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Journal of Personality Assessment

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/hjpa20

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To cite this article: Sofie Holmquist, Andreas Stenling, Susanne Tafvelin, Nikos Ntoumanis & Ingrid Schéle (29 Sep 2023): Dimensionality, Invariance, and Nomological Network of the Need Satisfaction and Frustration Scale (NSFS): An Extensive Psychometric Investigation in a Swedish Work Cohort, Journal of Personality Assessment, DOI: 10.1080/00223891.2023.2258960

To link to this article: https://doi.org/10.1080/00223891.2023.2258960

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JOURNAL OF PERSONALITY ASSESSMENT
https://doi.org/10.1080/00223891.2023.2258960

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Dimensionality, Invariance, and Nomological Network of the Need Satisfaction and Frustration Scale (NSFS): An Extensive Psychometric Investigation in a Swedish Work Cohort

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ABSTRACT

The present study evaluated the dimensionality, measurement invariance, and nomological network of the Need Satisfaction and Frustration Scale (NSFS) in a sample of Swedish workers. Using confirmatory factor analysis, exploratory structural equation modeling, and bifactor modeling, 30 different measurement models were evaluated cross-sectionally ($n = 2123$) and longitudinally ($n = 1506$). Measurement invariance was tested across gender and time. The nomological network of the NSFS was examined through its relations with life satisfaction and cognitive weariness. The findings supported a first-order six-factor ESEM model and measurement invariance of the Swedish version of the NSFS. Need satisfaction was positively related to life satisfaction and unrelated to cognitive weariness. Need frustration was negatively related to life satisfaction and positively related to cognitive weariness. The present study supported a six-factor structure of the Swedish NSFS, which appears suitable for assessing changes over time and gender differences in ratings.

ARTICLE HISTORY
Received 11 November 2022
Accepted 3 September 2023

Over the last two decades, self-determination theory's (Ryan & Deci, 2017) basic psychological needs concept has become increasingly central to organizational research in relation to aspects, such as leadership (Lian et al., 2012; Rahmadani et al., 2019), burnout (Gerber & Anaki, 2021; Van den Broeck et al., 2008), well-being (Van Den Broeck et al., 2016), job-design (Van den Broeck et al., 2008), motivation (Olafsen et al., 2018), and performance (Arshadi, 2010). Alongside the interest in pinpointing the role of basic psychological needs in work settings, a growing number of studies examine the psychometric properties of basic psychological needs instruments. Many studies empirically established the distinction between need satisfaction and need frustration across cultures and language-specific versions of instruments (Chen et al., 2015; Longo et al., 2016, 2018; Tóth-Király et al., 2018, 2019). Recently, the concept of need fulfillment was proposed as an overarching need continuum that comprises both need satisfaction and need frustration in life in general (Tóth-Király et al., 2018) and the work domain (Gillet et al., 2020; Sánchez-Oliva et al., 2017). However, compared to need satisfaction and frustration, the concept of need fulfillment appears less theoretically anchored in basic psychological needs theory. Further, studies incorporating the need fulfillment hypothesis in dimensionality analyses are limited to a few cultural and linguistic settings (French workers; Gillet et al., 2020; Portuguese workers; Sánchez-Oliva et al., 2017; Hungarian general population; Tóth-Király et al., 2018, 2019). More research is needed in different cultures and with language-specific versions of basic psychological needs instruments to further investigate their dimensionality and the concept of need fulfillment. Thus, the present study sought to evaluate the dimensionality of the Need Satisfaction and Frustration Scale (NSFS) in a sample of Swedish workers. To further establish the validity of the Swedish NSFS, the present study also investigated the nomological network and measurement invariance of the NSFS across gender and time.

Basic psychological needs

A key idea of basic psychological needs theory is that three basic psychological needs are critical to individuals' psychological growth, integrity, and well-being; these are the needs for autonomy, competence, and relatedness (Ryan & Deci, 2017). The theory emphasizes the critical role of each basic need and their un-interchangeability. The need for autonomy implies that people want to have agency and experience volition (De Charms, 1968; Ryan & Deci, 2000). Satisfaction of the need for autonomy occurs when the individual experiences a sense of volition, psychological freedom, and willingness when engaging in an activity, accompanied by an internal locus of control and perceived choice when taking action (e.g., when performing a specific work task). The need for competence concerns people's inherent desire to interact effectively with the environment and experience a sense of adequate ability (White, 1959). In addition, the theory posits that

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Supplemental data for this article is available online at https://doi.org/10.1080/00223891.2023.2258960
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competence leads people to seek to engage in sufficiently challenging activities that provide growth opportunities (e.g., volunteering for a new work task). The need for relatedness reflects the universal propensity to feel connected to significant others, to be cared for, and to care for others (Ryan & Deci, 2000). This need is satisfied when people see themselves as members of a group, experience a sense of communion, and develop close relations with others (e.g., co-workers).

Need satisfaction, need frustration, and need fulfillment

Initially, basic psychological needs research focused on the concept of need satisfaction and its role in predicting positive and negative outcomes, including in the work domain (Van Den Broeck et al., 2016). High need satisfaction was assumed to predict adaptive outcomes (e.g., well-being, intrinsic motivation), and low need satisfaction was assumed to predict maladaptive outcomes (e.g., ill-being, amotivation). However, some empirical studies failed to show that low need satisfaction predicted maladaptive outcomes, which spurred research into the existence of negative experiences not fully captured by the concept of low need satisfaction (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011; Bartholomew, Ntoumanis, Ryan, et al., 2011; Costa et al., 2015; Sheldon & Gunz, 2009).

In the last decade, the theoretical and empirical distinction between satisfaction and frustration of the basic psychological needs has received increasing support (Longo et al., 2016, 2018; Tóth-Király et al., 2019; Vansteenkiste & Ryan, 2013). Need frustration can be conceptualized as the deprivation of a basic need and is posited to reflect the experiences that occur when one's basic psychological needs are thwarted within one's current situation or context (Ryan & Deci, 2017). Need frustration experiences go beyond the mere absence of need satisfaction and can better explain adverse outcomes, such as emotional exhaustion, negative affect, and depression (Bartholomew, Ntoumanis, Ryan, et al., 2011; Tindall & Curtis, 2019; Vansteenkiste & Ryan, 2013). The workplace is an arena where employee needs can both be supported and thwarted, and where need satisfaction promotes psychological functioning and health. In contrast, thwarted and frustrated needs can induce ill-being (Deci et al., 2017).

A recent addition to basic needs research is the concept of need fulfillment, proposed as an overarching global continuum that encompasses both need satisfaction and need frustration across all three basic psychological needs (Gillet et al., 2020; Sánchez-Oliva et al., 2017; Tóth-Király et al., 2018). Tóth-Király et al. (2018) used bifactor modeling to show that basic psychological needs seem to be best described as consisting of both specific factors (need satisfaction and frustration) and a global factor (need fulfillment). However, in-depth theoretical descriptions of global need fulfillment are scarce.

Measuring need satisfaction and need frustration at work

Several measures have been developed to operationalize basic psychological needs satisfaction at work. A widely used measure, the Basic Psychological Need Satisfaction at Work Scale, consists of 21 items reflecting the satisfaction of the needs for autonomy, competence, and relatedness (Deci et al., 2001). However, due to reported problems with reliability, strong intercorrelations between sub-scales, and the incorporation of antecedents and consequences of needs satisfaction within items, the validity of the scale has been questioned. Several new scales have been developed to remedy these shortcomings (e.g., Tafvelin & Stenling, 2018; Van Den Broeck et al., 2010). However, need satisfaction represents only one facet of basic psychological needs, and substantial evidence shows that need frustration is important to capture and account for adverse work-related outcomes (Deci et al., 2017).

The dual-process model in which need satisfaction and need frustration are recognized as distinct constructs led to the development of new scales to operationalize the two dimensions, such as the Balanced Measure of Psychological Needs (Sheldon & Hilpert, 2012), and the Basic Psychological Needs Satisfaction and Frustration Scale (BPNSFS; Chen et al., 2015). Both scales assess general need satisfaction and frustration in life, although the BPNSFS has been adapted to the work domain in Norway (Olafsen et al., 2021) and Poland (Szulawski et al., 2021). Recently, Longo et al. (2016) developed the 18-item Need Satisfaction & Frustration Scale (NSNF) in response to a lack of measures of need satisfaction and frustration suitable for work and educational contexts. A six-factor structure of the NSFS, with three satisfaction and three frustration dimensions, was supported in a sample of British university students and American workers (Longo et al., 2016). Subsequently, these results were replicated in a sample of Spanish university students (Longo et al., 2018). Aurell and Wilsson (2015) validated a Swedish version of the NSFS in the general Swedish population. Their findings supported a three-factor structure of autonomy, competence, and relatedness.

Modeling basic psychological needs

A concern in dimensionality analyses of basic psychological needs instruments is the strict assumptions of confirmatory factor analyses (CFA). Specifically, in CFA, items are only allowed to load on their appointed factor, and all cross-loadings are constrained to zero. However, research suggests that empirical data rarely follow these strict assumptions and that even small, unaccounted-for cross-loadings can negatively impact model fit and tend to inflate factor correlations (Marsh et al., 2020). The exploratory structural equation modeling (ESEM) framework (Asparouhov & Muthén, 2009) is proposed as an alternative modeling method with similar strengths as CFA that accounts for some of its weaknesses. Specifically, ESEM allows for cross-loadings and restrains these cross-loadings from exactly zero to close to zero. In terms of the basic psychological needs, this approach suggests that, for example, an item tapping into autonomy satisfaction can simultaneously be expected to tap into autonomy frustration (or any other underlying basic needs dimension). Studies applying both

CFA and ESEM to basic psychological needs instruments have tended to favor ESEM representations (Sánchez-Oliva et al., 2017; Tóth-Király et al., 2018, 2019). Another concern when analyzing the dimensionality of basic psychological needs scales is the potential reversed item method effects (Costa et al., 2015; Maul, 2013). Method effects are important as model misspecifications may yield inaccurate assessment of construct properties and, in turn, erroneous evaluation and development of basic psychological needs theory.

A critical aspect of basic psychological needs instruments is whether they can adequately compare groups of individuals with different background characteristics (Marsh et al., 2009). Because research regularly has taken an interest in gendered need experiences at work, and meta-analytic results have shown that need satisfaction might differ between men and women (Van Den Broeck et al., 2016), it is vital to establish gender invariance of the NSFS. Furthermore, there is a growing number of publications addressing the effects of need supportive interventions, including in the work domain (Ntoumanis et al., 2021; Slemp et al., 2021), that require longitudinal comparisons of ratings. Unless measurement invariance of the NSFS is established, observed group differences are indistinguishable from differences in measurement. To our knowledge, there are, to this date, no studies addressing the measurement invariance of the NSFS.

The present study

Recently, research grounded in the bi-factor and ESEM frameworks has suggested that a global dimension of need fulfillment exists alongside specific dimensions of satisfaction and frustration of the three basic psychological needs for autonomy, competence, and relatedness (Tóth-Király et al., 2018). Few studies have investigated the structure underlying the basic needs instruments using the bi-factor ESEM framework, and there are, to our knowledge, no such studies in Swedish-speaking populations. Whether these previous results replicate across additional cultures, languages, and basic needs instruments is unclear. In addition, the theoretical description of a global need fulfillment dimension remains underdeveloped. Additional empirical investigations would add to the ongoing development of the basic psychological needs theory. The purpose of the present study was to evaluate the factorial structure of the Need Satisfaction and Frustration Scale (NSFS) in a sample of Swedish workers by applying CFA, ESEM, and bi-factor modeling. These dimensionality analyses of the NSFS may contribute to the theoretical understanding of the basic psychological needs. Given the severe implication of measurement non-invariance and the lack of studies addressing these aspects of the NSFS, the present study also aimed to investigate measurement invariance of the NSFS across gender and time. The invariance testing contributes to the validation of the NSFS as it assesses the suitability of comparing NSFS scores across gender and time. Finally, the nomological network of the basic psychological needs was examined through their relations with life satisfaction and cognitive weariness. These two outcome variables allowed us to test the hypothesis that needs satisfaction is a better predictor of positive outcomes (life satisfaction) and need frustration is a better predictor of adverse outcomes (cognitive weariness). According to basic psychological needs theory, need satisfaction was expected to be positively related to life satisfaction, while need frustration was expected to be positively related to cognitive weariness.

Methods

Participants and procedure

The research was conducted following the ethical guidelines of the Swedish Research Council and the Declaration of Helsinki. All participants were given information about the study and participation before giving their written informed consent. They were informed about the data management plan, that participation was voluntary and could be withdraw at any time. The Regional ethics committee approved the research protocol, Umeå, ID 2017/153-31. The study sample consisted of recent graduates from two university programs in Sweden (the Degree of Bachelor of Science in Social Work, or the Degree of Master of Science in Psychology). The study population was limited to the seven Swedish universities that, at the two time points, had alumni that had graduated from either of the two relevant educational programs between three months and three years prior. In a longitudinal design, data were collected in two waves, T1 consisted of individuals who graduated within 3 years from the spring of 2017, and at T2 within three years from the spring of 2018. A postal survey containing background questions and various scales assessing work-related contextual and individual factors and measures of well-being and health was administered by Statistics Sweden.

For the present investigation, inclusion criteria were reporting working currently with a job that aligns with their training/education as a social worker or psychologist. An overview of the study participants is given in Table 1. Individuals who met the inclusion criteria but had missing data on all NSFS items were excluded ($n = 46$ at T1, $n = 8$ at T2). The final study sample consisted of participants at T1 ($n = 2{,}123$) and T2 ($n = 1{,}506$), some of whom participated on both occasions ($n = 571$). Combining participants with baseline at T1 ($n = 2{,}123$) and participants with baseline at T2 ($n = 824$) yielded 2,947 individuals. Of those offered study participation at both waves, 1,261 respondents met the inclusion criteria at T1, and 1,002 met the inclusion criteria at T2.

Statistical analyses

SPSS (version 27) was used for descriptive analyses (IBM Corp, 2020). Mplus version 8.5 (Muthén & Muthén, 1998-2017) was used to analyze factor structure, measurement invariance, and the nomological network. The maximum likelihood estimator with robust standard errors (MLR) was used for the factor analysis to account for

potential non-normality. Full information maximum likelihood (FIML) was used to handle missing data. First, the dimensionality of NSFS ratings was extensively evaluated at T1 by specifying different CFA, ESEM, bi-factor-CFA, and bi-factor ESEM models, including models with correlated uniqueness (CU) and latent methods factors (LMF) to account for potential wording effects. In the ESEM the cross-loadings are constrained to be approximately zero, but not exactly zero. The dimensionality analyses aimed to disentangle construct-relevant and construct-irrelevant multidimensionality of the NSFS. In short, ESEM considers small construct-relevant associations between items and non-target basic needs factors. Bi-factor models consider global dimensions, testing a global factor of need fulfillment or two separate global factors of satisfaction and frustration. Three-factor models (autonomy, competence, and relatedness) and six-factor models (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) were evaluated to address each need as a unidimensional or a two-dimensional construct. Negatively worded items were recoded to represent need satisfaction for the three-factor model analysis. A description of all models evaluated in the present study are presented in Table 2. The retained model was cross-validated in the T2 sample.

Table 1. Overview of the study sample.

	n	Gender	Age
T1			
Offered study participation	5,213	19.6% men 80.4% women	61.7% 20–29 years 31.3% 30–39 years 6.0% 40–69 years
Responded	2,580 (rr = 48.2%)	15.8% men 84.2% women	61.7% 20–29 years 31.3% 30–39 years 6.0% 40–69 years
Included in the present study	2,123	16.4% men 82.9% women 0.5% other/dnwr 0.1% missing	Mean age (*SD*) = 29.77(5.74) years Range 22–60
T2			
Offered study participation	4,876	19.0% men 81.0% women	61.7% 20–29 years 30.6% 30–39 years 7.7% 40–69 years
Responded	1,819 (rr = 37.1%)	15.5% men 84.5% women	62.1% 20–29 years 31.0% 30–39 years 6.0% 40–59 years
Included in the present study	1,506	15.5% men 83.5% women 0.8% other/dnwr 0.1% missing	Mean age (*SD*) = 29.72 (5.74) years Range 21–56
Combined sample of participants with baseline at T1 and T2 used for gender invariance analyses			
Included in the present study	2,947	16.1% men 83.1% women 0.8% other/ dnwr/missing	Mean age (*SD*) = 29.68 (5.63) Range 22–60 years

Note. dnwr: do not wish to respond; rr: response rate; *SD*: standard deviation.

Measurement invariance

A conventional approach to invariance analyses seeks support for configural, weak, strong, and strict invariance (Meredith, 1993). *Configural invariance* configural invariance indicates whether the same pattern of fixed and free factor loadings is specified across groups and/or time points. *Weak invariance* tests the invariance of factor loadings across groups and indicates if it is adequate to compare relations to external variables across groups and time. *Strong invariance* assumes the invariance of item intercepts and indicates if latent scores can be compared across groups and time. Finally, *strict invariance* tests the invariance of measurement errors across groups and indicates if it is adequate to compare manifest scores across groups and time. Invariance analyses can be extended to detail the invariance of factor analysis parameters. In the present study, the taxonomy of invariance testing by Marsh et al. (2009) was used to assess 13 different models for gender and longitudinal invariance.

Table 2. Models evaluated in the present study.

Model	Description
1	Three-factor CFA (autonomy, competence, and relatedness)
2	Three-factor ESEM model (autonomy, competence, and relatedness)
3a–3i	Three-factor CFA (autonomy, competence, and relatedness) with methods corrections for potential reversed item bias.
4a–4i	Three-factor ESEM (autonomy, competence, and relatedness) with methods corrections for potential reversed item bias.
5	Six-factor CFA (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration)
6	Six-factor ESEM (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration)
7	Bi-factor CFA with three specific factors (autonomy, relatedness, competence) and one global factor (global need fulfillment)
8	Bi-factor ESEM with three specific factors (autonomy, relatedness, competence) and one global factor (global need fulfillment)
9	Bi-factor CFA with three specific factors (autonomy, relatedness, competence) and two global factors (global need satisfaction and global need frustration)
10	Bi-factor ESEM with three specific factors (autonomy, relatedness, competence) and two global factors (global need satisfaction and global need frustration)
11	Bi-factor CFA with six specific factors (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) and one global factor (global need fulfillment)
12	Bi-factor ESEM with six specific factors (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) and one global factor (global need fulfillment)
13	Bi-factor CFA with six specific factors (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) and two global factors (global need satisfaction and global need frustration).
14	Bi-factor ESEM with six specific factors (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) and two global factors (global need satisfaction and global need frustration).

Note. Corrections for potential reversed item bias: (a) Correlated uniqueness between negatively worded items within each need; (b) Correlated uniqueness between negatively worded items across all needs; (c) Correlated uniqueness between positively worded items within each need; (d) Correlated uniqueness between positively worded items across all needs; (e) Correlated uniqueness between positively and negatively worded items, respectively, within each need; (f) Correlated uniqueness between positively and negatively worded items, respectively, across all needs; (g) One latent method factor for all negatively worded items; (h) One latent method factor for all positively worded items; (i) Two latent method factors, one for all negatively worded items and one for all positively worded items.

For the longitudinal invariance analyses, all participants that were invited at both T1 and T2 were included (n T1 = 1,261, n T2 = 1,002 T2, n total = 2,263). Per recommendations, within-item correlated uniqueness over time was specified in the longitudinal invariance models (Marsh et al., 2009). Gender invariance between men and women was assessed using the combined baseline sample (n = 2,947) from T1 and T2. Before combining the T1 and T2 samples, measurement invariance between these samples was assessed.

Model evaluation

In model fit evaluation, the chi-square statistic was expected to reject the models based on the large sample size (Hooper et al., 2008). Thus, the fit of the CFA was investigated using conventional fit indices (Goodboy & Kline, 2017; Kline, 2016); the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and the Standardized Root Mean Square Residual (SRMR). Guidelines by Hu and Bentler (1999) suggest that RMSEA values below 0.06 are adequate, whereas values below 0.05 indicate "close fit." Further, CFI and TLI above 0.95 and SRMR values below 0.08 indicate a good fit. RMSEA values with a 90% CI upper limit of 0.08 (Maccallum et al., 1996) and CFI < 0.90 (Brown, 2015) served as indicators of unsatisfactory fit. The Bayesian Information Criterion (BIC), the Akaike information criteria (AIC), and the sample-size adjusted Bayesian information criteria (aBIC), which allows for comparisons between models (e.g., Brown, 2015; Kline, 2016), were also considered. Lower BIC values indicate a better fit.

For comparisons between CFA and ESEM models, the RMSEA and the TLI were prioritized based on their parsimony control. As CFA tends to overestimate factor correlations, guidelines suggest that ESEM representations should be preferred if they display lower factor correlations than the corresponding CFA model (Morin et al., 2016). Further, bi-factor models are preferred in the case of well-defined general factors(s) and relatively well-defined specific factors (Morin et al., 2016). For the measurement invariance analyses, reduced model fit when constraints are added to the model indicates a lack of measurement invariance. According to guidelines, an observed decrease of at least 0.010 in CFI or an increase of at least 0.015 in RMSEA indicates a lack of invariance (Chen, 2007).

Nomological networks

Structural equation modeling was used to investigate the nomological network of the retained model with measures of life satisfaction and cognitive weariness. In the structural equation model, the basic needs factors were predictors of the outcome variables (life satisfaction and cognitive weariness) and estimated with MLR.

Measures

Basic psychological need satisfaction and frustration

Need satisfaction and frustration at work were assessed with the Swedish version (Aurell & Wilsson, 2015) of the NSFS (Longo et al., 2016). The NSFS measures six dimensions; autonomy satisfaction (I feel completely free to make my own decisions), autonomy frustration (I feel forced to follow directions regarding what to do), competence satisfaction (I feel highly effective at what I do), competence frustration (I doubt whether I am able to carry out my tasks properly), relatedness satisfaction (I feel the people I interact with really care about me), relatedness frustration (Sometimes, I feel a bit rejected by others), rated on a 7-point Likert Scale. The stem for each item began with "In my job…."

Life satisfaction

Life satisfaction was measured with the Swedish version (Hultell & Gustavsson, 2008) of the Satisfaction with Life Scale (SWLS; Diener et al., 1985). The SWLS contains five items rated on a 7-point Likert scale (1, strongly disagree; 7, strongly agree) and includes items, such as "In most ways, my life is close to my ideal." CFA has confirmed a unidimensional structure of the SWLS (Hultell & Gustavsson, 2008).

Cognitive weariness

Cognitive weariness symptoms were measured with the cognitive weariness subscale in the Swedish version (Lundgren-Nilsson et al., 2012) of the 14-item Shirom-Melamed Burnout Questionnaire (SMBQ; Shirom & Melamed, 2006). The respondents are asked to rate to what extent they have the experiences described by the items throughout most of their day. The cognitive weariness scale consists of five items, e.g., "I feel I am not thinking clearly" rated on a 7-point Likert scale (1, almost never; 7, Almost always).

Results

Descriptive statistics

Means, standard deviations, range, skewness, and kurtosis of the NSFS items are presented in Table S3. Inspection of the item descriptives shows that all response alternatives (1–7) were used for all items and that the means were generally on the higher end of the response scale for the need satisfaction items and the lower end for the need frustration items.

Measurement structure

The goodness-of-fit indices associated with each of the alternative measurement models estimated in the T1 sample (n = 2,123) are presented in Table 3. Six models did not converge; the CFA and ESEM models with correlated uniqueness both within positively worded items and negatively worded items (Models 3e, 3f, 4e, and 4f), and the CFA and ESEM bi-factor models with six specific factors and two general factors (Models 13 and 14).

First, we investigated the three-factor CFA and ESEM models to understand how these models fit the data without method correction for potential reversed item bias and the impact of different types of methods correction (LMFs and CUs). The inspection of goodness-of-fit indices without methods correction showed that the CFA and ESEM

Table 3. Goodness-of-fit statistics for the estimated models on the need satisfaction and frustration scale in T1 ($n = 2{,}123$).

Model nr	Description	χ^2	*df*	CFI	TLI	RMSEA	RMSEA 90% CI	SRMR	AIC	BIC	aBIC
1	CFA 3F	2473.593***	132	0.840	0.814	0.091	[0.088–0.095]	0.058	122,960.8	123,283.4	123,102.3
2	ESEM 3F	2357.699***	102	0.846	0.768	0.102	[0.099–0.106]	0.051	122,809.7	123,302.2	123,025.8
3a	CFA 3F CU neg within same need	834.314***	123	0.951	0.939	0.052	[0.049–0.056]	0.053	121,066.9	121,440.5	121,230.8
3b	CFA 3F CU neg all	462.761***	96	0.975	0.960	0.042	[0.039–0.046]	0.029	120,689.3	121,215.8	120,920.3
3c	CFA 3F CU pos within same need	977.362***	123	0.942	0.927	0.057	[0.054–0.061]	0.043	121,227.5	121,601.1	121,391.4
3d	CFA 3F CU pos all	658.513***	96	0.961	0.939	0.053	[0.049–0.056]	0.033	120,921.4	121,447.8	121,152.3
3e	CFA 3F CU pos neg within same need	Unidentified									
3f	CFA 3F CU pos neg all	Unidentified									
3g	CFA 3F LMF neg	1160.637***	123	0.929	0.912	0.063	[0.060–0.066]	0.040	121,422.6	121,796.2	121,586.5
3h	CFA 3F LMF pos	1397.19***	123	0.913	0.892	0.070	[0.067–0.073]	0.056	121,689.7	122,063.3	121,853.7
3i	CFA 3F 2-LMF pos neg	788.205***	114	0.954	0.938	0.053	[0.049–0.056]	0.040	121,017.2	121,441.7	121,203.4
4a	ESEM 3F CU neg within same need	704.247***	93	0.958	0.931	0.056	[0.052–0.060]	0.037	120,976.7	121,520.1	121,215.1
4b	ESEM 3F CU neg all	351.654***	66	0.980	0.955	0.045	[0.041–0.050]	0.016	120,623.3	121,319.6	120,928.8
4c	ESEM 3F CU pos within same need	886.662***	93	0.946	0.911	0.063	[0.060–0.067]	0.038	121,167.6	121,711.0	121,406.0
4d	ESEM 3F CU pos all	557.852***	66	0.966	0.922	0.059	[0.055–0.064]	0.023	120,861.8	121,558.0	121,167.3
4e	ESEM 3F CU pos neg within same need	Unidentified									
4f	ESEM 3F CU pos neg all	Unidentified									
4g	ESEM 3F LMF neg	1021.427***	93	0.936	0.895	0.069	[0.065–0.072]	0.026	121,320.1	121,863.5	121,558.5
4h	ESEM 3F LMF pos	1129.366***	93	0.929	0.883	0.072	[0.069–0.076]	0.030	121,438.6	121,982.0	121,677.0
4i	ESEM 3F 2-LMF pos neg	642.249***	84	0.962	0.930	0.056	[0.052–0.060]	0.021	120,894.0	121,488.4	121,154.8
5	CFA 6F	785.168***	120	0.954	0.942	0.051	[0.048–0.055]	0.031	121,016.4	121,407.0	121,187.8
6	ESEM 6F	326.443***	60	0.982	0.953	0.046	[0.041–0.051]	0.012	120,545.7	121,275.9	120,866.0
7	B CFA 3SF 1GF	1504.976***	117	0.905	0.876	0.075	[0.071–0.078]	0.103	121,771.6	122,179.1	121,950.4
8	B ESEM 3SF 1GF	998.819***	87	0.938	0.890	0.070	[0.066–0.074]	0.026	121,306.1	121,883.5	121,559.4
9	B CFA 3SF 2GF	992.115***	116	0.940	0.921	0.060	[0.056–0.063]	0.071	121,238.3	121,651.5	121,419.6
10	B ESEM 3SF 2 GF	625.619***	83	0.963	0.932	0.055	[0.051–0.060]	0.020	120,869.7	121,469.7	121,133.0
11	B CFA 6SF 1GF	2243.816***	117	0.854	0.810	0.093	[0.089–0.096]	0.111	122,619.8	123,027.4	122,798.7
12	B ESEM 6SF 1 GF	122.572***	48	0.995	0.984	0.027	[0.021–0.033]	0.007	120,378.7	121,176.8	120,728.9
13	B CFA 6SF 2GF	Unidentified									
14	B ESEM 6SF 2 GF	Unidentified									

Note. CFA: confirmatory factor analysis; ESEM: exploratory structural equation modeling; LMF: latent method factor; pos: positively worded items; neg: negatively worded items; CU: correlated uniqueness; B: bifactor model; F: factor; GF: global factor estimated as part of a bifactor model; SF: specific factor estimated as part of a bifactor model; 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; SRMR: standardized root mean square residual; AIC: Akaike information criteria; BIC: Bayesian information criteria; aBIC: sample-size adjusted Bayesian information criteria.
***$p < 0.001$.

three-factor models had an unsatisfactory fit (e.g., RMSEA > 0.080, CFI and TLI < 0.90). Further, none of the three-factor bi-factor models that incorporated global factors (one global need fulfillment factor or two global factors of satisfaction *vs.* frustration) fit the data adequately. Although most of the first-order three-factor models that included methods correction showed adequate fit, only the three-factor CFA and ESEM models with CUs between all negatively worded items showed excellent fit. These two models almost fit the data equally well, although a slight advantage for the CFA model was observed (e.g., RMSEA 0.042 for the CFA *vs.* 0.045 for the ESEM; TLI 0.960 for the CFA model *vs.* 0.912 for the ESEM model). Neither the CFA nor ESEM model with three specific factors and a latent method factor for negatively worded items fitted the data adequately (e.g., RMSEA 0.063 and 0.069, TLI 0.912 and 0.895).

Next, we turned to the alternative first-order six-factor models. It is apparent that both the six-factor CFA and the six-factor ESEM described the data well, although the ESEM model showed superior fit (e.g., RMSEA 0.051 for the CFA *vs.* 0.046 for the ESEM; TLI 0.942 for the CFA model *vs.* 0.953 for the ESEM model). Further inspection of the parameter estimates also supported the superiority of the ESEM model. Specifically, both the CFA and ESEM representation had well-defined factors (CFA: $\lambda = 0.620$–0.861, $M = 0.771$; ESEM: $\lambda = 0.344$–1.007, $M = .712$). The cross-loadings in the ESEM solution, although some of them were statistically significant, were not large enough to pose a problem to the factor structure. More precisely, all items showed stronger loadings on their target factor and cross-loadings were generally weak ($|\lambda| = .001$–$.382$, $M = .055$, all but two cross-loading were <0.200) Specifically, the relatedness frustration item R4 had a cross-loading on relatedness satisfaction ($\lambda = -0.338$), and the competence satisfaction item C2 had a cross-loading on competence frustration ($\lambda = -0.382$). In addition, key parameters when comparing CFA and ESEM models are the factors correlations because some are inflated in the CFA models. The strongest factor correlations are between the satisfaction and frustration components within each need and they are lower in the ESEM representation than in the CFA representation. In detail, the factor correlations were weak ($|r| < 0.500$) for all but the satisfaction and frustration components of the same need, which were reduced in the ESEM model compared to those of the CFA model ($|r| = 0.731$ ESEM *vs.* 0.772 CFA for autonomy satisfaction and frustration; $|r| = 0.634$ ESEM *vs.*

0.778 CFA for competence satisfaction and frustration; $|r| = 0.546$ ESEM *vs.* 0.682 CFA for relatedness satisfaction and frustration).

Thus far, our analyses indicated the six-factor ESEM model and the three-factor CFA model with CUs among all negatively worded items as adequate models to retain. Both models are supported by basic psychological needs theory when incorporating theoretical considerations (Vansteenkiste et al., 2020). The question is whether the NSFS manages to distinguish between each need's satisfaction and frustration components or whether the NSFS is better viewed as a three-dimensional measure of need satisfaction of autonomy, competence, and relatedness. The NSFS was constructed to distinguish between the satisfaction and frustration components, and closer inspection of the items aligns theoretically with the six-factor model.[1] Thus, we decided to move forward with the six-factor ESEM model. The main reason to retain the six-factor ESEM model was that further inspecting this model might provide a more detailed view of the strengths and weaknesses of the NSFS as a measure of workers' need satisfaction and frustration.

In the next step, the six-factor ESEM model was compared to the bi-factor models with six specific factors and one global need fulfillment factor, which also displayed an excellent fit to the data (e.g., RMSEA 0.027; TLI 0.984). However, although the general need fulfillment factor was well-defined ($|\lambda| = .333–.748$, $M = 0.471$), the specific competence frustration factor was not. Specifically, none of the target loadings were significant. To allow for a detailed inspection, the full factor solutions of the six-factor first-order ESEM model and the bi-factor models with six specific factors and one global need fulfillment factor are available in the Supplementary Material (Tables S1 and S2). However, in light of the basic psychological needs theory's emphasis on the un-interchangeability of basic needs (Ryan & Deci, 2017), it becomes hard to describe and define a general need fulfillment factor theoretically. Thus, the first-order six-factor ESEM representation was retained.

To ensure that the suitability of retaining the first-order six-factor ESEM model was replicated in another sample, this model, together with the two most competitive models—the first-order six-factor CFA model and the bi-factor models with six specific factors and one global need fulfillment factor—were estimated using the T2 sample ($n = 1{,}506$). The goodness-of-fit indices associated with each of these three alternative measurement models estimated in the T2 sample are presented in Table S4. The goodness-of-fit parameters showed a similar pattern as the corresponding results from the T1 sample, as all three models fit the data well. Further inspection of additional parameter estimates (factor loadings, cross-loadings, and factor correlations) supported the conclusion of retaining the first-order six-factor ESEM model. In detail, the factor correlations were reduced in the first-order six-factor ESEM model compared to the equivalent CFA model, and the cross-loadings in the ESEM model were small. In contrast, the factors were well-defined by their target loadings. Although all the target loadings of the bi-factor models with six specific factors and one global need fulfillment factor were statistically significant, some remained weak ($\lambda = 0.273$, Item c1; $\lambda = 0.306$ Item c2).

Measurement invariance

Gender invariance

To maximize the sample size and statistical power for analyses of gender invariance, we combined the T1 sample with a subsample of T2 (consisting of individuals only responding at T2) and tested measurement invariance across these two groups, hereby referred to as the baseline sample. The goodness-of-fit statistics of the invariance analyses between these two samples are reported in Table S5. Because full factorial invariance was supported (ΔCFI $\leq$ .010, ΔRMSEA $\leq$ .015), the samples were merged and used in the analyses of gender invariance. The baseline sample consisted of 2,923 individuals ($n = 473$ men and $n = 2{,}450$ women). The sequences of the different invariance models are presented in Table S5, and support for full factorial gender invariance is shown (ΔCFI $\leq$ .010, ΔRMSEA $\leq$ .015). These results confirm the equivalence of levels of the six basic needs constructs and the adequacy of comparing groups of men and women on their latent and manifest scores of the NSFS.

Longitudinal invariance

Longitudinal invariance was analyzed in a subsample of the study sample, consisting of those offered study participation at both waves ($n = 1{,}261$ T1; $n = 1{,}002$ T2). Longitudinal data were obtained for 571 of these individuals. Internal missing data were handled with full information maximum likelihood rather than compromising statistical power by excluding participants with only one measurement point. The sequence of the different longitudinal invariance models and their results are presented in Table S6 and supported full factorial longitudinal invariance (ΔCFI $\leq$ .010, ΔRMSEA $\leq$ .015). These results confirm the adequacy of comparisons over time on the participants' latent and manifest scores of the NSFS.

Nomological network

The structural equation model in which the latent factors of the retained first-order six-factor ESEM model were modeled to predict outcome variables of life satisfaction (SWLS) and cognitive weariness (subscale of the SMBQ) showed good fit to the data (Chi-square = 39340.933, $p < 0.001$, $df = 406$; RMSEA = 0.030; RMSEA 90%CI = 0.028–0.032; CFI = 0.980; TLI = 0.972). All latent variables were well-defined by their respective items. The regression coefficients of the structural

[1]Specifically, the frustration items are worded so that they do not merely represent the opposite of need satisfaction. That is, they describe frustration experiences with terminology such as feeling "incapable," "rejected by others," and "forced to follow directions," which is theorized to represent a different experience than experiencing low levels of need satisfaction (Ryan & Deci, 2017). Low need satisfaction is expressed as disagreeing with statements using terminology such as feeling "highly capable," "perfectly integrated into a group," and "free to decide." In basic psychological needs theory, these different experiences, that is, needs satisfaction and needs frustration, are postulated to be distinct experiences that affect different outcomes.

Table 4. Need satisfaction and frustration scale (NSFS) subscales predicting outcomes of life satisfaction and cognitive weariness ($n = 2,947$).

	Life satisfaction			Cognitive weariness		
Basic need factor	Standardized path coefficient	*SE*	*p*-value (two-tailed)	Standardized path coefficient	*SE*	*p*-value (two-tailed)
Autonomy satisfaction	0.169***	0.040	<0.001	−0.041	0.039	0.287
Autonomy frustration	0.006	0.041	0.878	0.170***	0.042	<0.001
Relatedness satisfaction	0.171***	0.030	<0.001	−0.022	0.030	0.476
Relatedness frustration	−0.104***	0.032	0.001	0.120***	0.033	<0.001
Competence satisfaction	0.028	0.040	0.477	−0.004	0.043	0.932
Competence frustration	−0.195***	0.039	<0.001	0.409***	0.042	<0.001

Note. SE: standard error.
***$p < 0.001$.

equation model are displayed in Table 4. In an initially fitted structural equation model, problems occurred with an improper solution due to a negative uniqueness of one of the items. Thus, we constrained the uniqueness of item c5 to the same value of uniqueness (0.564) that this item displayed in the original ESEM model. With this constraint, the model converged to a proper solution.

The results showed that the basic psychological needs satisfaction factors were the main predictors of life satisfaction. However, this pattern was not fully consistent as competence satisfaction did not significantly predict life satisfaction ($r = 0.028$, $p = 0.477$), whereas both relatedness frustration ($r = -0.104$, $p = 0.001$) and competence frustration ($r = -0.195$, $p < 0.001$) were statistically significant predictors. Further, the relations between the need frustration factors and cognitive weariness were as expected. All three need frustration factors were significant predictors of cognitive weariness, whereas none of the three satisfaction factors were significant predictors for this outcome variable. Competence frustration displayed the strongest relation with cognitive weariness ($r = 0.409$, $p < 0.001$). All other significant regression coefficients were small (<0.200).

Discussion

The present study examined the dimensionality, measurement invariance, and nomological validity of the Swedish version of the NSFS in a large sample of Swedish workers. The results supported a first-order six-factor ESEM representation of the NSFS, consisting of autonomy satisfaction, autonomy frustration, competence satisfaction, competence frustration, relatedness satisfaction, and relatedness frustration. The ESEM representation was superior to the corresponding CFA representation, mainly because it reduced factor correlations. Lower factor correlations in the ESEM model indicate that the factor correlations observed in the CFA potentially were inflated due to the strict assumption of the CFA of zero cross-loadings. On the other hand, competing measurement models were generally inferior in terms of goodness-of-fit, and three-factor models did not fit the data well without methods correction for potential reversed item bias.

Further, the present study established measurement invariance of the NSFS longitudinally and between women and men. With longitudinal measurement invariance, the NSFS can be used to compare ratings over time, for example, in intervention studies. Similarly, the present results support using the NSFS to compare basic needs ratings across gender.

A key finding of the present study was that the hypothesized pattern of satisfaction as a better predictor of adaptive outcomes, and frustration as a better predictor of maladaptive outcomes, was only partially supported. Specifically, the predictors of life satisfaction were autonomy satisfaction, relatedness satisfaction, relatedness frustration, and competence frustration. However, in line with the basic psychological needs theory, the present results supported that needs frustration predict cognitive weariness better than needs satisfaction. One issue with these relations is that the basic psychological needs were work-specific, whereas the outcomes are general. The combination of domain-specific needs and domain-general outcomes may have influenced the magnitude of the relations, given that they are on different levels.

Global need fulfillment and basic psychological needs theory

In contrast to previous studies (Gillet et al., 2020; Sánchez-Oliva et al., 2017; Tóth-Király et al., 2018, 2019), our findings did not support a global need fulfillment factor. Although a bi-factor model with six specific factors and one orthogonal global need fulfillment factor had an excellent fit to the data, the competence frustration factor was undefined by its target loadings as none of them were statistically significant. Furthermore, although the bifactor model with six specific factors and one global need fulfillment factor had better psychometric qualities, such as well-defined specific and global factors, when cross-validated in a second sample, it remains difficult to describe and label the latent factors of such a model from a theoretical perspective (Ryan & Deci, 2017; Van Den Broeck et al., 2016). Specifically, the global need fulfillment factor is orthogonal to the satisfaction and frustration components of the three basic needs (autonomy, competence, and relatedness). Thus, when theoretically defining the global need fulfillment factor, it must consist of "something" unrelated (or orthogonal) to the three previously defined basic psychological needs. It is hard to imagine what this might be because, in the literature, global need satisfaction is directly derived from each need satisfaction factor (Ryan & Deci, 2017). Also, psychological need satisfaction and frustration are viewed as distinct processes (Van Den Broeck et al., 2016).

In contrast, a continuum view (as reflected in one global factor) assumes that one's needs are either satisfied or frustrated. Within a particular moment in time, this view might be plausible. However, over days, weeks, or months (which is the time frame used in the vast majority of the literature),

individuals often experience both satisfaction and frustration with their needs, depending on the social contexts they find themselves in (Bartholomew, Ntoumanis, Ryan, et al., 2011; Vansteenkiste & Ryan, 2013). Conceptually, two global factors would be more appropriate to indicate the degree to which one's needs are satisfied and frustrated. Besides the issue of independence between satisfaction and frustration, the other concern is the issue of consistency across levels. With one global factor, there is a mismatch between how need satisfaction and frustration are conceptualized at the global level (varying along a continuum) and the specific level (separate dimensions). This inconsistency is not conceptually defensible. Another concern about the concept of global need fulfillment is that simulation studies have found that the bifactor model tends to show superior goodness of fit over other models (e.g., first-order models) even when the true population structure is not best described by a bifactor model (Greene et al., 2019; Murray & Johnson, 2013).

Different constructs or method effects?

The results from the present study and previous research (e.g., Van Den Broeck et al., 2016) highlight challenges with distinguishing between potential method effects and differences between the constructs measured, even though method effects in basic psychological needs instruments appear to be small (Costa et al., 2015). The advantages of including reversed items in the self-rating scale are well-established, for example, control of acquiescence, less risk of construct underrepresentation, and disruption of non-substantive responding (Podsakoff et al., 2003). However, reversed items also commonly lead to measurement problems, such as irregular or complex factor structures. Thus, a challenging task is to determine whether the instrument measures distinct constructs or if the observed psychometric multidimensionality at least partially stems from method effects. For example, in our study, both six-factor and three-factor representations with methods correction for reversed item bias fit the data well. Thus, theoretical considerations are crucial. When examining the linguistic properties of the items, it is notable that two of the competence frustration items in the Swedish NSFS are incompatible with the concept of need frustration. Specifically, these two items are better described as reversed need satisfaction items as they use negations, that is, "not" ("inte" in Swedish). However, it is important to note that the NSFS was not designed to disentangle the effect of reversed items *vs.* alternative frustration/satisfaction constructs. Such a measure could be developed and evaluated in future research.

Strengths and limitations

A significant contribution of the present study is evaluating the concepts of need satisfaction, need frustration, and global basic psychological need fulfillment in a new cultural context, namely the Swedish work context. Further, the present study adds to the current knowledge by establishing measurement invariance of the NSFS over gender and time, which has not previously been investigated. Some limitations should also be addressed. First, the present study relied on self-reported measures and examined the nomological network of the NSFS in a cross-sectional sample, and this approach precludes causal inferences. Further, the study sample was limited to individuals within three years of graduation from two Swedish university programs—the Degree of Bachelor of Science in Social Work, or the Degree of Master of Science in Psychology and did not reflect the Swedish working population's age, gender, or sectors.

Conclusions

The present study found support for a six-factor ESEM representation of basic psychological needs and added to the current literature by establishing measurement invariance of the Swedish NSFS across gender and time. Although a bifactor representation of basic psychological needs fits the data well, the present study did not support a global need fulfillment construct because of its inconsistency with basic psychological needs theory. Further, the findings indicate that the Swedish NSFS does not empirically fully distinguish between need satisfaction and need frustration. In terms of practical implications, our findings mainly support the use of six separate dimensions (rather than three dimensions) when assessing need satisfaction and frustration at work with the NSFS. Thus, for practitioners interested in assessing need satisfaction and frustration at work, the NSFS is an option for doing so. It is, however, important to note that this is the first large-scale evaluation of the Swedish version of the NSFS in work settings and more work is needed, for example regarding the NSFS sensitivity to capture change and its predictive validity (e.g., work performance, sickness absence).

Author note

A previous version of this manuscript has been published in print as part of the first author's Ph.D. dissertation entitled "*Analyzing Self-Report Instruments: Assessing basic psychological needs in education and at work*," ISBN 978-91-7855-891-9.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

Requests to access the datasets should be directed to ingrid.schele@umu.se.

Funding

This work was supported by a grant from AFA Insurance (Grant number 140271).

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