Motivation and Emotion
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ORIGINAL PAPER

Basic psychological needs satisfaction: an international examination of invariance across 22 languages and 32 countries

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Abstract

Basic psychological needs are purported to be essential ingredients to human well-being. In recent years, the Basic Psychological Needs Satisfaction and Frustration Scale (BPNSFS) has arguably emerged as the most widely used measure of Basic Psychological Needs. Since its original publication in 2015, the BPNSFS has been translated across multiple languages, applied in numerous settings, and adapted to various contexts. Nonetheless, limited research has examined the psychometric qualities of the scale in a global context. Accordingly, the present work sought to establish the measurement invariance of the BPNSFS across 32 countries and 22 languages. Additionally, this study examined such invariance across gender and sexual orientation. Using data (N = 76,597) from a recently collected international consortium (The International Sex Survey), the structure and psychometric properties of the BPNSFS were evaluated. Across nationalities, languages, sexual orientations, and gender identity, the original, 6-factor structure of the BPNSFS was found to demonstrate partial-to-strong measurement invariance. Collectively, these results provide support for the 6-factor structure of the inventory and suggest that the measure is a reliable measure of basic psychological needs across the globe, further illustrating the cross-cultural utility of the scale.

Basic psychological need (dis)satisfaction

An international examination of invariance across 26 languages and 32 countries

Self-determination theory (SDT) posits that all humans have essential psychological needs that are critical to overall well-being. These needs are, in the vernacular of SDT, *essential nutrients* for overall well-being (R. M. Ryan, 1995). That is, they are not simply useful or helpful in achieving well-being, but are, instead, absolutely necessary. Moreover, these needs are ostensibly universal, being observable across the globe. Indeed, almost 30 years of research related to the Basic Psychological Need Theory (BPNT)

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have proven the construct to be measurable in numerous countries, across numerous contexts, and in a wide variety of age groups (for a recent review, see: Vansteenkiste et al., 2020). Central to much recent work in this domain has been the Basic Psychological Needs Satisfaction and Frustration Scale (BPNSFS; B. Chen et al., 2015), which was itself initially validated in four cultural contexts.

Though it is not the only measure of BPNT, the BPNSFS has been considerably influential in its relatively short existence (i.e., since 2015). The scale is very widely cited (cited over 3,000 times as of January, 2025), has been adapted and used in numerous languages, and has been tailored to a variety of specific contexts (e.g., intellectual disability, Frielink et al., 2019; exercise, Rodrigues et al., 2019). Even so, large-scale, comparative research into the global utility of the scale has been somewhat limited since its original development.

The primary purpose of the present work was to test the cross-cultural utility of the BPNSFS. More specifically, we sought to systematically evaluate the variance or invariance of the BPNSFS in a large-scale, international sample across multiple languages (22), countries (32), gender identities (3), and sexual orientations (8). As prior works have sought to test the inventory in various countries and formats, the current work is not entirely novel in this regard. However, the scale at which we sought to evaluate the BPNSFS is substantially larger than prior studies (e.g., 4 countries vs. 32 countries). Additionally, though the BPNSFS has been translated into a wide variety of languages, many of these studies have not attempted to assess the invariance of the measure in these languages. This is a major gap in prior research on this topic as, though rigorous translations efforts for the BPNSFS are to be commended, translation alone is not sufficient to establish if a scale has cross-cultural utility. Finally, though tests of invariance by language have been attempted in prior studies, tests of nationality, sexual orientation, and gender identity are more limited. Given that a number of prior works have sought to examine how BPNT applies to sexual and gender minorities (Herrick et al., 2022), establishing invariance across such identities is also essential.

Basic psychological needs

SDT has proven one of the most seminal theories of psychological processes and human well-being of the last half century (Deci & Ryan, 2012; R. M. Ryan & Deci, 2000, 2006). Broadly, SDT is a psychological framework that focuses on human motivation, emphasizing the importance of motivation in influencing human behavior and overall well-being across all domains of life. SDT suggests that fostering environments that support these needs leads to greater personal growth, well-being, and optimal performance Central to our current work, we note that SDT proposes that people are most motivated when their BPNs for autonomy, competence, and relatedness are satisfied. BPNT is a sub-theory of SDT more broadly (R. M. Ryan, 1995) and postulates that humans have three basic needs that are needed to thrive: autonomy, relatedness, and competence. As alluded to above, SDT does not consider these needs to be optional for human thriving or potentially useful for overall well-being. Instead, these needs *must* be met for the individual to experience well-being.

Autonomy refers to that aspect of human nature that needs to feel personal integrity, self-determination, willingness, and volition (Vansteenkiste et al., 2020). Indeed, in multiple situations and contexts, humans demonstrate both desires and needs to feel psychologically free or in possession of the ability to make their own decisions, choose their own behaviors, and pursue their own goals (Van den Broeck et al., 2016). This desire for autonomy does not imply independence from all others, as other needs point to human motivations to work in conjunction with others. However, considerable evidence suggests that humans, over time and across cultures, value freedom in decisions they make in their lives.

Relatedness needs reflect human status as social animals. As described previously, humans have a fundamental need to belong (R. M. Ryan, 1995; Vansteenkiste et al., 2020). Across situations, over time, and in various settings, human connection, interpersonal bonds, social support, and meaningful relationships are foundational to human psychological makeup (Baumeister & Leary, 1995). Accordingly, it is unsurprising that meeting human relatedness needs is foundational for people to both live and thrive.

Finally, competence needs refer to the human desire for mastery and achievement across a variety of life domains (R. M. Ryan, 1995). That is, humans want to feel a sense of accomplishment and skill as they navigate the environment in which they live, work, and play (Van den Broeck et al., 2016). Human history in a variety of cultures is replete with manifestations of this need, and extensive research clearly supports that such needs exist (Cerasoli et al., 2016; Deci & Ryan, 2012; Vansteenkiste et al., 2020).

Universality

Within BPNT, there is a strong theoretical assumption that BPNs are human universals (B. Chen et al., 2015). As Ryan states: "Psychological needs are innate in the sense that they are an invariant aspect of human nature. They are universal in that they apply to all humans in all cultures…" (R. M. Ryan & Sapp, 2007). Indeed, this is a general assumption of

SDT more broadly: The general principles underlying SDT and its component sub-theories should exist cross-culturally.

In general, evidence for the universality of the BPNT is strong. Numerous studies have investigated BPNs in the workplace (Slemp et al., 2021; Van den Broeck et al., 2016), in sport (Camiré et al., 2019; Vlachopoulos et al., 2013), in familial relationships (Liang et al., 2021; Przybylski & Weinstein, 2019) and in life in general (Vansteenkiste et al., 2020). Collectively, these findings then suggest that BPNs manifest through all aspects of life, influencing well-being across domains. Similarly, cross-cultural work suggests that BPNs can be reasonably measured across multiple cultures and languages (B. Chen et al., 2015). Finally, longitudinal work suggest that basic psychological needs are rather stable over time (Holding et al., 2020; Olafsen et al., 2018; Tian et al., 2014), though whether or not those needs are fulfilled or unfulfilled may vary.

Need satisfaction

The existence of basic psychological needs necessarily implies that those needs may be met or unmet. When such needs are met, it is referred to as *need satisfaction*. Within SDT, satisfaction of needs is a necessary condition for thriving and growth as a human. Furthermore, research generally supports the notion that need satisfaction is an important component of psychological well-being. Indeed, greater need satisfaction is linked to better mental, emotional, and social well-being (Lataster et al., 2022), more positive health behaviors (Ntoumanis et al., 2021), better emotional regulation (Benita et al., 2020; Emery et al., 2016), less problematic patterns of substance use (Richards et al., 2023), and better academic performance (Carmona-Halty et al., 2019). Basic psychological needs are not always satisfied, however, often with diverse consequences.

Need frustration

In contrast to the satisfaction of basic psychological needs, the experience of unmet basic psychological needs is often a byproduct of *need frustration*. Need frustration generally refers to the experience of having basic psychological need satisfaction thwarted by some internal or external experience (Vansteenkiste & Ryan, 2013). That is, according to prevailing definitions of basic psychological need satisfaction and frustration, need frustration is more than just the lack of need satisfaction. Rather, it is the experience of being actively thwarted in the pursuit of basic psychological needs by some circumstance, experience, or individual. Whereas need satisfaction is linked to multiple positive outcomes, need frustration is linked to negative outcomes. Need frustration is associated with worse well-being (Lataster et al., 2022), poor emotional regulation (Benita et al., 2020; Emery et al., 2016), more problematic use of substances (Richards et al., 2023), more addictive behaviors generally (Mills et al., 2021), and various other problems. In short, need frustration is robustly associated with poor outcomes across multiple life domains.

Measurement

Given the utility of BPNT in accounting for well-being, there has been powerful motivation to measure such needs accurately and consistently. As BPNs are considered human universals, the measurement of such BPNs should similarly be cross-culturally consistent. Though multiple measures of BPNs exist, in recent years, the BPNSFS has been the most used. Originally developed across four countries with different social and linguistic contexts (Belgium, China, Peru, and the United States), the BPNSFS purports to measure both need satisfaction and need frustration across all three BPNs, resulting in a 24 item, six-subscale measure (B. Chen et al., 2015). Initial tests of the measure demonstrated that it demonstrated acceptable internal consistency (Cronbach's α=.64—.88) across sub scales, that it was invariant across such cultural contexts, and that it was meaningfully associated with various outcomes that would be expected from prior literature (i.e., need satisfaction was associated with greater self-esteem and well-being; need frustration was associated with diminished well-being and symptoms of depression).

Thus far, the BPNSFS has been adapted for use in adolescents (Laporte et al., 2021), workplace settings (Olafsen et al., 2018), sports settings (Rodrigues et al., 2019), schools (Buzzai et al., 2021), and multiple other contexts. Moreover, individual studies have translated it into different languages, including Indonesian (Abidin et al., 2021), Polish (Szulawski et al., 2021), French (Chevrier & Lannegrand, 2021), Afrikaans and Setswana (Cromhout et al., 2022), Japanese (Nishimura & Suzuki, 2016), and others. Most studies have suggested that the specific translations were invariant with the original English translation, although some found it was not (Cromhout et al., 2022). Collectively, these findings support the cross-cultural utility of the measure. However, most studies have examined the scale across single countries, with the original publication of the measure remaining as the culturally broadest single-study examination of the measure. Though such efforts are impressive, and the BPNSFS (and, indeed, many of the measurement scales associated with SDT more broadly) has been tested cross-culturally in ways that few psychological measures can match, continued efforts to validate the scale globally are needed.

Additionally, although language and cultural contexts are important when evaluating the cross-cultural utility of

specific measures, the application of the SDT and BPNT to specific populations extends beyond language and country of residence alone. Specifically, SDT and BPNT are often used to study the experiences and struggles of minority populations, such as sexual and gender minorities. Indeed, SDT is useful in understanding the experiences of sexual and gender minorities (W. S. Ryan et al., 2017; W. S. Ryan & Ryan, 2019), and the BPNSFS has been used in such populations to demonstrate that need frustration is associated with poor well-being (Herrick et al., 2022; Leij, 2020) and that need satisfaction and frustration often mediate links between minority stress and well-being measures (Benesch, 2022). However, to date, efforts to specifically test the utility and invariance of measurement scales in sexual and gender minority groups are limited (Kuhlemeier, 2022), a critique that also applies to the use of the BPNSFS in such groups. Although we did not expect to find that the BPNSFS would be variant across sexual and gender identities (i.e., we expected invariance across these groups), to our knowledge, no prior works have sought to empirically demonstrate such invariance. As it is likely that BPNT and SDT will continue to provide valuable insights into the experiences of sexual and gender minorities, demonstrating the invariance of the measure across these groups will provide a more solid, empirical foundation for such investigations.

Finally, we note, recent research has cast doubt on current conceptions and measurement of need frustration (Murphy et al., 2023). Specifically, this recent work suggests that the manner in which the BPNSFS measures need frustrations falls short of theoretical and psychometric objectives. More simply, Murphy and colleagues argue that the need frustration subscales of the BPNSFS do not conceptually seem to measure need frustration (e.g., an active thwarting of psychological needs) nor does the empirical factor structure of the scale conform to a six-subscale structure (instead, a four-subscale structure is proposed). As the primary purpose of the present work was not to compare these various models, instead simply seeking to establish further evidence of the cross-country, cross-language utility of the BPNSFS, the present work did not seek to systematically test all models proposed by Murphy and colleagues (2023). Even so, these recent criticisms are of importance when evaluating the BPNSFS and bear implications for our results, as we explore later.

The present study

The primary purposes of the present work were to systematically evaluate the utility of the BPNSFS in cross-cultural and inter-group settings and evaluate one aspect of evidence for the universality of BPNT. To accomplish these goals, we evaluated data from a large-scale international sample across multiple languages (22), countries (32), gender identities (3), and sexual orientations (8). As prior works have sought to test the inventory in various countries and formats, the current work is not entirely novel in this regard. However, the scale at which we sought to evaluate the BPNSFS is substantially larger than prior studies (e.g., 4 countries vs. 32 countries). Additionally, though the BPNSFS has been translated into a wide variety of languages, many of these studies have not attempted to assess the invariance of the measure in these languages. This is a major gap in prior research on this topic as, though rigorous translations efforts for the BPNSFS are to be commended, cross-cultural validity depends not only on the accurate translation of the measure but also on the examination and evaluation of the measure's psychometric properties across those contexts, and ultimately on the relation of the measure to real world phenomena that corroborate the tenets of BPNT. Finally, though tests of invariance by language have been attempted in prior studies, tests of nationality, sexual orientation, and gender identity are more limited. Given that a number of prior works have sought to examine how BPNT applies to sexual and gender minorities (Herrick et al., 2022), establishing invariance across such identities is also worthwhile.

Given that the present work is, to our knowledge, the largest cross-country and cross-language evaluation of the BPNSFS, many aspects of the present work can be described as primarily psychometric or methodological in nature. Invariance testing is, increasingly, considered to be a benchmark of good cross-cultural research. Yet, the hagiography of invariance testing in cross-cultural psychology is not without controversy (Leitgöb et al., 2023; Marsh et al., 2018). Measurement invariance alone is insufficient to guarantee that an inventory, scale, or construct can be validly compared across groups or situations (Raykov, 2024; Robitzsch & Lüdtke, 2023). The violation of invariance does not necessarily preclude cross-cultural comparisons (Funder & Gardiner, 2024; Raykov, 2024), nor does the establishment of invariance "prove" that a construct or scale is truly equivalent across cultures (Funder & Gardiner, 2024; Robitzsch & Lüdtke, 2023). Yet, measurement invariance is one (among many) important tool for understanding intergroup or cross-cultural differences in how concepts, constructs, and scales within psychological research might manifest (Lacko et al., 2022; Leitgöb et al., 2023). That is, rather than proving (or disproving) the utility of a scale in different contexts or cultures, measurement invariance can provide some data on the overall performance of such a scale, and, in cases where invariance is established, can provide a piece of evidence for the cross-cultural nature of a construct. In keeping with this, the primary goal of the present work was to evaluate the cross-cultural utility of the BPNSFS and evaluate one potential piece of evidence for the universality

of BPNT more broadly. In light of the above discussion, we did not specifically define a priori hypotheses. However, we did generally expect to find that, consistent with BPNT and the widespread use of the BPNSFS, the factor structure of the BPNSFS as published by Chen and colleagues (2015) would be supported. Moreover, we expected to find that this structure would remain invariant across languages, countries of residence, gender identities, and sexual orientations.

Methods

The study was conducted in accordance with the Declaration of Helsinki. The study procedures were approved by appropriate ethics review boards for collaborating countries or, in some cases, the appropriate ethics review boards considered the study exempt from additional approval as it had already been approved by the ethics review boards of the principal investigators' institutions (https://osf.io/e93kf). All participants were informed about the study and provided informed consent.

Participants and procedure

Data were collected as a part of the International Sex Survey (Bőthe et al., 2021), a global collaboration of scientists seeking to understand human sexual preferences and behaviors. The ISS is a large, cross-sectional, multi-national study, conducted online in numerous countries and languages. The study design was preregistered (https://osf.io/xcgzf), as was the general structure of validation papers (https://osf.io/csyjq). Data were collected between October of 2021 and May of 2022. Participants who responded to the study advertisements completed on the Qualtrics Research Suite an anonymous survey that took approximately 25 to 45 min to complete. Detailed information regarding data collection was described previously (Bőthe et al., 2021).

In general, participants who (a) failed more than one out of three attention questions and/or (b) produced response patterns suggesting inattentiveness (e.g., contradictory answers to several questions, see [https://osf.io/csyjq] for a detailed description) were excluded from analyses. Next, after excluding all participants with missing values in the variables of interest, data collected from 76,597 participants (M_{age} = 32.84, SD = 12.57) were included in the analyses. Of all participants, 41,360 identified as women (57.0% of the total sample), 28,877 as men (39.8%), and 2,390 (3.3%) as gender-diverse individuals. Detailed sociodemographic information is presented in Table 1.

To ensure transparency, all published manuscripts and conference presentations which employ data gathered as part of the ISS project are available using the following links: publications, [https://osf.io/jb6ey/]; conference presentations, [https://osf.io/c695n/].

Measures

The original survey battery for the larger ISS study was compiled in English. After this, all measures were translated into necessary languages (n = 25), resulting in a total of 26 languages. This process followed established guidelines for multi-language works (Beaton et al., 2000). Comprehensive details regarding this process are available in the previously published study protocol (Bőthe et al., 2021). The complete set of measures, in all languages, is available online at: [https://osf.io/jcz96/]. For the present work, we focused on the Basic Psychological Needs Satisfaction and Frustration Scale. This scale contains 24 items across 6, 4-item subscales (Subscales measuring need satisfaction and need frustration across Autonomy, Relatedness, and Competency).

Statistical analyses

Model estimation and specification

All analyses were conducted using Mplus 8.8 (Muthén & Muthén, 2017), and models were estimated with the weighted least squares mean- and variance-adjusted estimator and theta parameterization.[1] Previous studies have shown that this estimator tends to perform better than maximum-likelihood-based estimators when items are ordered-categorical in nature or when their response categories have asymmetric thresholds (e.g., Bandalos, 2014; see Finney & DiStefano, 2013 for a review). Based on previous studies in this area (e.g., Gillet et al., 2020; Sánchez-Oliva et al., 2017; Tóth-Király et al., 2019), we estimated and contrasted confirmatory factor analysis (CFA) and exploratory structural equation modeling (ESEM) models (see Fig. 1 for a schematic visualization) on the total sample. These analyses (ESEM) were in addition to the previously mentioned analytic plan, based on current recommend best practices for model specification and invariance testing. These CFA and ESEM models were specified in alignment with typical guidelines and recommendations (Marsh et al., 2014; Morin et al., 2020). In CFA, items were only associated with their a priori six factors, cross-loadings were constrained to zero,

[1] Due to the large, international nature of the present project, we are not able to share the data publicly as not all collaborating countries' IRBs approved sharing the data publicly. Therefore, although the ISS follows open-science practices, the dataset is not publicly available. The corresponding author may provide data upon justified request.

Table 1 Participants' Sociodemographic Characteristics

Variables	*N* = 76,597	%
Country of residence		
Algeria	20	0
Australia	596	0.8
Austria	713	0.9
Bangladesh	328	0.4
Belgium	603	0.8
Bolivia	352	0.5
Brazil	3343	4.4
Canada	2367	3.1
Chile	1119	1.5
China	2381	3.1
Colombia	1828	2.4
Croatia	2204	2.9
Czech Republic	1597	2.1
Ecuador	248	0.3
France	1616	2.1
Germany	3116	4.1
Gibraltar	52	0.1
Hungary	10,362	13.5
India	157	0.2
Iraq	88	0.1
Ireland	1519	2
Israel	1228	1.6
Italy	2164	2.8
Japan	515	0.7
Lithuania	1889	2.5
Malaysia	1119	1.5
Mexico	1980	2.6
New Zealand	2620	3.4
North Macedonia	1168	1.5
Panama	300	0.4
Peru	2445	3.2
Poland	9132	11.9
Portugal	2104	2.7
Slovakia	1042	1.4
South Africa	1698	2.2
South Korea	1355	1.8
Spain	2186	2.9
Switzerland	1107	1.4
Taiwan	2602	3.4
Turkey	734	1
United Kingdom	1301	1.7
United States of America	2227	2.9
Other	1068	1.4
Language		
Arabic	126	0.2
Bangla	299	0.4
Croatian	2323	3
Czech	1546	2
Dutch	485	0.6
English	12,853	16.8
French	3752	4.9
German	3355	4.4
Hebrew	1209	1.6
Hindi	14	0

Table 1 (continued)

Variables	*N* = 76,597	%
Hungarian	10,097	13.2
Italian	2198	2.9
Japanese	424	0.6
Korean	1328	1.7
Lithuanian	1964	2.6
Macedonian	1211	1.6
Mandarin-Simplified	2425	3.2
Mandarin- Traditional	2617	3.4
Polish	9546	12.5
Portuguese- Brazil	3411	4.5
Portuguese- Portugal	2110	2.8
Romanian	67	0.1
Slovak	1984	2.6
Spanish- Latin American	8310	10.8
Spanish- Spain	2174	2.8
Turkish	765	1
Sex assigned at birth		
Male	30,853	40.3
Female	45,729	59.7
Gender (original answer options in the survey)		
Masculine/Man	30,199	39.4
Feminine/Woman	43,754	57.1
Indigenous or other cultural gender minority identity (e.g., two-spirit)	156	.2
Non-binary, gender-fluid, or something else (e.g., genderqueer)	2171	2.8
Other	280	.4
Gender (categories used in the analyses)		
Man	30,199	39.4
Woman	43,754	57.1
Gender-diverse individuals	2607	3.4
Trans status		
No, I am not a trans person	73,823	96.4
Yes, I am a trans man	335	.4
Yes, I am a trans woman	274	.4
Yes, I am a non-binary trans person	821	1.1
I am questioning my gender identity	1067	1.4
I don't know what it means	250	.3
Sexual orientation (original answer options in the survey)		
Heterosexual/Straight	52,284	68.3
Gay or lesbian or homosexual	4297	5.6
Heteroflexible	5774	7.5
Homoflexible	504	.7
Bisexual	7126	9.3
Queer	892	1.2
Pansexual	1831	2.4
Asexual	1010	1.3
I do not know yet or I am currently questioning my sexual orientation	1804	2.4
None of the above	754	1.0
I don't want to answer	288	.4
Sexual orientation (categories used in the analyses)		
Heterosexual	52,284	68.3
Gay or lesbian or homosexual	4297	5.6
Bisexual	7126	9.3
Queer and pansexual	2723	3.6
Homoflexible and heteroflexible identities	6278	8.2

Table 1 (continued)

Variables	*N*=76,597	%
Asexual	1010	1.3
Questioning	1804	2.4
Other	754	1.0
	M	*SD*
Age (years)	32.57	12.61

Note. Percentages might not add up to 100% due to missing data. *M*=mean, *SD*=standard deviation

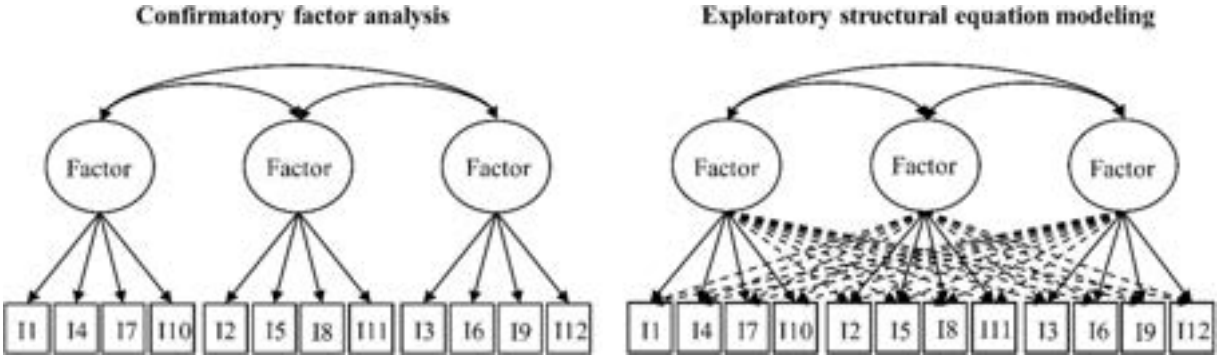

Fig. 1 Schematic Visualization of the Typical CFA and ESEM Models CFA: confirmatory factor analysis; ESEM: exploratory structural equation modeling; I: item. Circles represent latent variables; squares represent scale items. One-headed full arrows represent factor loadings, one-headed dashed arrows represent cross-loadings, and two-headed arrows represent factor correlations

and the six factors were allowed to freely correlate with one another. In ESEM, the six factors were defined in the same manner as in CFA, but all cross-loadings were freely estimated and targeted to be as close to zero as possible through the confirmatory oblique target factor rotation (Browne, 2001).

Tests of measurement invariance

We performed tests of measurement invariance based on language, country of residence, gender (i.e., men, women, gender-diverse individuals), and sexual orientation (i.e., heterosexual, gay/lesbian, bisexual, queer and pansexual, homoflexible and heteroflexible, asexual, people who question their sexual orientation, and individuals identifying with other sexual orientations). For the former two variables, due to the high number of categories, we created two random sets of groups to ensure model convergence in line with the preregistered analytic plan (https://doi.org/10.17605/OSF.IO/DK78R). These groups were created based on the names of languages and countries in English, by sorting them in alphabetical order and splitting them into two and three groups of languages and countries, respectively.

For language, the first set of groups consisted of Croatian, Czech, Dutch, English, French, German, Hebrew, Hungarian, Italian, Japanese, and Korean. The second set consisted of Lithuanian, Macedonian, simplified and traditional Mandarin, Polish, Portuguese (Brazil) and Portuguese (Portugal), Slovakian, Spanish (Latin American) and Spanish (Spain), and Turkish. For country of residence, three sets of groups were created: the first set included Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Croatia, Czech Republic, France, and Germany. The second set included Hungary, Ireland, Israel, Italy, Japan, Lithuania, Malaysia, Mexico, New Zealand, North Macedonia, and Peru. Finally, the third set included Poland, Portugal, Slovakia, South Africa, South Korea, Spain, Switzerland, Taiwan, Turkey, the United Kingdom, and the United States.

Tests of measurement invariance were performed following a commonly used sequence (Meredith, 1993; Millsap, 2011): (1) configural invariance (equal factor structure); (2) metric invariance (equal factor loadings); (3) scalar invariance (equal item thresholds); (4) residual invariance (equal item uniquenesses); (5) invariance of the variance–covariance matrix (equal latent variance–covariance matrix); and (6) invariance of the latent means (equal latent means). While models 1–4 investigate the presence of measurement biases across the samples, models 5–6 test for the presence of meaningful group-based differences at the level of factor variances, covariances, and means. As it is rare to see support for full invariance using a relatively big number of groups (Leitgob et al., 2023), when necessary, partial measurement invariance models were also estimated in which a subset of parameters were not constrained to be invariant (Byrne et al., 1989; Morin et al., 2013). We aimed to keep at least half, or more, of the parameters per factor invariant which is considered sufficient (Morin, 2023). Given that all BPNSFS factors have four items, we aimed to keep

at least two or more items invariant. Our approach aligns with the recommendations of Steenkamp and Baumgartner (1998) who argue that at least two items per factor need to exhibit metric or scalar invariance for meaningful group comparisons.

Model evaluation

The estimated models were evaluated using typical goodness-of-fit indices (Hu & Bentler, 1999; Marsh et al., 2005): the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the root mean square error of approximation (RMSEA) with its 90% confidence interval (90% CI). CFI and TLI values are considered to be adequate or excellent when they are above .90 and .95, respectively. RMSEA values are considered to be adequate or excellent below .08 and .06, respectively. Because the chi-square test has been demonstrated to be oversensitive to even minor model misspecifications and dependent on sample size (Marsh et al., 2005), it is reported for the sake of transparency but not used in model evaluation. Comparing the goodness-of-fit of the CFA and ESEM models, however, is not sufficient and should be accompanied by the examination of parameter estimates (Morin, 2023; Morin et al., 2020). To this end, we compared factor definition (i.e., average factor loadings), factor reliability (ω; McDonald, 1970), and factor correlations. When compared to CFA, the ESEM model is supported when it is characterized by equally well-defined factors coupled with reduced estimates of factor correlations.

The comparison of the nested models within the measurement invariance test sequence was based on the examination of relative changes (Δ) in CFI, TLI, and RMSEA. Specifically, a decrease of at least .010 or higher for CFI and TLI and an increase of at least .015 or higher for RMSEA were used as an indication of the lack of invariance (F. F. Chen, 2007; Cheung & Rensvold, 2002). Important for our purpose is the notion that these cut-off values have mostly been statistically tested in studies characterized by a limited number of groups and/or with simpler factor structures (e.g., one-factor CFA). In reality, the performance of these cut-off values during tests of measurement invariance tends to vary depending on multiple factors, including the number and sizes of the groups, treatment of the data, and complexity of the estimated measurement model (Byrne et al., 1989; Rutkowski & Svetina, 2014). To alleviate some of these concerns, less restrictive cut-off values have been proposed (Desa, 2014; Khojasteh & Lo, 2015), which have their supporters and opponents. Our view on the matter falls in the middle and is in alignment with Marsh (2007) who suggests that strictly adhering to any cut-off values without substantive interpretations could lead to biased interpretations and erroneous conclusions (see also: Heene et al., 2011; Perry et al., 2015). As such, given the complexity of our sample (i.e., multiple groups) and the complexity of the measurement model (i.e., ESEM), we relied on the cut-off values mentioned above as rough guidelines instead of golden rules, and small deviations (up to an additional Δ of .005) in only one of the three fit statistics were considered acceptable (Van Heel et al., 2019). This approach is similar to two previous studies (Scherer et al., 2016; Tóth-Király & Neff, 2021), in which complex measurement structures were estimated across multiple groups. Finally, it is also worth noting that the TLI and RMSEA (but not CFI) are corrected for parsimony (i.e., more parsimonious models can fit the data better than less parsimonious ones), which has considerable importance given that more parameters are estimated in ESEM than in CFA (Marsh et al., 2009; Morin et al., 2020).

Results

Descriptive statistics and correlations

Descriptive statistics and correlations are available in Table 2. Participants reported greater levels of satisfaction than frustration across all domains. Correlations were apparent between all subscales, ranging in size from large (r=-.32 between Relatedness Satisfaction and Autonomy Frustration; Funder & Ozer, 2019) to very large (r=-.72 between Competence Satisfaction and Competence Frustration).

Measurement model: CFA vs. ESEM

The results associated with the CFA and ESEM measurement models first showed that the ESEM solution (χ^2=59,798.524, df=237, CFI=.971, TLI=.966, RMSEA=.057 [90% CI .057, .058]) provided an increased level of fit to the data (ΔCFI=+.022, ΔTLI=+.020, ΔRMSEA=-.020) when compared to the CFA solution (χ^2=15,450.985, df=147, CFI=.993, TLI=.986, RMSEA=.037 [90% CI .036, .037]). This result was consistent with the model fit comparisons across the various subgroups: out of the 67 CFA-ESEM comparisons, the superiority of ESEM was indicated by a single fit index in one comparison, by two fit indices in seven comparisons, and all three fit indices in 59 comparisons. Across the various subgroups, the ESEM models, on average, showed a CFI increase of .027, a TLI increase of .024, and a RMSEA decrease of .022, further supporting ESEM's superiority to the CFA solution.

Standardized parameter estimates for the total sample are reported in Table 3. These results showed that all factors remained generally well-defined (CFA: λ=.534 to .877, M=.778; ESEM: λ=.363 to .900, M=.624) and reliable

Table 2 Total Sample Descriptive Statistics and Pearson Correlations for the BPNSFS

	mean	SD	Cronbach's Alpha	McDonald's Omega	min	max	skew	kurtosis	1	2	3	4	5
1. Relatedness Satisfaction	16.14	3.16	0.84	0.84	4	20	-0.81	0.42	1				
2. Relatedness Frustration	8.19	3.57	0.8	0.8	4	20	0.79	0.04	-0.64	1			
3. Autonomy Satisfaction	14.61	3.14	0.78	0.79	4	20	-0.4	-0.08	0.47	-0.4	1		
4. Autonomy Frustration	11.44	3.58	0.76	0.76	4	20	0.08	-0.49	-0.32	0.48	-0.47	1	
5. Competence Satisfaction	15.14	3.49	0.87	0.87	4	20	-0.68	0.17	0.43	-0.43	0.64	-0.39	1
6. Competence Frustration	10.13	4.29	0.86	0.86	4	20	0.42	-0.69	-0.38	0.57	-0.53	0.53	-0.72

All correlations significant at $p < .001$ with Holm correction

(CFA: ω=.789 to .902; ESEM; ω=.761 to .855) for both solutions. Although the latter incorporates multiple statistically significant cross-loadings, most of them remained small enough not to undermine the definition of the factors (|λ|=.000 to .421, *M*=.086). In fact, only three of the estimated cross-loadings were greater than.300, with one item associated with the relatedness satisfaction, relatedness frustration, and competence frustration factors. A closer look at these cross-loadings suggested that they tended to show comparable, negative loadings on the opposing factor (e.g., the competence frustration item on the competence satisfaction factor), which is theoretically reasonable. As for the factor correlations (see Table 4), they were substantially reduced in the ESEM (|*r*|=.287 to .640, *M*=.460) relative to the CFA (|*r*|=.422 to .857, *M*=.620) solution, and were positive among subscales with the same valence (satisfaction-satisfaction, frustration-frustration) and negative among subscales with a distinct valence (satisfaction-frustration). Based on the available information, the ESEM model was retained for further analyses.

Invariance across languages

First, we verified the extent to which the ESEM model replicated across language groups. In the first set of language groups (MILA1 models shown in Table 5), the first model with no invariance constraints provided good fit to the data (CFI=.983, TLI=.968, RMSEA=.058), suggesting that the factor structure was the same across these 11 groups. The gradual inclusion of invariance constraints on the various model parameters (MILA2-6) showed that (1) the CFI, TLI, and RMSEA indicated excellent fit on all levels; (2) ΔTLI and ΔRMSEA never crossed their suggested thresholds, while ΔCFI only went over its threshold by .003 for the latent mean invariant model (MILA6). These results suggest that the measure functions the same way across these 11 language groups. As for the second set of language groups (MILB in Table 5), the results were largely similar with one notable exception. Full scalar invariance was not achieved, which led us to estimate partial scalar invariance models by freeing up item thresholds highlighted by modification indices. Of the 960 item thresholds across the 11 groups, 37 had to be freed up in the various groups, leading to the identification of a partial strong invariance model. Across the 11 groups, there was no obvious pattern in that freed thresholds represented a mix of items from all six factors. While it was sufficient to keep at least half, or more, of the item thresholds invariant in most groups, there were a few exceptions. Namely, one competence satisfaction item in Lithuanian, one relatedness satisfaction item in Portuguese (Brazil) and two relatedness frustration items in

Table 3 Standardized Parameter Estimates for the CFA and ESEM Solutions on the Full Sample

	CFA		ESEM						
	Factor (λ)	δ	AS (λ)	RS (λ)	CS (λ)	AF (λ)	RF (λ)	CF (λ)	δ
Autonomy satisfaction (AS)									
Item 1	.701**	.509	**.387****	.055**	.260**	−.281**	−.036**	.219**	.527
Item 7	.784**	.385	**.872****	−.080**	.000	.074**	−.050**	−.023**	.321
Item 13	.768**	.410	**.900****	−.045**	−.041**	.108**	−.058**	−.013**	.318
Item 19	.730**	.467	**.466****	.146**	.109**	−.200**	.161**	−.038**	.497
ω	.834		.806						
Relatedness satisfaction (RS)									
Item 3	.761**	.421	.059**	**.447****	.124**	−.011**	−.350**	.159**	.443
Item 9	.834**	.305	−.037**	**.874****	.069**	.017**	.010*	.002	.248
Item 15	.877**	.230	−.026**	**.883****	.054**	.014**	−.012**	−.021**	.193
Item 21	.778**	.394	.115**	**.586****	.010*	−.014**	−.139**	.022**	.435
ω	.887			.855					
Competence satisfaction (CS)									
Item 5	.843**	.289	.029**	.010*	**.756****	.015**	−.098**	−.091**	.241
Item 11	.853**	.273	.121**	.114**	**.591****	.026**	.016**	−.195**	.284
Item 17	.836**	.301	.198**	.132**	**.525****	−.058**	.104**	−.157**	.314
Item 23	.809**	.345	.123**	.125**	**.571****	.008*	.098**	−.205**	.332
ω	.902				.836				
Autonomy frustration (AF)									
Item 2	.534**	.715	.061**	.034**	−.055**	**.663****	.024**	−.079**	.620
Item 8	.786**	.382	−.109**	.022**	−.028**	**.665****	.117**	−.062**	.422
Item 14	.700**	.510	.019**	.040**	.072**	**.671****	.018**	.172**	.469
Item 20	.746**	.443	−.086**	−.052**	.121**	**.616****	−.038**	.182**	.473
ω	.789					.775			
Relatedness frustration (RF)									
Item 4	.752**	.435	−.048**	−.019**	−.037**	.085**	**.613****	.077**	.435
Item 10	.766**	.414	−.008	−.185**	.040**	.079**	**.616****	.039**	.365
Item 16	.808**	.348	−.061**	−.049**	.036**	.000	**.662****	.197**	.326
Item 22	.742**	.449	−.050**	−.322**	.123**	.088**	**.363****	.163**	.466
ω	.851						.776		
Competence frustration (CF)									
Item 6	.820**	.328	.073**	.118**	−.421**	.068**	.222**	**.432****	.296
Item 12	.801**	.358	−.065**	−.027**	−.026**	.101**	.077**	**.651****	.333
Item 18	.822**	.325	−.035**	.067**	−.239**	.064**	.090**	**.580****	.302
Item 24	.817**	.332	−.063**	−.051**	−.026**	.122**	.134**	**.588****	.336
ω	.888							.800	

Note. *$p < .05$; **$p <$ .01; CFA: Confirmatory factor analysis; ESEM: Exploratory structural equation modeling; λ: Factor loading; δ: Item uniqueness; Target factor loadings are in bold

Table 4 Latent Factor Correlations from CFA (below the diagonal) and ESEM (above the diagonal) Solutions on the Full Sample

	AS	RS	CS	AF	RF	CF
Autonomy satisfaction (AS)	—	.533**	.618**	−.525**	−.351**	−.517**
Relatedness satisfaction (RS)	.588**	—	.340**	−.347**	−.631**	−.287**
Competence satisfaction (CS)	.781**	.526**	—	−.357**	−.304**	−.640**
Autonomy frustration (AF)	−.621**	−.422**	−.497**	—	.479**	.506**
Relatedness frustration (RF)	−.524**	−.797**	−.538**	.640**	—	.484**
Competence frustration (RF)	−.650**	−.465**	−.857**	.677**	.712**	—

Note. **$p < .01$; *CFA:* Confirmatory factor analysis; *ESEM* Exploratory structural equation modeling

Spanish (Latin American) had three of their four thresholds freed up. This result, however, might not be extremely concerning as we still had at least two fully invariant items per factor (Steenkamp & Baumgartner, 1998). The remaining invariance levels were fully achieved, providing us with reasonable support for the functioning of the measure across the second set of language groups with no significant differences among language-based groups.

Table 5 Goodness-of-Fit Statistics for the Estimated Group-Specific and Measurement Invariance Models Across Language Groups

Model	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
Group-Specific Models						
L1 Croatian CFA	2162.325*	237	.974	.970	.059	.057, .061
L1 Croatian ESEM	761.100*	147	.992	.984	.042	.039, .045
L2 Czech CFA	1540.139*	237	.964	.958	.060	.057, .062
L2 Czech ESEM	598.244*	147	.987	.976	.045	.041, .048
L3 Dutch CFA	693.463*	237	.971	.967	.063	.057, .068
L3 Dutch ESEM	322.982*	147	.989	.979	.050	.042, .057
L4 English CFA	12,098.851*	237	.973	.968	.062	.061, .063
L4 English ESEM	3507.618*	147	.992	.986	.042	.041, .043
L5 French CFA	3238.270*	237	.974	.969	.058	.056, .060
L5 French ESEM	1096.728*	147	.992	.984	.041	.039, .044
L6 German CFA	3050.330*	237	.966	.961	.059	.058, .061
L6 German ESEM	751.787*	147	.993	.986	.035	.033, .037
L7 Hebrew CFA	1027.947*	237	.976	.972	.053	.049, .056
L7 Hebrew ESEM	361.754*	147	.993	.988	.035	.030, .039
L8 Hungarian CFA	10,649.487*	237	.959	.952	.066	.065, .067
L8 Hungarian ESEM	2886.551*	147	.989	.980	.043	.042, .044
L9 Italian CFA	2295.941*	237	.965	.959	.063	.060, .065
L9 Italian ESEM	887.292*	147	.987	.976	.048	.045, .051
L10 Japanese CFA	660.990*	237	.961	.955	.065	.059, .071
L10 Japanese ESEM	279.974*	147	.988	.977	.046	.038, .054
L11 Korean CFA	2723.241*	237	.934	.923	.089	.086, .092
L11 Korean ESEM	767.976*	147	.984	.969	.056	.052, .060
L12 Lithuanian CFA	2077.452*	237	.965	.959	.063	.060, .065
L12 Lithuanian ESEM	548.830*	147	.992	.985	.037	.034, .041
L13 Macedonian CFA	1228.424*	237	.959	.952	.059	.055, .062
L13 Macedonian ESEM	313.319*	147	.993	.987	.031	.026, .035
L14 Mandarin simplified CFA	2376.596*	237	.964	.958	.061	.059, .063
L14 Mandarin simplified ESEM	1085.857*	147	.984	.970	.051	.048, .054
L15 Mandarin traditional CFA	7326.871*	237	.903	.887	.107	.105, .109
L15 Mandarin traditional ESEM	1031.901*	147	.988	.977	.048	.045, .051
L16 Polish CFA	13,649.133*	237	.942	.933	.077	.076, .078
L16 Polish ESEM	2948.445*	147	.988	.977	.045	.043, .046
L17 Portuguese Brazil CFA	3856.217*	237	.963	.957	.067	.065, .069
L17 Portuguese Brazil ESEM	850.246*	147	.993	.987	.037	.035, .040
L18 Portuguese Portugal CFA	2077.753*	237	.975	.971	.061	.058, .063
L18 Portuguese Portugal ESEM	596.931*	147	.994	.988	.038	.035, .041
L19 Slovak CFA	2219.826*	237	.965	.959	.065	.062, .067
L19 Slovak ESEM	917.207*	147	.986	.974	.051	.048, .054
L20 Spanish Latin American CFA	8628.026*	237	.965	.960	.065	.064, .066
L20 Spanish Latin American ESEM	1982.730*	147	.992	.986	.039	.037, .040
L21 Spanish Spain CFA	2579.988*	237	.962	.955	.067	.065, .070
L21 Spanish Spain ESEM	752.355*	147	.990	.981	.043	.040, .047
L22 Turkish CFA	1512.179*	237	.942	.932	.084	.080, .088
L22 Turkish ESEM	341.094*	147	.991	.983	.041	.036, .047
Measurement Invariance Models (Groups 1–11)						
MILA1 Configural	21,537.649*	1617	.983	.968	.058	.058, .059
MILA2 Metric	23,996.336*	2697	.982	.980	.047	.046, .047
MILA3 Scalar	33,103.343*	3357	.975	.977	.050	.049, .050
MILA4 Residual	37,474.802*	3597	.971	.976	.051	.051, .052
MILA5 Latent variances-covariances	25,338.913*	3807	.982	.985	.040	.039, .040
MILA6 Latent means	40,460.033*	3867	.969	.976	.051	.051, .052
Measurement Invariance Models (Groups 12–22)						
MILB1 Configural	20,159.962*	1617	.981	.965	.059	.058, .059
MILB2 Metric	25,366.939*	2697	.977	.974	.050	.050, .051

Table 5 (continued)

Model	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
MILB3 Scalar	42,628.051*	3357	.960	.964	.059	.059, .060
MILB3p Partial Scalar	35,329.134*	3320	.968	.970	.054	.053, .054
MILB4 Residual	45,784.769*	3560	.957	.964	.060	.059, .060
MILB5 Latent variances-covariances	40,887.690*	3770	.962	.970	.054	.054, .055
MILB6 Latent means	52,277.110*	3830	.951	.961	.062	.061, .062

Note. *CFA* Confirmatory factor analysis; *ESEM* Exploratory structural equation modeling; χ^2: Robust chi-square test of exact fit; *df* Degrees of freedom; *CFI* Comparative fit index; *TLI* Tucker-Lewis index; *RMSEA* Root mean square error of approximation; *90% CI* 90% confidence interval of the RMSEA; *$p < .01$

Invariance across countries

To examine whether the ESEM model differed among countries, we performed tests of measurement invariance across the three sets of countries outlined above. In the first set (see the MICA models shown in Table 6), we found support for the configural, metric, partial scalar, residual, latent variance–covariance, and latent mean invariance of the model. In the case of the partial scalar model, based on the inspection of modification indices, 28 of the 1056 thresholds had to be freed up in the various groups. Similar to the tests of language invariance, there was no obvious pattern across the 12 groups in the current analyses, the freed thresholds represented a mix of items from all six factors. Importantly, one relatedness satisfaction item in Brazil had three of its four thresholds freed up, leading to this factor having three fully invariant items (Steenkamp & Baumgartner, 1998). In contrast, full measurement invariance was achieved for the second (MICB models in Table 6) and third (MICC models in Table 6) set of groups. These results again provide reasonable support for the invariance of the ESEM solution across groups based on countries and indicate no significant differences between the groups.

Invariance across genders

Next, we investigated the invariance of the retained ESEM solution across gender groups. The results (see the MIG models in Table 7) led us to similar conclusions: fit indices remained excellent across all invariance models (CFI≥.991, TLI≥.985, RMSEA≤.037) and the changes in model fit never crossed the thresholds on any of the three fit indices (ΔCFI≤-.006, ΔTLI≤-.006, ΔRMSEA≤ +.012). These findings suggest that this measure functions the same way not just in different groups based on language and country of residence, but also in different gender groups with no significant gender differences.

Invariance across sexual orientations

Finally, does this ESEM model work the same way across groups based on sexual orientation? We addressed this question by conducting tests of measurement invariance across these groups (see the MIS models in Table 8). The inclusion of each set of equality constraints did not result in substantial changes in fit indices for the model of configural (CFI, TLI, and RMSEA were .992, .985, and .037, respectively), metric (CFI, TLI, and RMSEA were .995, .995, and .022, respectively), scalar (CFI, TLI, and RMSEA were .995, .995, and .021, respectively), residual (CFI, TLI, and RMSEA were .995, .996, and .020, respectively), latent variance–covariance (CFI, TLI, and RMSEA were .997, .998, and .014, respectively) and latent mean (CFI, TLI, and RMSEA were .988, .990, and .030, respectively) invariance models. As all changes in fit indices remained reasonably within the recommended cut-off values, it can be concluded that the measure operates the same way across sexual orientations as well with no significant differences between sexual-orientation-based groups.

Discussion

At the outset of this work, we aimed to evaluate the factor structure of the BPNSFS and the invariance of the scale across language, nationality, sexual orientation, and gender identity. In a very large (N = 76,597), international sample, we found that the original, six-factor solution for the BPNSFS emerged as the optimal fit for the scale. Finally, we demonstrated that the BPNSFS is largely invariant (wholly invariant in many cases, partially invariant in all cases) across 22 languages, 32 countries, 3 gender identities, and 8 sexual orientations. Below, we consider the implications of these findings.

Table 6 Goodness-of-Fit Statistics for the Estimated Group-Specific and Measurement Invariance Models Across Country Groups

Model	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
Group-Specific Models						
C1 Australia CFA	677.552*	237	.980	.976	.056	.051, .061
C1 Australia ESEM	344.334*	147	.991	.983	.047	.041, .054
C2 Austria CFA	797.148*	237	.972	.967	.058	.053, .062
C2 Austria ESEM	297.733*	147	.992	.986	.038	.032, .044
C3 Belgium CFA	733.224*	237	.971	.967	.059	.054, .064
C3 Belgium ESEM	354.388*	147	.988	.977	.048	.042, .055
C4 Brazil CFA	3792.422*	237	.963	.956	.067	.065, .069
C4 Brazil ESEM	834.818*	147	.993	.986	.037	.035, .040
C5 Canada CFA	2057.476*	237	.978	.974	.057	.055, .059
C5 Canada ESEM	761.190*	147	.992	.986	.042	.039, .045
C6 Chile CFA	1520.867*	237	.961	.955	.070	.066, .073
C6 Chile ESEM	461.804*	147	.990	.982	.044	.039, .048
C7 China CFA	2320.644*	237	.964	.959	.061	.059, .063
C7 China ESEM	1103.545*	147	.984	.969	.052	.049, .055
C8 Colombia CFA	1919.811*	237	.964	.958	.062	.060, .065
C8 Colombia ESEM	715.275*	147	.988	.977	.046	.043, .049
C9 Croatia CFA	2136.635*	237	.973	.969	.060	.058, .063
C9 Croatia ESEM	752.294*	147	.992	.984	.043	.040, .046
C10 Czech Republic CFA	1572.411*	237	.964	.958	.059	.057, .062
C10 Czech Republic ESEM	611.440*	147	.987	.976	.044	.041, .048
C11 France CFA	1743.807*	237	.967	.962	.063	.060, .065
C11 France ESEM	614.399*	147	.990	.981	.044	.041, .048
C12 Germany CFA	2582.778*	237	.969	.964	.056	.054, .058
C12 Germany ESEM	734.965*	147	.992	.985	.036	.033, .038
C13 Hungary CFA	10,192.496*	237	.963	.956	.064	.063, .065
C13 Hungary ESEM	2823.325*	147	.990	.981	.042	.041, .043
C14 Ireland CFA	1569.343*	237	.974	.969	.061	.058, .064
C14 Ireland ESEM	547.965*	147	.992	.985	.042	.039, .046
C15 Israel CFA	1046.925*	237	.974	.970	.053	.049, .056
C15 Israel ESEM	371.894*	147	.993	.986	.035	.031, .040
C16 Italy CFA	2255.704*	237	.966	.960	.063	.060, .065
C16 Italy ESEM	869.400*	147	.988	.977	.048	.045, .051
C17 Japan CFA	786.655*	237	.960	.954	.067	.062, .072
C17 Japan ESEM	319.341*	147	.987	.977	.048	.041, .055
C18 Lithuania CFA	1955.407*	237	.966	.961	.062	.059, .064
C18 Lithuania ESEM	562.905*	147	.992	.985	.039	.035, .042
C19 Malaysia CFA	1686.441*	237	.952	.944	.074	.071, .077
C19 Malaysia ESEM	461.966*	147	.990	.980	.044	.039, .048
C20 Mexico CFA	2681.128*	237	.960	.953	.072	.070, .075
C20 Mexico ESEM	527.698*	147	.994	.988	.036	.033, .039
C21 New Zealand CFA	2422.035*	237	.976	.972	.059	.057, .061
C21 New Zealand ESEM	785.307*	147	.993	.987	.041	.038, .043
C22 North Macedonia CFA	1217.876*	237	.958	.951	.059	.056, .063
C22 North Macedonia ESEM	316.550*	147	.993	.986	.031	.027, .036
C23 Peru CFA	2376.097*	237	.973	.969	.061	.059, .063
C23 Peru ESEM	610.783*	147	.994	.989	.036	.033, .039
C24 Poland CFA	12,990.456*	237	.943	.934	.077	.076, .078
C24 Poland ESEM	2835.053*	147	.988	.978	.045	.043, .046
C25 Portugal CFA	2098.532*	237	.975	.971	.061	.059, .064
C25 Portugal ESEM	608.118*	147	.994	.988	.039	.035, .042
C26 Slovakia CFA	1190.166*	237	.967	.961	.062	.059, .066
C26 Slovakia ESEM	534.791*	147	.986	.975	.050	.046, .055
C27 South Africa CFA	1582.788*	237	.974	.970	.058	.055, .061
C27 South Africa ESEM	580.488*	147	.992	.985	.042	.038, .045

Table 6 (continued)

Model	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
C28 South Korea CFA	2690.774*	237	.936	.926	.087	.084, .090
C28 South Korea ESEM	745.760*	147	.984	.971	.055	.051, .059
C29 Spain CFA	2539.228*	237	.963	.957	.067	.064, .069
C29 Spain ESEM	729.317*	147	.991	.982	.043	.039, .046
C30 Switzerland CFA	1177.825*	237	.974	.970	.060	.056, .063
C30 Switzerland ESEM	466.551*	147	.991	.983	.044	.040, .049
C31 Taiwan CFA	7237.612*	237	.904	.888	.107	.104, .109
C31 Taiwan ESEM	1013.519*	147	.988	.978	.048	.045, .050
C32 Turkey CFA	1455.120*	237	.941	.931	.084	.079, .088
C32 Turkey ESEM	362.843*	147	.990	.980	.045	.039, .050
C33 United Kingdom CFA	1231.197*	237	.974	.970	.057	.054, .060
C33 United Kingdom ESEM	490.113*	147	.991	.983	.042	.038, .046
C34 United States CFA	2305.568*	237	.974	.970	.063	.060, .065
C34 United States ESEM	674.535*	147	.993	.988	.040	.037, .043
Measurement Invariance Models (Groups 1–12)						
MICA1 Configural	7991.677*	1764	.990	.981	.044	.043, .045
MICA2 Metric	12,265.496*	2952	.984	.983	.042	.041, .043
MICA3 Scalar	22,809.271*	3678	.968	.971	.054	.053, .055
MICA3p Partial Scalar	18,972.242*	3650	.974	.977	.048	.048, .049
MICA4 Residual	24,292.995*	3914	.966	.971	.054	.053, .055
MICA5 Latent variances-covariances	21,554.135*	4145	.971	.977	.048	.048, .049
MICA6 Latent means	29,745.078*	4211	.958	.967	.058	.057, .058
Measurement Invariance Models (Groups 13–23)						
MICB1 Configural	8846.500*	1617	.990	.982	.043	.042, .044
MICB2 Metric	16,930.175*	2697	.981	.979	.046	.046, .047
MICB3 Scalar	22,309.015*	3357	.975	.977	.048	.047, .049
MICB4 Residual	25,742.600*	3597	.970	.975	.050	.049, .051
MICB5 Latent variances-covariances	17,896.394*	3807	.981	.985	.039	.038, .039
MICB6 Latent means	2665.794*	3867	.970	.976	.049	.048, .050
Measurement Invariance Models (Groups 24–34)						
MICC1 Configural	10,081.523*	1617	.988	.978	.048	.047, .048
MICC2 Metric	16,109.936*	2697	.981	.979	.046	.046, .047
MICC3 Scalar	26,359.264*	3357	.968	.971	.054	.054, .055
MICC4 Residual	30,617.845*	3597	.962	.968	.057	.056, .057
MICC5 Latent variances-covariances	28,841.441*	3807	.965	.972	.053	.053, .054
MICC6 Latent means	36,333.857*	3867	.955	.965	.060	.060, .061

Note. *CFA* Confirmatory factor analysis; *ESEM* Exploratory structural equation modeling; χ^2: Robust chi-square test of exact fit; *df* Degrees of freedom; *CFI* Comparative fit index; *TLI* Tucker-Lewis index; *RMSEA* Root mean square error of approximation; *90% CI* 90% confidence interval of the RMSEA; *$p < .01$

The Universality of basic psychological needs

The primary implication of the present work is that the BPNSFS performs essentially the same across a wide range of languages and countries of residence. On its face, this is a psychometric conclusion: invariance was generally found across countries of residence and languages (partial invariance in some cases). Yet, these findings also imply a more conceptual conclusion: As is implied by SDT and BPNT, our findings add further evidence to an already large body of work that supports the universality of the ideas posited by the BPNT. Moreover, our results specifically show that the BPNSFS is reliably assessing the same constructs across a large variety of languages and countries of residence, as well as across gender and sexual orientation.

Collectively, these findings demonstrate that the BPNSFS can continue to be confidently used globally and may imply that results from BPNSFS scores across the globe are comparable. More practically, the results of the present work add to an already large body of literature suggesting the cross-cultural relevance of SDT and BPNT. By demonstrating the invariance of the scale across such a wide variety of contexts, our work adds credibility to the insights being gained from the BPNSFS in diverse settings. This is not a novel realization, as the scale was originally developed

Table 7 Goodness-of-Fit Statistics for the Estimated Group-Specific and Measurement Invariance Models Across Gender Identity Groups

Model	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
Group-Specific Models						
G1 Men CFA	21,617.316*	237	.973	.969	.055	.054, .055
G1 Men ESEM	5606.561*	147	.993	.987	.035	.034, .036
G2 Women CFA	35,436.645*	237	.970	.965	.058	.058, .059
G2 Women ESEM	9679.376*	147	.992	.985	.038	.038, .039
G3 Gender-diverse individuals CFA	2806.442*	237	.967	.962	.064	.062, .067
G3 Gender-diverse individuals ESEM	965.960*	147	.990	.981	.046	.043, .049
Measurement Invariance Models						
MIG1 Configural	16,275.155*	441	.992	.985	.037	.037, .038
MIG2 Metric	12,559.937*	657	.994	.992	.027	.026, .027
MIG3 Scalar	16,175.059*	789	.992	.992	.028	.027, .028
MIG4 Residual	15,312.325*	837	.993	.993	.026	.026, .026
MIG5 Latent variances-covariances	7636.509*	879	.997	.997	.017	.017, .018
MIG6 Latent means	19,755.041*	891	.991	.991	.029	.028, .029

Note. *CFA* Confirmatory factor analysis; *ESEM* Exploratory structural equation modeling; χ^2: Robust chi-square test of exact fit; *df* Degrees of freedom; *CFI* Comparative fit index; *TLI*: Tucker-Lewis index; *RMSEA* Root mean square error of approximation; *90% CI* 90% confidence interval of the RMSEA; *$p < .01$

Table 8 Goodness-of-fit statistics for the estimated group-specific and measurement invariance models across sexual orientation groups

Model	χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
Group-Specific Models						
S1 Heterosexual CFA	38,574.431*	237	.971	.966	.056	.055, .056
S1 Heterosexual ESEM	9873.088*	147	.993	.986	.036	.035, .036
S2 Gay/lesbian CFA	3723.535*	237	.972	.968	.058	.057, .060
S2 Gay/lesbian ESEM	1106.712*	147	.992	.986	.039	.037, .041
S3 Bisexual CFA	6011.956*	237	.972	.967	.058	.057, .060
S3 Bisexual ESEM	1669.887*	147	.993	.986	.038	.036, .040
S4 Queer and Pansexual CFA	2605.676*	237	.972	.967	.061	.058, .063
S4 Queer and Pansexual ESEM	951.389*	147	.990	.982	.045	.042, .048
S5 Homoflexible or Heteroflexible CFA	6503.771*	237	.963	.957	.065	.064, .066
S5 Homofelxible or Heteroflexible ESEM	1606.482*	147	.991	.984	.040	.038, .042
S6 Asexual CFA	1241.180*	237	.965	.960	.065	.061, .068
S6 Asexual ESEM	480.182*	147	.988	.978	.047	.043, .052
S7 Questioning CFA	1982.557*	237	.960	.954	.064	.061, .067
S7 Questioning ESEM	657.627*	147	.988	.978	.044	.040, .047
S8 Other CFA	883.554*	237	.968	.963	.060	.056, .064
S8 Other ESEM	388.582*	147	.988	.978	.047	.041, .052
Measurement Invariance Models						
MIS1 Configural	16,486.706*	1176	.992	.985	.037	.036, .037
MIS2 Metric	10,799.737*	1932	.995	.995	.022	.022, .022
MIS3 Scalar	12,694.459*	2394	.995	.995	.021	.021, .022
MIS4 Residual	12,381.682*	2562	.995	.996	.020	.020, .020
MIS5 Latent variances-covariances	8003.885*	2709	.997	.998	.014	.014, .015
MIS6 Latent means	26,328.869*	2751	.988	.990	.030	.030, .030

CFA Confirmatory factor analysis, *ESEM* Exploratory structural equation modeling, χ^2 Robust chi-square test of exact fit, *df* Degrees of freedom, *CFI* Comparative fit index, *TLI* Tucker-Lewis index, *RMSEA* Root mean square error of approximation, *90% CI* 90% confidence interval of the RMSEA, *$p < .01$

cross-culturally, but our work extends such cross-country testing to a much larger context that accounts for both language and nationality. Moreover, the expansive inclusion of a variety of lower income countries, non-Western countries of residence, and countries with lower median education levels than typically seen in the U.S. and Europe is a clear strength of the present work and evidence that the BPNSFS is useful in non-W.E.I.R.D. (Western, Educated, Industrialized, Rich, Democratic) contexts.

Our work also applied invariance testing to both gender and sexual orientation, which is a notable extension on past work. Though BPNT has been applied to gender-diverse

populations in the past and has shown clear relationships with important outcomes, there is only limited past work testing the invariance of commonly used scales in such populations. The results of the present work suggest that BPNT can and should be applied to research in such groups and that the BPNSFS is likely an excellent tool for conducting such research.

Ultimately, the above conclusions about the utility of the BPNSFS across languages and cultures points to a need for further cross-cultural work within the BPNT and SDT frameworks. Few psychological theories boast the cross-cultural applicability of SDT, and even fewer use measures that demonstrate similar cross-cultural utility. These strengths of BPNT and SDT more broadly demonstrate the value of studying these domains in the global context. Similarly, the above conclusions about the utility of the BPNSFS across genders and sexual orientations demonstrates another domain in which BPNT and SDT could and should be fruitfully applied. Indeed, it is likely that these theories offer potential novel insights within the psychologies of gender and sexuality. Though some work has already applied these theories to such domains, these are areas in which the potential insights offered by BPNT and SDT have been underexplored. It is quite likely that SDT can add further understanding to the unique experiences of people that are sexually or gender diverse (e.g., for a recent example, see: Clements & Rostosky, 2025), and exploration of these constructs in such populations is warranted.

Frustration or dissatisfaction?

Our results suggest that a six-factor solution for the scale is psychometrically sound, particularly in an international context when age is not restricted. Such a conclusion is in contrast to recent work in this domain (Murphy et al., 2023), which noted that the factor structure of the BPNSFS may not reliably match its common scoring and interpretation. In the present work, we also found strong cross-country support for the six-factor solution, though we did not compare alternate solutions. Even so, our results do not directly address the greater criticism that a plain-text reading of the so-called "frustration" items measure a lack of satisfaction rather than frustration. Indeed, the wording of the items of the BPNSFS do lack the active thwarting that seems central to the theoretical underpinnings of need frustration; however, this is more a limitation of the scale itself than the methodology of our current study.

The discrepancy between our findings and Murphy and colleagues' (2023) findings may be best understood as related to conceptualization of the frustration items. Though we certainly agree that they seem to lack the necessary theoretical components implied by the frustration component of BPNT, we would contend that there is likely a difference between need satisfaction and need dissatisfaction. Indeed, this distinction between satisfied needs, unmet needs, and frustrated needs has been posited in past theoretical works (Vansteenkiste & Ryan, 2013). Our results suggest that respondents differentiate between low satisfaction and dissatisfaction or, conversely, between high satisfaction and low dissatisfaction in completing the BPNSFS. This is consistent with prior research in this domain that clearly show that both low satisfaction and high dissatisfaction are related to key negative outcomes and that people differentiate, to some degree, between the two domains. Importantly, then, as Murphy and colleagues note, we note the need for continued work to carefully differentiate between need frustration and unsatisfied needs.

Limitations

Despite the strengths of the present study, we do note a few very key limitations that should temper conclusions from our work (see the general limitation of the International Sex Survey at https://osf.io/6kscb). Primarily, the present study relied on the general version of the BPNSFS and did not test domain-specific versions. Although we would contend that measurement evaluation efforts such as the present should start generally and move to more specific applications, given the extensive dissemination, translation, and use of domain-specific versions of the BPNSFS, there is a fundamental need to evaluate multiple versions of the scale across multiple cultures.

While our study relied on the well-established multigroup invariance testing approach, other approaches have recently been developed that seek to address some of its limitations such as the lack of full metric or scalar invariance (e.g., Marsh et al., 2018). As such, further investigations might be warranted using these newer, and other, modeling techniques to identify if the variability of item parameters across groups might be explained by individual or group-level variables. Still, recent evidence from a comprehensive simulation study (Pokropek et al., 2019) showed that partial invariance might be sufficient under various conditions and tend to perform as well as these newer modeling techniques.

Although our findings contribute to the documentation of the cross-country relevance of BPNs and the BPNSFS, they do not "prove" the validity of BPNSFS across cultures, and, indeed, such efforts would require much greater emphasis on external markers of validity (for a discussion of this in the context of invariance see: Funder & Gardiner, 2024). Even so, we would contend that there is already a large body of literature suggesting that BPNs and the BPNSFS

are valid cross-culturally and that our findings add further evidence to this body of work.

Related to the above point and as we discussed earlier, the current study does not directly address the theoretical critiques of the BPNSFS "frustration" items. Though our results suggest such items are factorially distinct from satisfaction items, future work needs to consider alternative wording formats that address the active thwarting that seems essential to theoretical conceptualizations of frustration.

We also note that, though our study represents a first-of-its-kind examination of the BPNSFS with regards to the languages assessed and countries included, we had very poor representation in some regions, particularly continental Africa. Indeed, continental Africa is sorely underrepresented in the majority of psychological research. Given rapid population growth in Africa over recent decades, future investigations need to address this failing of the field. Moreover, in at least one prior study examining the structure of the BPNSFS in Africa, the scale demonstrated poor psychometric characteristics (Cromhout et al., 2022), further illustrating the need for careful validation in this cultural context.

Finally, we note that the present study is entirely cross-sectional in nature. The temporal invariance of the present measure is not yet established, and associations reported in the present study should be interpreted as associations, not directional or causal links.

Conclusions

The BPNSFS is widely used instrument measuring a key component of SDT more broadly. The present work strongly suggests that the measure is invariant across numerous domains is useful in a wide variety of contexts. Practically speaking, this further illustrates the utility of the BPNSFS in cross-cultural research. Moreover, the present work suggests that the six hypothesized subscales of the BPNSFS can be treated as six distinct scales. More simply, subscales measuring need satisfaction and need frustration seem distinct, as opposed to simply measuring opposite ends of the same spectrum. Even so, there remains a need for careful work examining whether the BPNSFS measures need frustration as opposed to need dissatisfaction.

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