal consistency coefficients are reported in Table 2.

[AQ6]To adapt and translate the BPNSFS from its original language (English) into Portuguese in the exercise context, we followed methodological procedures suggested by Vallerand (1989) and recommended by Banville, Desrosiers, and Genet-Volet (2000) except that we chose not to use the technical translation/back translation technique (see Brislin, 1970) proposed by Vallerand

(1989). Instead, we applied the committee approach translation methodology (see Brislin, 1980). Therefore, we used a five-step process as follows:

(a) Preliminary translation in which we designed the first version of the questionnaire and had three experts with higher education in English–Portuguese languages translate it;
(b) First evaluation panel in which an analysis of this initial Portuguese version was reviewed by four specialists, each from different fields of scientific expertise (English–Portuguese teacher, psychologist, sports psychologist, and researcher in sport science) to generate a second version of the questionnaire that incorporated their suggested modifications;
(c) Second evaluation panel in which this second Portuguese version of the questionnaire was evaluated by a different panel composed of four other specialists (psychologist, sports psychologist, researcher in sports sciences) who, together with the first panel of experts, came to a consensual judgment of the content of a new version third version (in this stage, the items of each construct of the scale were already translated and adapted to Portuguese exercisers);
(d) Pilot study in which the third version of the questionnaire was administered to 40 bilingual college students with exercise experience for testing English/Portuguese syntax and comprehension, resulting in a fourth version; and
(e) Final revision in which two Portuguese teachers reviewed the fourth version for syntax, spelling, and grammar and produced the fifth and final version. The final Portuguese version of the BPNSFS in Exercise (BPNSFS-E) is seen in Online Appendix 1.

Behavioral Regulation Exercise Questionnaire-3. We used the Portuguese version of the Behavioral Regulation Exercise Questionnaire-3 (BREQ-3; Cid et al., 2018) to evaluate exercisers' motivational regulations. This questionnaire has 18 items grouped into six factors: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation, based on SDT (Deci & Ryan, 2000). Using a 5-point Likert-type scale ranging from 0 (*totally disagree*) and 4 (*totally agree*), participants were asked to indicate their agreement to each statement. Recent studies have supported reliability and validity of the BREQ-3 in a Portuguese exercise context (Cid et al., 2018). Internal consistency ranged from .71 to .84 in the calibration sample and .73 to .86 in the validation sample.

Physical Activity Enjoyment Scale. Participants completed the Portuguese version of the Physical Activity Enjoyment Scale (Teques, Calmeiro, Silva, & Borrego, 2017). This questionnaire assesses enjoyment when exercising, through eight items which participants responded to using a Likert-type scale ranging from

1 (*totally disagree*) to 7 (*totally agree*). Psychometric tests from previous studies in exercise (Teques et al., 2017) and sport (Monteiro et al., 2017) support the use of present scale. Internal consistency ranged from .92 in the validation sample to .94 in the calibration sample.

Statistical Analysis

We performed a preliminary analysis of the data in order to verify data distribution normality and assess for missing values and outliers. We performed test–retest analysis in order to test reliability prior to conducting a confirmatory factor analysis (CFA). We used Pearson's r coefficient in order to determine test–retest reliability of participants' responses to the BPNSFS. For evaluating test–retest reliability, as recommended by Vallerand (1989) and Banville et al. (2000), 40 Portuguese exercisers were considered based on several guidelines recommending a minimum of 30 participants for this analysis (e.g., Hill & Hill, 2008). Based on probability theory, a sample size of $N = 30$ approximates a normal distribution and therefore is considered acceptable and recommended for this type of test (Hair, Babin, Anderson, & Black, 2019). Although time between survey administrations in past research was not uniform and ranged from 1 to 4 weeks (Banville et al., 2000; Vallerand, 1989), the interval in this study was 4 weeks.

Subsequently, to assess data fit (i.e., factorial validity), we performed a CFA using AMOS 23.0. We assumed a 10:1 ratio (i.e., 10 subjects for each parameter to be estimated), as suggested by Kline (2016) and used a maximum likelihood method and measurement model adequacy verified by the traditional absolute and incremental indices of Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), standard mean root square residual (SRMR), and root mean square error of approximation (RMSEA), with a 90% confidence interval (CI). For these indices, we used cutoff values suggested by several authors (e.g., Byrne, 2010; Hair, Black, Babin, & Anderson, 2014; Marsh, Hau, & Wen, 2004). Specifically, we used CFI and TLI $\geq .90$, SRMR $\leq .8$, and RMSEA $\leq .8$. We analyzed internal consistency through composite reliability (CR) and calculated it by Raykov's (1997) formula, adopting .70 as the cutoff value (Hair et al., 2014). We calculated average variance extracted (AVE) to evaluate convergent validity, and we defined values $>.50$ as the cutoff for acceptability. Discriminant validity was achieved when construct AVE values were larger than the squared correlations across constructs of the measurement model (Hair et al., 2014).

Nomological validity. We evaluated correlations (r) to assess relationships among all study variables and to determine nomological validity with the motivational regulations via BREQ-3 (Cid et al., 2018) and enjoyment via Physical Activity Enjoyment Scale (Teques et al., 2017).

Multigroup analysis. Multigroup analysis enables assessment of the equivalence of the measurement model between groups with different characteristics (Sass, 2011). Several authors have described the importance of measurement invariance testing between groups (Cheung & Rensvold, 2002) in order to determine whether certain measurements can be applied to different groups with different characteristics. Therefore, we performed multigroup analysis between samples and gender, according to several authors' recommendations (Byrne, 2010; Cheung & Rensvold, 2002). Specifically, prior guidelines were that (a) the measurement model should represent a good fit in each of the groups and (b) there should be configural, metric, scalar, and residual invariance. Thus, according to some authors (e.g., Byrne, 2010; Cheung & Rensvold, 2002), residual invariance is optional as it is very difficult to achieve, especially in the field of social sciences as is the case in the exercise context. We verified invariance assumptions through CFI differences ($\Delta CFI \leq .01$) in line with recommendations by Cheung and Rensvold (2002). We evaluated invariance models using recommendations (e.g., F. Chen, 2007), as follows: (a) for metric invariance, we used a change in SRMR ($\Delta SRMR$) of less than .030, and a change in RMSEA ($\Delta RMSEA$) of less than .015 as support for model fit; and (b) for scalar invariance, we used a change in SRMR ($\Delta SRMR$) of less than .010 and a change in RMSEA ($\Delta RMSEA$) of less than .015 as an indication of good invariance.

Latent mean differences analysis. There are two types of measurement invariance (Sass, 2011): (a) one based on an analysis of the psychometric properties of the scale, including its configural, metric, scalar, and residual invariance and (b) one based on an examination of group differences in variance, covariance, and latent means.

According to several authors (e.g., Kline, 2016; Sass, 2011), a comparison across latent means can only be done after obtaining acceptable measurement (or psychometric property) invariance. In other words, latent means are created from the factor loadings and intercepts to ensure that it is possible to compare constructs (Meredith, 1993). These two types of measurement invariance are crucial in order to test whether the scale is invariant between groups and to understand how the constructs interact between the different groups. We used mean and covariance structure analyses to test for latent mean differences across each need satisfaction and frustration construct between samples and genders. Latent mean values for the calibration sample and male sample were always constrained to zero, while it was freely estimated for the validation sample and female sample. The Z statistic was used to determine statistical significance between latent means. We calculated Cohen's (1988) d criteria to obtain the correspondent effect size, following Kline's (2016) recommendations. [AQ7] We evaluated effect sizes as follows: (a) trivial (0–.19), (b) small (.20–.49), (c) average (.50–.79), and (d) large (greater than or equal to .80), as suggested by Cohen (1992).

Results

Preliminary Analysis

Missing values were less than 0.1% and six cases were identified as univariate outliers ($z > 3.00$) and multivariate outliers ($D^2 = p1 < .001$, $p2 < .001$). The data were imputed using regression procedures of AMOS, and nonresponders were excluded ($n = 10$). Descriptive analysis revealed no violations of the univariate distribution as skewness and kurtosis were contained between -2 and $+2$, and -7 and $+7$, at a 95% CI. However, the Mardia coefficient in calibration (240.627), validation (237.55), male (140.145), and female (184.359) exceeded the expected value for multivariate normality (Byrne, 2010). Thus, following recommendations of several authors (Hair et al., 2019; Nevitt & Hancock, 2001), we used a Bollen–Stine bootstrap of 2,000 samples for the subsequent analysis.

Test–Retest Analysis

Correlations from responses given to each item in the first and second administrations of the questionnaire ranged from .77 (Item 4) to .87 (Item 2) as seen in Table 1. Thus, there were acceptable test—retest correlations (>.70), indicating that the BPNSFS had a high degree of temporal reliability. [AQ8]

Construct Validity

Results from CFA supported the original six-factor model by B. Chen et al. (2015) in both the calibration sample, $\chi^2(237) = 471.814$, $\chi^2/df = 1.99$; B–S $p < .001$, CFI = .935, TLI = .924, SRMR = .047, RMSEA = .057 (90% CI = [.050, .065]), and the validation sample, $\chi^2(237) = 571.796$, $\chi^2/df = 2.41$; B–S $p < .001$, CFI = .948, TLI = .940, SRMR = .038, RMSEA = .047 (90% CI = [.042, .052]). Factor loadings of individual items ranged from .46 (autonomy support) to .83 (competence satisfaction) in the validation sample, as shown in Figure 1.

Table 2 shows the descriptive analysis (mean and *SD*) of the BPNSFS constructs as well as results regarding reliability, convergent, and discriminant validity analysis in both samples. All constructs showed acceptable adjusted levels of internal consistency (CR > .70).

Nomological Validity

Table 3 shows correlations between basic psychological needs satisfaction and basic psychological needs frustration with behavioral regulations and enjoyment in validation sample. Moderate positive associations were evident between satisfaction of BPNs and the more autonomous forms of motivation (i.e., identified, integrated, and intrinsic regulation) and enjoyment. Conversely, frustration of BPNs exhibited negative and significant associations with more autonomous

Table 1. Test–Retest Reliability Analysis [AQ18].

Items	$M \pm SD$	r	p	α
Item 1: pre–post	3.99 ± 1.01–4.06 ± 1.02	.80	<.001	
Item 2: pre–post	1.81 ± 0.989–1.57 ± 0.753	.87	<.001	
Item 3: pre–post	4.04 ± 0.943–3.97 ± 0.816	.80	<.001	
Item 4: pre–post	1.39 ± 0.658–1.44 ± 0.694	.77	<.001	
Item 5: pre–post	4.39 ± 0.679–4.37 ± 0.705	.84	<.001	
Item 6: pre–post	2.00 ± 1.04–1.91 ± 1.01	.83	<.001	
Item 7: pre–post	3.92 ± 0.933–4.19 ± 0.786	.84	<.001	
Item 8: pre–post	1.86 ± 1.05–1.76 ± 1.05	.80	<.001	
Item 9: pre–post	4.09 ± 1.02–4.03 ± 1.02	.79	<.001	
Item 10: pre–post	1.51 ± 0.864–1.53 ± 0.812	.72	<.001	
Item 11: pre–post	4.28 ± 0.803–4.27 ± 0.779	.83	<.001	
Item 12: pre–post	2.12 ± 1.02–2.19 ± 1.12	.87	<.001	
Item 13: pre–post	3.97 ± 0.950–3.91 ± 0.880	.75	<.001	
Item 14: pre–post	2.01 ± 0.929–1.83 ± 0.851	.71	<.001	
Item 15: pre–post	4.07 ± 1.05–4.00 ± 1.03	.88	<.001	
Item 16: pre–post	1.39 ± 0.699–1.30 ± 0.682	.73	<.001	
Item 17: pre–post	4.24 ± 0.873–4.26 ± 0.863	.84	<.001	
Item 18: pre–post	1.88 ± 0.979–1.84 ± 0.942	.71	<.001	
Item 19: pre–post	3.99 ± 0.929–4.06 ± 0.883	.81	<.001	
Item 20: pre–post	1.64 ± 0.930–1.54 ± 0.863	.77	<.001	
Item 21: pre–post	3.95 ± 0.935–3.70 ± 1.04	.79	<.001	
Item 22: pre–post	1.69 ± 0.920–1.80 ± 0.894	.86	<.001	
Item 23: pre–post	4.04 ± 0.784–4.06 ± 0.796	.84	<.001	
Item 24: pre–post	1.49 ± 0.798–1.37 ± 0.685	.72	<.001	
Autonomy satisfaction pre–post	3.97 ± 0.721–4.05 ± 0.684	.88	<.001	.73–.74
Competence satisfaction pre–post	1.83 ± 0.808–1.68 ± 0.701	.79	<.001	.71–.71
Relatedness satisfaction pre–post	4.04 ± 0.842–3.92 ± 0.836	.86	<.001	.78–.77
Autonomy frustration pre–post	1.49 ± 0.652–1.53 ± 0.625	.85	<.001	.81–.82
Competence frustration pre–post	4.23 ± 0.652–4.24 ± 0.636	.77	<.001	.75–.74
Relatedness frustration pre–post	1.87 ± 0.794–1.83 ± 0.748	.73	<.001	.76–.76

Note. SD = standard deviation.

forms of motivation as well as enjoyment. Amotivation was significantly positively correlated with frustration of BPNs and significantly negatively correlated with satisfaction of BPNs and enjoyment. Enjoyment showed a moderate positive association with more autonomous forms of motivation and a negative association with more controlled forms of motivation and amotivation.

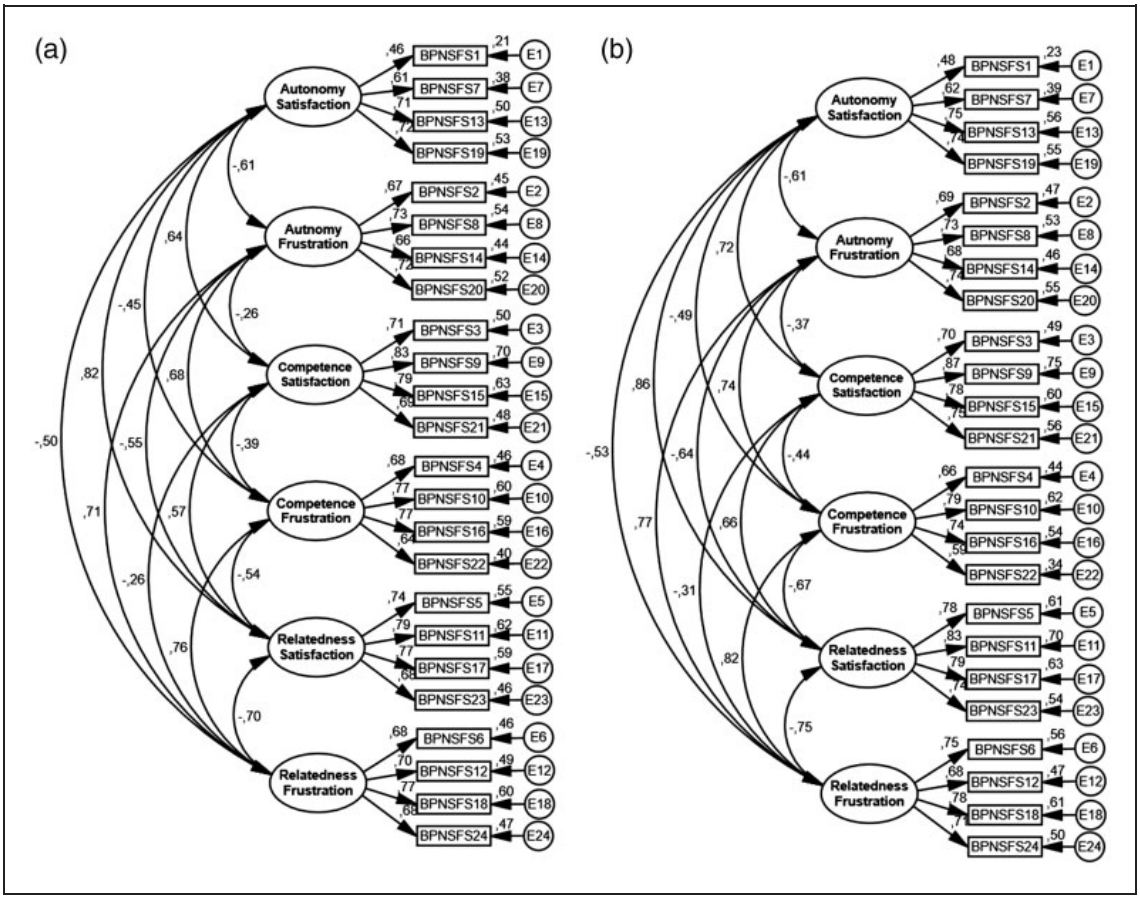

Figure 1. Standardized model of the BPNSFS-E in the calibration sample (a) and the validation sample (b). BPNSFS = Basic Psychological Need Satisfaction and Frustration Scale.

Multigroup Analysis

Multigroup analysis revealed that the measurement model was invariant between samples and gender, based on recommended criteria that (a) the measurement model fit was achieved for each group, including both genders: male, $\chi^2(237) = 437.126$, $\chi^2/df = 1.84$; B–S $p = .006$, CFI = .935, TLI = .924, SRMR = .048, RMSEA = .054 (90% CI = [.046, .056]), and female, $\chi^2(237) = 454.566$, $\chi^2/df = 1.91$; B–S $p = .003$, CFI = .939, TLI = .929, SRMR = .043, RMSEA = .052 (90% CI = [.044, .059]) and (b) invariance variables (configural, metric, and scalar) were confirmed (see Table 4).

Latent Mean Differences Between Male and Female Exercisers

Results related to latent mean differences analysis between samples and genders regarding BPN's satisfaction and frustration constructs are shown in Table 5. There were no differences between samples and gender, except that the relatedness-frustration construct differed between male and female exercisers ($z = 2.28$; $p = .023$; $d = .01$).

Table 2. Mean, *SD*s, CR, AVE, and Correlations.

	Mean	*SD*	CR	AVE	1	2	3	4	5	6
Calibration sample										
1. Autonomy satisfaction	4.12	0.61	.75	.43	1					
2. Autonomy frustration	1.72	0.69	.83	.50	.37	1				
3. Competence satisfaction	4.09	0.71	.86	.59	.52	.13	1			
4. Competence frustration	1.56	0.59	.79	.49	.24	.45	.19	1		
5. Relatedness satisfaction	4.31	0.57	.86	.62	.74	.41	.44	.45	1	
6. Relatedness frustration	1.82	0.75	.82	.53	.28	.50	.10	.67	.56	1
Validation sample										
1. Autonomy satisfaction	4.03	0.58	.72	.41	1					
2. Autonomy frustration	1.8	0.72	.79	.49	.36	1				
3. Competence satisfaction	4.01	0.69	.84	.58	.4	.07	1			
4. Competence frustration	1.59	0.61	.81	.51	.19	.46	.14	1		
5. Relatedness satisfaction	4.25	0.53	.83	.56	.67	.29	.31	.28	1	
6. Relatedness frustration	1.89	0.73	.80	.51	.24	.49	.06	.58	.48	1

Note. *SD* = standard deviation; CR = composite reliability; AVE = average variance extracted.

Discussion

This study aimed to translate the BPNSFS into Portuguese and validate it in an exercise context (BPNSFS-E). In addition, we tested the instrument's nomological validity with behavioral regulations and enjoyment and showed significant relationships between these constructs, based on SDT (Deci & Ryan, 1985). Finally, we tested the measurement analysis between global adjustment and latent mean differences between our two samples and males and females. Our results suggest that the original BPNSFS measurement model for the six-factor solution measuring all six types of basic psychological needs according to the SDT framework did fit well the Portuguese version in both samples and in male and female exercisers.

Factorial Validity of the New BPNSFS-E in CFA

Our first step was to develop the Portuguese version of the BPNSFS and analyze its dimensionality and validity. A CFA performed on the 24-item scale on both samples extracted six correlated but distinct factors, assessing satisfaction and frustration of the three basic psychological needs. These results were expected, as other studies in other languages using this scale have found similar outcomes (e.g., B. Chen et al., 2015; Nishimura & Suzuki, 2016). Our results confirmed that all factors were internally consistent, as values of CR were > .70 (Hair et al., 2014), ranging from .71 to .84.

Table 3. Mean, *SD*s, Range, and Correlations Between Study Variables.

Factors	Mean	*SD*	Range	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Autonomy satisfaction	4.03	0.58	1–5	1												
2. Autonomy frustration	1.8	0.72	1–5	−.459**	1											
3. Competence satisfaction	4.01	0.69	1–5	.517**	−.219**	1										
4. Competence frustration	1.59	0.61	1–5	−.329**	.544**	−.342**	1									
5. Relatedness satisfaction	4.25	0.53	1–5	.643**	−.453**	.489**	−.439**	1								
6. Relatedness frustration	1.89	0.73	1–5	−.369**	.570**	−.226**	.614**	−.574**	1							
7. Amotivation	0.31	0.52	0–4	−.215**	.457**	−.188**	.540**	−.340**	.432**	1						
8. External regulation	0.86	0.80	0–4	−.164**	.427**	−.004	.343**	−.257**	.389**	.476**	1					
9. Introjected regulation	1.87	0.90	0–4	−.030	.244**	−.001	.200**	−.106**	.276**	.096*	.298**	1				
10. Identified regulation	3.27	0.52	0–4	.208**	−.152**	.213**	−.165**	.242**	−.097*	−.320**	−.046	.414**	1			
11. Integrated regulation	3.18	0.66	0–4	.418**	−.388**	.263**	−.266**	.421**	−.278**	−.371**	−.244**	.231**	.584**	1		
12. Intrinsic regulation	3.43	0.57	0–4	.426**	−.444**	.292**	−.301**	.494**	−.316**	−.409**	−.256**	.083*	.481**	.700**	1	
13. Enjoyment	5.44	1.11	2–7	.575**	−.181**	.678**	−.283**	.111*	−.274**	−.356**	−.448**	.226**	.274*	.398**	.341**	1

Note. *SD* = standard deviation.
*$p < .05$. **$p < .01$.

Table 4. Invariance Analysis in Basic Psychological Need Satisfaction and Frustration Scale in Exercise Between Samples Groups and Gender.

	χ^2	*df*	χ^2/df	$\Delta\chi^2$	Δdf	B–S *p*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
Calibration–validation												
CI	996.356	474	2.102	–	–	–	.942	–	.036	–	.0522	–
MI	1,006.601	492	2.046	10.245	18	<.001	.943	.001	.035	.001	.0521	.001
SI	1,015.734	513	1.980	19.378	39	<.001	.944	.002	.034	.002	.0529	.007
RI	1,030.613	537	1.919	34.257	63	<.001	.945	.003	.033	.003	.0531	.009
Male–female												
CI	891.711	474	1.88	–	–	–	.937	–	.037	–	.0481	–
MI	917.459	492	1.86	25.748	18	.106	.936	.001	.037	.000	.0490	.009
SI	1,030.771	513	2.01	139.059	39	<.001	.927	.01	.040	.003	.0581	.010
RI	1,093.191	537	2.03	201.48	63	<.001	.916	.021	.041	.004	.0652	.017

Note. χ^2 = chi-square; *df* = degrees of freedom; $\Delta\chi^2$ = differences in the value of χ^2; Δdf = differences in the *df*; B–S p = Bollen–Stine bootstrap level of significance; CFI = Comparative Fit Index; ΔCFI = differences in the value of the CFI; CI = configural invariance; MI = metric invariance; SI = structural invariance; RI = residual invariance; SRMR = standard mean root square residual; RMSEA = root mean square error of approximation. [AQ19]

Table 5. Latent Mean Differences Between Sample and Gender on Basic Needs Constructs.

	Difference	*z*	*p*	*d*
Calibration–validation				
Autonomy satisfaction	.092	1.184	.237	.013
Competence satisfaction	.033	0.308	.758	.007
Relatedness satisfaction	.076	1.308	.191	.005
Autonomy frustration	.011	0.210	.834	.022
Competence frustration	.004	0.054	.957	.011
Relatedness frustration	.084	1.167	.243	.029
Male–female				
Autonomy satisfaction	−.01	−0.30	.764	.151
Competence satisfaction	−.06	−1.15	.250	.130
Relatedness satisfaction	−.10	1.96	.051	.020
Autonomy frustration	−.02	−0.42	.677	.132
Competence frustration	−.08	−1.89	.059	.033
Relatedness frustration	.13	2.28	.023*	.014

Note. *$p < .05$.

AVE values indicated that convergent validity of autonomy satisfaction was somewhat below the suggested <.50 level (Hair et al., 2014), but the construct was retained to ensure the complete theory could be tested. Thus, we cautiously interpreted the findings for this construct. Other studies using this scale also identified convergence validity problems with this factor (B. Chen et al., 2015, Nishimura & Suzuki, 2016). B. Chen et al. (2015) found convergent validity problems in four of the six factors (i.e., autonomy frustration, competence satisfaction, competence frustration, and relatedness frustration), and Nishimura and Suzuki (2016) found problems in all but the competence frustration factor. These past data would suggest that items regarding autonomy satisfaction do not function as intended, but, in our study, all factorial weights were significant in their respective factors with no cross-loadings detected, suggesting good convergent validity (Byrne, 2010; Hair et al., 2014).

We examined and confirmed discriminant validity for 13 of the 15 possible comparisons. In our study, satisfaction of each need was negatively correlated with the need's frustration. Similarly, covariance among satisfaction factors was positive and significant. We also similarly verified frustration factors. These analyses suggest that these needs are distinguishable (Hair et al., 2014). [AQ9] Moreover, according to SDT as proposed by Deci and Ryan (2017), these constructs are indeed different: "each (need) is independently important,... In addition, SDT sees these three basic needs as interdependent" (p. 248).

As stressed by these authors, "... needs vary independently (e.g., one feels incompetent while performing a valued activity), SDT expects that the three needs will tend to be highly intercorrelated, especially in measurements that aggregate satisfaction or frustration experience in a domain ..." (p. 249).

According to our analysis, only one item had a factor loading below .50 (autonomy satisfaction) in both samples. In line with suggestions made by Hair et al. (2014), factor loadings below cutoff values should be considered for elimination. But this suggestion was only a guideline (Hair et al., 2014). Other considerations are that this item enhances content validity, removing the item does not improve model fit, and the overall measurement model exhibits good fit. Therefore, we retained Item 1 so the scale would remain as close as possible to the original version. Overall, with respect to the model, our results show satisfactory fit (Byrne et al., 2010; Hair et al., 2014; Marsh et al., 2004). [AQ10] Other studies analyzing the psychometric proprieties of BPNSFS (B. Chen et al., 2015; Costa et al., 2018; Longo et al., 2018; Nishimura & Suzuki, 2016) found similar outcomes. These results demonstrate that the scale is applicable in a different culture and context from its original development.

Nomological Validity

Our results showed nomological validity between BPN's satisfaction and frustration as well as between different forms of motivational regulation. BPN satisfaction exhibited positive associations with more autonomous forms of motivation and negative associations with the more controlled forms of motivation. This evidence is in line with other studies both in exercise (Murcia et al., 2008) and sport (Monteiro et al., 2018). Moreover, BPN's frustration was positively associated with more controlled regulations and negatively associated with more autonomous forms of motivation. Results showed significant positive and negative correlations between amotivation and BPN's frustration and satisfaction, respectively. These results are consistent with SDT conceptualizations (R. Ryan & Deci, 2017) and other empirical studies (Rocchi & Pelletier, 2017; Teixeira et al., 2018). [AQ11] Considering all BPN under analysis, relatedness satisfaction had the strongest and most significant correlation with intrinsic motivation ($r = .494$), showing that individuals do not always prioritize autonomy satisfaction within the exercise context, but rather may be particularly motivated by positive social interactions and a sense of belonging (Rodrigues et al., 2018; R. Ryan & Deci, 2017).

The BPNSFS-E also revealed adjusted nomological validity with enjoyment. As enjoyment and BPN satisfaction had a significant positive association, and enjoyment and BPN frustration had a significant negative association. These results are in line with SDT conceptualizations, as BPN satisfactions are theorized to be the basis for more autonomous motivation, namely, intrinsic

motivation. In contrast, BPN frustrations are said to be related to controlled forms of motivation (external and introjected regulations) as well as amotivation (R. Ryan & Deci, 2017). Several studies in different domains, such as exercise (Murcia et al., 2008), physical education (Schneider & Kwan, 2013), work (Ding, Babenko, Koppula, Oswald, & White, 2019), and sport (Rocchi & Pelletier, 2017), have also empirically supported this theory. As noted, our results show significant positive correlation between more autonomous forms of motivation and a significant negative correlation with enjoyment. Specifically, the highest identified correlations between behavioral regulations and enjoyment was integrated regulation ($r = .398$) and intrinsic motivation ($r = .576$), meaning that when individuals feel the value of exercise, they self-perceive higher levels of enjoyment. According to SDT, the high correlational pattern found between intrinsic motivation and enjoyment is because intrinsic motivation itself represents inherent enjoyment in the practice of a certain activity (Deci & Ryan, 2000).

Measurement Invariance

With respect to measurement invariance between our two samples and between males and females, our results support the equivalence of BPNSFS-E across these populations, as all invariance assumptions were met (Byrne, 2010; F. Chen, 2007; Cheung & Rensvold, 2002). Regardless of sample or gender, all factors of the BPNSFS-E had the same number items (configural invariance) and all factorial weights were invariant between male and female exercisers. [AQ12] This demonstrates metric invariance and scalar invariance. A previous study (Sass, 2011) affirmed scalar invariance of the measurement model, supporting comparisons among different groups, even though residual invariance was not met. Hair et al. (2014) noted that higher levels of invariance are seldom achieved and recommended moving ahead when configural and metric invariance are confirmed, as was the case in this study. Therefore, our data confirmed the applicability of BPNSFS-E between gym samples and between male and female Portuguese exercisers.

Latent Mean Differences

Our study found no significant differences in terms of latent means between genders, except for relatedness frustration. No previous study has analyzed BPN's satisfaction and frustration latent mean differences between genders in an exercise context. Vlachopoulos et al. (2013) compared means of respondents from four different countries (e.g., Portugal, Greece, Spain, and Turkey) in the exercise context and found differences between them such that those from Western countries (Portugal and Spain) were likely to value more

interdependence and less social interactions, but these differences did not suggest validity issues in applying the instrument. Our finding of differences in relatedness frustration between male and female exercisers suggests that female exercisers (relative to male exercisers) may derive more support from the social context (e.g., exercise professionals) and then feel less frustrated. This proposition needs to be further tested, however, to better understand the influence of interpersonal behaviors on exercise motivation (Rocchi, Pelletier, Cheung, Baxter, & Beaudry, 2017). Of importance, all magnitude effects were trivial in this comparison, showing that that variance was minimal between male and female BPN's satisfaction and frustration experiences.

Study Limitations

Our study has several limitations. First, this research was limited to Portuguese exercisers, and findings cannot be easily generalized to other countries. Second, our study was cross-sectional, and longitudinal research would better address assessments of time invariance in the exercise context. We believe it is possible that BPN's satisfaction and frustration might fluctuate over time in the exercisers' experiences (e.g., weeks, months, years), as individuals may experience activities differently on daily basis (Cordeiro et al., 2016). Future research should aim to address this gap. Third, although we found solid relationships between BPN satisfaction and more autonomous regulations and enjoyment, and between BPN frustration and more controlled forms of motivation, there are links in the theoretical framework of SDT that should be investigated further. Future research should examine the relationship between basic psychological need satisfaction and frustration within the social context, and how supportive or thwarting social behaviors may influence the exercisers' experience, perhaps particularly for female exercisers. Several studies in other contexts (e.g., Rocchi et al., 2017) report that supportive social behaviors may lead to BPN satisfaction and thwarting social behaviors to need frustration. Therefore, this relationship needs to be tested for context invariance.

Conclusion

Overall, our results support the factorial and construct validity of the BPNSFS-E, providing new evidence for construct distinctiveness of BPN satisfaction versus frustration, in line with the theoretical framework of SDT. The present work reinforced the importance of analyzing satisfaction and frustration as distinct factors, affirms that satisfaction is correlated to more autonomous forms of motivation, and that frustration of BPNs are more related to controlled forms of motivation. Finally, our study demonstrated that this scale is reliable in measuring BPN's satisfaction and frustration of Portuguese male and female exercisers.

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