TPM®

ITEM RESPONSE THEORY ANALYSIS OF PSYCHOMETRIC PROPERTIES OF SUBJECTIVE VITALITY SCALE IN FRENCH UNIVERSITY STUDENTS

CYRILLE KOSSIGAN KOKOU-KPOLOU
UNIVERSITY OF PICARDY JULES VERNE

SUNYOUNG PARK
CALIFORNIA LUTHERAN UNIVERSITY

Previous validation studies using classical test theory (CTT) methods have proposed multiple versions of the Subjective Vitality Scale (SVS) due to some relatively inadequate items. To resolve the discrepancies between these versions, we used item response theory (IRT) modeling to examine the psychometric properties of the scale's items and the latent trait, in a large sample of French university students. Factor analysis showed that the original 7-item SVS fits the data well. However, IRT modeling revealed that Items 2, 3, and 5 performed poorly in discriminating the latent trait. As a consequence, Items 1, 4, 6, and 7 were the most discriminant items. The new version (4-item SVS) demonstrates an excellent model fit, and improves better than the 7-item version. The two versions correlated, in the expected direction, with measures of life satisfaction and depression, respectively, but the new version displayed significantly higher strength of correlation with depression measure than the 7-item version. This study confirmed the advantages of IRT methods over the CTT ones, and demonstrated that the 4-item SVS was a reliable and valid alternative version for accurately measuring subjective vitality.

Keywords: Subjective Vitality Scale; Item response theory; Generalized partial credit model; Factor structure; Construct validity.

Correspondence concerning this article should be addressed to Cyrille Kossigan Kokou-Kpolou, Department of Psychology, University of Picardy Jules Verne, Chemin du Thil, CS 52501, 80025 Amiens Cedex 1, France. Email: kkkcyrille@yahoo.fr

Being filled with vitality and energy is generally considered as a significant indicator of healthy functioning; conversely, the depletion of vitality and energy is perceived as an indicator of ill-being. Ryan and Frederick (1997) introduced the concept of *subjective vitality* and conceptualized it as one's conscious experience of possessing enthusiasm, aliveness, and energy that one can harness or regulate for purposive actions. Stated differently, vitality refers to energy available to and emanating from one's self for life pursuits (Ryan & Deci, 2008). Thus, it differs from any form of activation of emotions or affects such as anger, anxiety, agitation, or arousal that are related to negative affects and mood states (Ryan & Deci, 2008).

The concept of subjective vitality has increasingly gained more research interest, as it represents an important component of physical and psychological well-being. The Subjective Vitality Scale (SVS) is a self-report scale developed by Ryan and Frederick (1997) for assessing subjective vitality as positive feelings of energy and aliveness. The SVS includes both a trait-level and a state-level scale. However, only the trait-level scale is addressed in the present study. The items are rated as ordered categories on a 7-point Likert scale ranging from 1 (*not at all true*) to 7 (*very true*), and result in a single factor. In a series of studies, Ryan and Frederick (1997) found the scale to yield a satisfactory level of internal consistency (Cronbach's alpha coefficients, α = .84 to .86). With a few exceptions (Fayad & Kazarian, 2013; Salama-Younes, 2011), all

validation studies confirmed a good internal reliability of the 7-item SVS. The 8-week test–retest coefficient was .64 (Ryan & Frederick, 1997). More recently, Uysal et al. (2014) confirmed the test–retest reliability, which was found to be .79.

From a theoretical standpoint, Ryan and Frederick (1997; see also Martela et al., 2016) viewed subjective vitality as a reflection of both organismic and psychological wellness and expected it to be influenced by both psychological and environmental factors. As such, one should report subjective vitality to the degree which one is free of conflicts, unburdened by external controls, and feeling capable of effecting action. Greater subjective vitality should also accompany the experiences of autonomy and integration or self-actualization and other variables relating to the perception of oneself as a "fully functioning" person. By contrast, conflicts and demands upon the self that threaten self-regulation and actualization are expected to decrease vitality. Substantial cumulative evidence supports that subjective feeling of vitality seemingly covariates and is positively associated with self-actualization, capacity of self-control, satisfaction with life, subjective happiness, and quality of life. Experimental research has consistently shown that people who are high in vitality, are more resilient to physical and viral stressors and less vulnerable to illness (Cohen et al., 2006; Polk et al., 2005). Furthermore, subjective feeling of vitality was found to correlate negatively with feelings of fatigue and school burnout, with psychopathological attributes such as anxiety, and with depression (Goldbeck et al., 2019; Rouse et al., 2015; Ryan & Frederick, 1997).

The SVS has been validated in many Western and non-Western languages. Bostic et al. (2000) were the first to validate the SVS with a Midwest college population using the structural equation modeling techniques. To accurately improve the model fit indices, the authors removed Item 2 ("I don't feel very energetic"), which was the one negatively worded item, from the model. Accordingly, they suggested the use of a 6-item SVS model. Thereafter, some researchers continued to use the 7-item model. For example, the French version of 7-item SVS, which is still in use, has been validated by Salama-Younes et al. (2009). This model's results yielded worst fit statistics — e.g., root mean squared error of approximation (RMSEA = .20) — however the authors failed to provide clearer information about inadequate items. Furthermore, other authors used the new 6-item model of the SVS as a superior fitting model (e.g., Castillo et al., 2017; Couto et al., 2017). Besides, some researchers found that Item 5 ("I look forward to each new day") displayed a low loading coefficient and argued that this item may be a poor indicator of vitality (Kawabata et al., 2017). This led to two 6-item models of the SVS, one omitting Item 2, and the second model omitting Item 5. More recently, the reduced 5-item model has emerged from two studies conducted in Asian countries (Kawabata et al., 2017; Liu & Chung, 2019). The new German version also confirmed the 5-item model (Goldbeck et al., 2019). The discrepancies between these different SVS models, and the deletion of some items seem problematic as they raise psychometric issues about the extent to which the SVS items reflect and adequately link to the hypothesized latent trait: the subjective vitality.

Based on a large sample of French university students, the present study analyzed the appropriateness of those SVS items whose potential ambiguity led to different models being employed by researchers. In fact, the existing validity studies used the classical test theory (CTT; involving factor analytic methods) to probe item loadings and to confirm the factor structure of SVS. Relatively recent mathematical models, such as item response theory (IRT) models, offer alternative and complementary approaches to parsimoniously frame the latent trait of the measure used (Hambleton et al., 1991; Reise & Waller, 2009). IRT models have been developed to capture the interaction between an individual's response to an item and the underlying latent trait/construct being measured by the scale. As a result this enables the determination of the extent to which each item is accurately relates to the underlying construct. Thus, IRT models offer advantages over the CTT methods in evaluating the performance of items and sets of items and ensuring that the items provide

adequate precision (Edelen & Reeves, 2007). When responses to items are rated as ordered categories, the appropriate IRT methods are comprised of the rating scale model including graded response model (GRM; Samejima, 1969), partial credit model (PCM; Andersen, 1983; Masters, 1982), and generalized partial credit model (GPCM; Muraki, 1992).

Although both GRM and GPCM would be equally appropriate in most practical applications, Kang et al. (2009) outlined that the GRM uses a proportional odds model in which all response categories for an item are collapsed into two categories for estimating the boundary characteristic curves. In contrast under the GPCM, the focus is on the relative difficulty of each needed step in order to transition from one category to the next in an item. This is due to the fact that the GPCM uses an adjacent odds model. The GPCM assumption appropriately captures the transitions of SVS response categories, which will be further detailed below. Therefore, the present study aimed to use the GPCM-framework to examine the latent construct and psychometric item properties of the SVS. Furthermore, this model also assesses its construct (concurrent and divergent) validity among French university students. The construct validity has been measured by the Satisfaction with Life Scale (SWLS; Diener et al., 1985) and Beck Depression Inventory (BDI-II; Beck et al., 1996), respectively. Expanding on previous studies, we expected that the subjective vitality would be strongly and positively correlated with life satisfaction, and inversely with depressive symptoms.

Methods and Materials

Data Collection

This study used the data collected through web-based self-report questionnaires, distributed locally and nationally from January to February 2019. Participants were all students in Humanities and Social Sciences (psychology, sociology, physical activity and sports sciences, …). In compliance with the Declaration of Helsinki of 1975, as revised in 2008, all of the study's information was collected on the basis of signed informed consent. The sample included 1,435 participants. This sample size (> 500) fulfilled the requirements for accurate parameter estimates in IRT-based model analyses (Tsutakawa & Johnson, 1990). Age ranged from 16 to 43 years (M = 20.5; SD = 3.38; Mdn = 20). Female respondents represented 87.1% of the sample population. Undergraduates in years one to three made up 82.6% of participants and 17.4% were postgraduates. Nearly 97% were French citizens. For a more detailed descriptive information of the study sample, see Kokou-Kpolou et al. (2020).

Assessments

Participants were requested to complete the French trait-level version of the 7-item SVS (Salama-Younes et al., 2009), the Satisfaction with Life Scale (SWLS; Diener et al., 1985), and the Beck Depression Inventory (BDI-II; Beck et al., 1996). For the purpose of this article, approval to use the SVS was obtained from Professor Richard M. Ryan.

As broadly described in the introduction, the original SVS contains 7 items. We used the trait-level measure, in terms of how the items apply to the respondents "in general in their life." They were asked to indicate the degree to which the statement of each item was true for them on a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*).

SWLS is a 5-item scale developed to evaluate global cognitive judgments of one's life satisfaction. Participants indicate how much they agree or disagree with each statement, using a 7-point scale, from 7 (*strongly agree*) to 1 (*strongly disagree*).

BDI-II is a standard, self-administered depression screening instrument designed for use among individuals 13 years old and older. It contains 21 items rated on a 4-point Likert-type scale ranging from 0 to 3. Respondents are requested to endorse statements characterizing how they have been feeling throughout the past two weeks; the higher the summed score (range = 0-63), the higher the level of depression.

Statistical Procedures

The GPCM assumes the parametric unidimensionality of the scale items and local independence. As such, the dimensionality was tested through confirmatory factor analysis (CFA) using R Version 3.5.0 (R Core Team, 2017), the lavaan (Rosseel, 2012) and semTools (semTools contributors, 2018) packages were implemented. We used the maximum likelihood (ML) estimation, which provide accurate parameter estimates in the presence of missing data (Enders, 2010). The fit of the model was examined using absolute fit indices of root mean squared error of approximation (RMSEA), and incremental fit indices of comparative fit index (CFI), and Tucker-Lewis index (TLI). As guidelines, RMSEA $\leq .06$, both CFI and TLI $\geq .95$ were considered as good fit indices (Hu and Bentler, 1999).

Technically speaking, the GCPM is based on the values of three parameters corresponding to the respondent's trait level in the interaction with three item characteristics: the category, slope, and location parameters of the item. First, the category parameter represents the difficulty of the step when moving from one response option to another. For example, as SVS items are rated on 7 points, this corresponds to 6 steps (1 to 2, 2 to 3, …, and 6 to 7) reflecting the possibility of moving from one response option to another. Higher positive values indicate difficult steps, while low and negative values indicate easy steps. Secondly, the slope parameter indicates the extent to which the item is related to the underlying construct. A steeper slope indicates a closer relation to the construct and therefore a more discriminating item. Furthermore, the difficulty of an item is indicated by the location parameter. For this, a large positive value indicates a difficult item, or that few examinees respond in the high categories. A negative value indicates an easy item or that few examinees respond in the low categories. The location parameter functions to shift the category parameters up and down the latent trait scale. This being stated, we tested for the local independence of the items. This parameter can be ascertained by examining the residual correlations from the number of factors resulting in the CFA model. With CFA, the residuals of locally dependent items will have substantial correlations. As recommended by Reeves et al. (2007), we used correlations of more than .20 as indicative of the presence of local dependence in the items.

This study used the marginal maximum likelihood estimation procedure implemented in PARSCALE 4.1 (Muraki & Block, 2003) to conduct all the GPCM analyses. This allows for the direct testing of model data fit in relation to the GPCM. For each item, a likelihood-ratio Chi-square (χ^2) is computed, indicating the goodness of fit between the expected (based on the GPCM) and the observed response frequencies. Nonsignificant difference indicates a good fit. However, χ^2 differences are sensitive to the sample size. Thus, given that our study relied on quite a large sample (N = 1,435), χ^2 values for all items were significant.

To determine the internal consistency, we used Cronbach's alpha (α) plus alternative indices such as McDonald's omega (ω) and the greatest lower bound (GLB) which provide more accurate values of a

scale's reliability (McNeish, 2018; Revelle & Zinbarg, 2009; Sijtsma, 2009; Trizano-Hermosilla & Alvarado, 2016). Finally, we probed the construct (concurrent and divergent) validity of SVS score through a bivariate correlation with scores on SWLS and BDI-II.

RESULTS

IRT Analyses

Table 1 displays the descriptive characteristics of the SVS items. The mean score of the SVS was 24.39 (*SD* = 8.16, range: 7 to 47). The mean item scores ranged from 2.34 (Item 3) to 4.09 (Item 1).

TABLE 1
Descriptive statistics of item scores, inter-item and item-total correlations, and standardized estimate of factor loadings

Items	M (*SD*)	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Total score	Factor loadings[a]
Item 1	4.09 (1.49)	1.00							.70	.73
Item 2	3.78 (1.66)	.56	1.00						.60	.62
Item 3	2.34 (1.39)	.48	.39	1.00					.53	.56
Item 4	3.92 (1.53)	.61	.55	.46	1.00				.76	.84
Item 5	3.24 (1.61)	.54	.43	.41	.62	1.00			.69	.76
Item 6	3.50 (1.52)	.50	.46	.38	.62	.57	1.00		.69	.73
Item 7	3.51 (1.53)	.51	.39	.36	.57	.60	.62	1.00	.66	.70

Note. [a] Values are the standardized estimate of factor loadings. Please refer to the study by Salama-Younes et al. (2009) for detail on the French version of SVS items.

We conducted a series of CFAs, separately, corresponding to the different models of the SVS. As shown in Table 2, the 7-item SVS (Model 1) fits the data well. The absolute and incremental fit indices were as follows: χ^2 = 46.98, *df* = 10; CFI = .981; TLI = .967; RMSEA = .070. In comparison, Models 2, 3, and 4 demonstrated unacceptable fitting predictions to the data. The RMSEA values were very high, and the incremental fit indices (CFI and TLI)' values did not reach the cut-off of ≥ .95 for each model. The standardized estimate of factor loadings for all items were high, ranging from .56 (Item 3) to .84 (Item 4), indicating very good appropriateness of items. The composite SVS score demonstrated a very good internal consistency (α = .88; McDonald ω = .88; GLB = .89). All inter-item (ranging from .36 to .62) and item-total correlations (ranging from .60 to .76) were moderate to strong.

As a result of local independence, the maximum correlation of the residuals was 0.22, which is between Item 6 and Item 7. This indicates an acceptable coefficient supporting the local independence in the 7-item SVS**.** Table 3 presents the IRT parameter values for each item. In terms of difficulty, the category parameter values increased relatively from Step 3 to Step 6. These values were negative for Steps 1, 2, and 3, except for Item 2 and Item 5 for Step 2, and for Item 2 for Step 3. In terms of discrimination (slope), Items 1, 4, 5, 6, and 7 had positive values and higher than 1.0 indicating (probable) good items. On the other hand, Items 2 and 3 had lower discrimination values. This is speculated on the basis that all participants answered

in the same way to these items. Most likely due to the fact that the items were too difficult, which resulted in row discrimination level. Furthermore, Items 3 and 5 had a different pattern of category parameters compared to other items. For example, at Step 2, both items had positive values (more difficult) whereas other items had negative values (easier).

TABLE 2
Fit indices for four CFA models of the Subjective Vitality Scale (SVS)

Models	χ^2	*df*	*p*-value	CFI	TLI	RMSEA
Model 1	46.98	10	< .001	.981	.967	.070
Model 2	724.93	12	< .001	.841	.721	.204
Model 3	1064.25	12	< .001	.765	.588	.248
Model 4	1754.44	14	< .001	.611	.416	.296

Note. Model 1 = all the 7 items; Model 2 = 6 items, except for Item 2; Model 3 = 6 items, except for Item 5; Model 4 = 5 items, except for Items 2 and 5; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean squared error of approximation.

TABLE 3
Generalized partial credit model item parameter values for the 7 items of Subjective Vitality Scale (SVS)

Items	Category						Slope	Location
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6		
1	–2.352	–0.838	–0.662	0.082	1.264	2.337	1.126	0.004
2	–2.200	–1.112	0.881	0.092	0.641	2.822	0.667	0.214
3	–0.450	2.448	–0.424	2.102	3.473	2.490	0.623	1.413
4	–2.007	–0.721	–0.315	0.180	1.233	2.091	1.751	0.098
5	–1.172	0.191	–0.200	0.776	1.811	2.625	1.129	0.664
6	–1.921	–0.138	–0.180	0.450	2.013	2.371	1.150	0.449
7	–1.814	–0.207	–0.152	0.405	1.957	2.845	1.011	0.521
M	–1.702	–0.054	–0.150	0.584	1.770	2.512	1.065	0.480
SD	0.667	1.192	0.488	0.713	0.896	0.273	0.375	0.474

In summary, although the CFAs confirmed the 7-item model, IRT-GCPM indicated that Items 1, 4, 6, and 7 were the most discriminant items. We conducted a further CFA to probe the model fit of the reduced version. The results were as follows: $\chi^2 = 5.779$, $df = 1$; CFI = .998; TLI = .988; RMSEA = .058, suggesting an excellent model fit, and slightly better than the 7-item model.

The standardized estimate of factor loadings for the four items were high in magnitude, ranging from .68 (Item 7) to .86 (Item 4). The estimates of the internal consistency were satisfactory ($\alpha = .84$; $\omega = .84$; GLB = .87). As a consequence, the 4-item model (comprising Items 1, 4, 6, and 7) is an alternative useful short-version.

Construct Validity

The 7-item model (Model 1) and the 4-item model (Model 5), respectively, were used to examine their concurrent and divergent validity. The results are summarized in Table 4. As expected, Pearson's moment correlation analyses supported that both SVS models were substantially and positively related to satisfaction with life and negatively to depressive symptoms, as measured by SWLS and BDI-II, respectively (all *p*s < .001). However, Pearson's coefficients for the 4-item model displayed a significantly higher strength of correlation with BDI-II score than the 7-item model ($z = –2.36$, $p < .05$).

TABLE 4
Difference in correlations between 7-item SVS, 4-item SVS, SWLS, and BDI-II

	7-item SVS (Model 1)	4-item SVS (Model 5)	Difference (z-score)
SWLS	.63, $p < .001$	.65, $p < .001$	0.83, $p = .41$
BDI-II	–.60, $p < .001$	–.66, $p < .001$	–2.36, $p = .02$

Note. SVS = Subjective Vitality Scale; SWLS = Satisfaction with Life Scale; BDI-II = Beck Depression Inventory-II.

Discussion

The present study used IRT-GCPM to examine the psychometric properties of the SVS. Since its development, the SVS has gained a special interest among researchers as *vitality* is increasingly recognized as an important component of subjective well-being (Ryan & Deci, 2008). To date, we have found different models that were proposed due to the deletion of some items that might perform inadequately. We believe that ITR modeling posits well to probe the accurate psychometric performance of scale items and the hypothesized latent trait. To that end, we have used data from a large sample of French university students, which fulfilled the sample size requirements for accurate parameter estimates in IRT-based model analyses.

The results of CFAs have supported the original unidimensionality of the scale. The standardized estimates of all the items reached a high level of significance. Also, the SVS displayed a very good reliability of the scale (.88) and across the items as measured by Cronbach's α, which was approximately similar to many reported in validation studies. Furthermore, the CFA using maximum likelihood (ML) estimation confirmed that the 7-item version proved to be a better fitting model with respect to the classical test theory (CTT) methods used. This result accorded with two previous validation studies of an identical version in Turkish adolescent and young adult samples (Akin et al., 2016; Sariçam, 2015).

In the previous studies, the multiple versions of SVS were due to the deletion of Items 2 and 5 as they might not perform well. In this study, we found neither Item 2 ("I don't feel very energetic," [R]) nor Item 5 ("I look forward to each new day") displaying poor factor loadings as reported by many studies (Castillo et al., 2017; Gouveia et al., 2012; Kawabata et al., 2017; Liu & Chung, 2019). In these studies, the rationales behind the deletion of these items were twofold. First, Bostic et al. (2000) argued for the balance of negatively worded Item 2 with other positively worded items that might affect the excellence of the data model fit; therefore they removed Item 2. It should be remembered that Bostic and colleagues found all of the items to yield high factor loadings, exceeding .60, in contrast to some reports. Although some researchers followed the recommendation of Bostic and colleagues, the deletion of Item 2 or both Item 2 and Item 5 due to their weak coefficients of factor loadings has emerged latterly. In the present study, when removing either

Item 2 (Model 2) or Item 5 (Model 3), or both (Model 4), none of these models met the criterion for an acceptable model fit. Thus, this approach provided further evidence for the superiority of the 7-item SVS model with respect to CTT methods. However, these results require cautious interpretation for, since internal consistency and factor analysis provide insufficient information, as argued by many scholars (e.g., Doll et al., 1994),

The IRT modeling enhanced the utility of the SVS by providing more rigorously accurate characteristics of its items. The results indicated three indiscriminant items: the two previous ones and Item 3 ("Sometimes I feel so alive I just want to burst"). It should be noted that this study is the first to identify Item 3 as a weak discriminant item. In fact, examination of the output of IRT-GCPM parameter estimates have shown that they were not equally informative across the entire trait range. More precisely, they were not quite closed to the underlying latent construct of subjective vitality. These items have been answered in the same way, suggesting that they were more difficult for the participants. In further studies, it would be interesting to explore, through in-depth qualitative studies, the underlying meaning of these items. Such studies could adopt a comparative cross-cultural design since the meanings could slightly but significantly differ depending on the cultural and philosophical traditions. This may help to refine them and, in extenso, to broaden the conceptualization and the measurement of subjective vitality. Until further explanation is available, Kawabata et al. (2017) have argued that Item 5, specifically, may express more optimism and hope than energy. Importantly, we found that Item 3 and Item 5 are located in a specific region away from the trait domain. This indicates that the two items may have a shared meaning for the participants. Although they could be refined to be more flexible and discriminant, one could consider the assumption of plausible multidimensionality of the subjective vitality concept. Nevertheless, the conceptual border between energy expression and optimism needs to be questioned. Again, until further empirical insights, IRT modeling allows us to propose the reliable and valid 4-item version for alternative use. Interestingly, this new short-version has demonstrated better model fit indices, with more significantly higher strength of correlation with BDI-II (Beck et al., 1996) than the original 7-item of SVS. This confirms the advantages of IRT methods over CTT ones. If we had limited our approach to CTT methods, we would have retained the seven items of the SVS; thus our results would not have been significantly different.

Conclusion

In summary, based only on CTT methods, the original 7-item model of SVS has demonstrated good model fit indices as a reliable and valid instrument for measuring subjective vitality in French university students. However, different parameter estimates from IRT modeling have revealed that three items performed poorly in discriminating the latent trait. Therefore, the 4-item SVS was proposed as a reliable and valid alternative version. As a whole, the study findings can be viewed as a valuable contribution to rigorously measuring subjective vitality, as currently defined as positive feelings of aliveness and energy. However, the results should be interpreted with respect to our study sample, which was overrepresented by female participants, and also characterized by a convenience sampling. Lastly, although this was a quite large sample, we could not ascertain its representativeness of all French university students from Humanity and Social Sciences faculties. Despite these limitations, the present study based on IRT modeling has provided strong preliminary results for measuring subjective vitality with more accuracy.

ACKNOWLEDGEMENTS

The authors would like to thank Nicolas Nieuviarts for his helpful contribution in data collection, and Steven Kator Iorfa and Isabella Zemshman for their help in refining and editing of the revised manuscript. They also thank the participants whose participation made this study possible.

REFERENCES

Akin, U., Akin, A., & Ugŭr, E. (2016). Mediating role of mindfulness on the associations of friendship quality and subjective vitality. *Psychological Report*, *119*(2), 516-526. https://doi.org/10.1177/0033294116661273

Andersen, E. B. (1983). A general latent structure model for contingency table data. In H. Wainer & S. Messik (Eds.), *Principals of modern psychological measurement* (pp. 117-138). Hillsdale, NJ: Erlbaum.

Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. F. (1996). Comparison of Beck Depression Inventories-IA and-II in Psychiatric Outpatients. *Journal of Personality Assessment*, *67*(3), 588-597. https://doi.org/10.1207/s15327752jpa6703_13

Bostic, T. J., Rubio, D. M., & Hood, M. (2000). A validation of the subjective vitality scale using structural equation modeling. *Social Indicators Research*, *52*(3), 313-324. https://doi.org/10.1023/A:1007136110218

Castillo, I., Tomás, I., & Balaguer, I. (2017). The Spanish-version of the Subjective Vitality Scale: Psychometric properties and evidence of validity. *Spanish Journal of Psychology*, *20*, e26. https://doi.org/10.1017/sjp.2017.22

Cohen, S., Alper, C. M., Doyle, W. J., Treanor, J. J., & Turner, R. B. (2006). Positive emotional style predicts resistance to illness after experimental exposure to rhinovirus or influenza A virus. *Psychosomatic Medicine*, *68*(6), 809-815. https://doi.org/10.1097/01.psy.0000245867.92364.3c

Couto, N., Antunes, R., Monteiro, D., Moutão, J., Marinho, D., & Cid, L. (2017). Validation of the Subjective Vitality Scale and study of the vitality of elderly people according to their physical activity. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *19*(3), 261-269. https://doi.org/10.5007/1980-0037.2017v19n3p261

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, *49*(1), 71-75. https://doi.org/10.1207/s15327752jpa4901_13

Doll, W. J., Xia, W., & Torkzadeh, G. (1994). A confirmatory factor analysis of the end-user computing satisfaction instrument. *MIS Quarterly*, *18*(4), 453-461.

Edelen, M. O., & Reeves, B. B. (2007). Applying item response theory (IRT) modeling to questionnaire development, evaluation, and refinement. *Quality of Life Research*, *16*, 5-18. https://doi.org/10.1007/s11136-007-9198-0

Enders, C. K. (2010). *Applied missing data analysis*. New York, NY: Guilford Press.

Fayad, Y. I., & Kazarian, S. S. (2013). Subjective Vitality of Lebanese adults in Lebanon: Validation of the Arabic Version of the Subjective Vitality Scale. *Social Indicators Research*, *114*(2), 465-478. https://doi.org/10.1007/s11205-012-0156-z

Goldbeck, F., Hautzinger, M., & Wolkenstein, L. (2019). Validation of the German version of the Subjective Vitality Scale - A cross-sectional study and a randomized controlled trial. *Journal of Well-Being Assessment*, *3*(1), 17-37. https://doi.org/10.1007/s41543-019-00019-8

Gouveia, V. V., Milfont, T. L., Gouveia, R. S., de Medeiros, E. D., Vione, K. C., & Soares, A. K. S. (2012). Escala de vitalidade subjetiva–EVS: Evidências de sua adequação psicométrica [Subjective Vitality Scale – SVS: Evidences of its psychometric adequacy]. *Psicologia: Teoria e Pesquisa*, *28*(1), 5-13.

Hambleton, R. K., Swaminathan, H., & Rogers, J. (1991). *Fundamentals of item response theory*. Newbury Park, CA: Sage.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Kang, T., Cohen, A. S., & Sung, H. J. (2009). Model selection indices for polytomous items. *Applied Psychological Measurement*, *33*(7), 499-518. https://doi.org/10.1177/0146621608327800

Kawabata, M., Yamazaki, F., Guo, D. W., & Chatzisarantis, N. (2017). Advancement of the subjective vitality scale: Examination of alternative measurement models for Japanese and Singaporeans. *Scandinavian Journal of Medicine & Science in Sports*, *27*(12), 1793-1800. https://doi.org/10.1111/sms.12760

Kokou-Kpolou, K. C, Jumageldinov, A., Park, S., Nieuviarts, N., Noorishad, P. G., & Cénat, J. M. (2020). Prevalence of depressive symptoms and associated psychosocial risk factors among French University students: The moderating and mediating effects of resilience. *Psychiatric Quarterly*. Advance online publication. https://doi.org/10.1007/s11126-020-09812-8

Liu, J. D., & Chung, P. K. (2019). Factor structure and measurement invariance of the Subjective Vitality Scale: Evidence from Chinese adolescents in Hong Kong. *Quality of Life Research*, *28*(1), 233-239. https://doi.org/10.1007/s11136-018-1990-5

Martela, F., DeHaan, C. R., & Ryan, R. M. (2016). On enhancing and diminishing energy through psychological means: Research on vitality and depletion from self-determination theory. In E. R. Hirt, J. J. Clarkson, & L. Jia (Eds.), *Self-Regulation and Ego Control* (pp. 67-85). Academic Press. https://doi.org/10.1016/B978-0-12-801850-7.00004-4

Masters, G. N. (1982). A Rasch model for partial credit scoring. *Psychometrika, 47*(2), 149-174.

McNeish, D. (2018). Thanks coefficient alpha, we'll take it from here. *Psychological Methods*, *23*(3), 412-433. https://doi.org/10.1037/met0000144

Muraki, E. (1992). A generalized partial credit model: Application of an EM algorithm. *Applied Psychological Measurement, 16*, 159-176. https://doi.org/10.1002/j.2333-8504.1992.tb01436.x

Muraki, E., & Block, R. D. (2003). *PARSCALE (version 4.1)*. Chicago, IL: Scientific Software, Inc.

Polk, D. E., Cohen, S., Doyle, W. J., Skoner, D. P., & Kirschbaum, C. (2005). State and trait affect as predictors of salivary cortisol in healthy adults. *Psychoneuroendocrinology*, *30*(3), 261-272. https://doi.org/10.1016/j.psyneuen.2004.08.004

Reeves, B. B., Hays, R. D., Bjorner, J. B., Cook, K. F., Crane, P. K., Teresi, J. A, . . . Cella, D. (2007). Psychometric evaluation and calibration of health-related Quality of Life item banks: plans for the patient-reported outcomes measurement information systems (PROMIS). *Medical Care*, *45*(5), S22-S31.

Reise, S. P., & Waller, N. G. (2009). Item response theory and clinical measurement. *Annual Review of Clinical Psychology*, *5*, 27-48. https://doi.org/10.1146/annurev.clinpsy.032408.153553

Revelle, W., & Zinbarg, R. E. (2009). Coefficients Alpha, Beta, Omega, and the glb: Comments on Sijtsma. *Psychometrika*, *74*(1), 145-154. https://doi.org/10.1007/s11336-008-9102-z

R Core Team. (2017). *R: A language and environment for statistical computing*. [Computer Software]. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from http://www.R-project.org/

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*, 1-36. http://dx.doi.org/10.18637/jss.v048.i02

Rouse, P. C., Veldhuijzen Van Zanten, J. J. J. C. S., Ntoumanis, N., Metsios, G. S., Yu, C., Kitas, G. D., & Duda, J. L. (2015). Measuring the positive psychological well-being of people with rheumatoid arthritis: A cross-sectional validation of the subjective vitality scale. *Arthritis Research & Therapy*, *17*(1), 312. https://doi.org/10.1186/s13075-015-0827-7

Ryan, R. M., & Deci, E. L. (2008). From ego depletion to vitality: Theory and findings concerning the facilitation of energy available to the self. *Social and Personality Psychology Compass*, *2*(2), 702-717. https://doi.org/10.1111/j.1751-9004.2008.00098.x

Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality*, *65*(3), 529-565. https://doi.org/10.1111/j.1467-6494.1997.tb00326.x

Salama-Younes, M. (2011). Positive mental health, subjective vitality and satisfaction with life for French physical education students. *World Journal of Sport Sciences*, *4*(2), 90-97.

Salama-Younes, M., Montazeri, A., Ismaïl, A., & Roncin, C. (2009). Factor structure and internal consistency of the 12-item general health questionnaire (GHQ-12) and the subjective vitality scale (SVS), and the relationship between them: A study from France. *Health and Quality of Life Outcomes*, *7*(1), 22. https://doi.org/10.1186/1477-7525-7-22

Samejima, F. (1969). Estimation of latent ability using a response pattern of graded scores. *Psychometrika Monograph Supplement*, *34*(4, Pt. 2), 100.

Sariçam, H. (2015). Mediating role of self efficacy on the relationship between subjective vitality and school burnout in Turkish adolescents. *The International Journal of Educational Researchers*, *6*(1), 1-12.

Tsutakawa, R. K., & Johnson, J. C. (1990). The effect of uncertainty of item parameter estimation on ability estimates. *Psychometrika*, *55*(2), 371-390. https://doi.org/10.1007/BF02295293

semTools Contributors. (2018). *semTools: Useful tools for structural equation modeling. R package version 0.4 –15.915*. Retrieved from https:// cran.rproject.org/web/packages/semTools/semTools.pdf

Sijtsma, K. (2009). Reliability beyond theory and into practice. *Psychometrika*, *74*(1), 169-173. https://doi.org/10.1007/s11336-008-9103-y

Trizano-Hermosilla, I., & Alvarado, J. M. (2016). Best alternatives to Cronbach's Alpha reliability in realistic conditions: Congeneric and asymmetrical measurements. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.00769

Uysal, R., Sariçam, H., & Akin, A. (2014). Öznel Zindelik Ölçeği Türkçe Formunun Psikometrik Özellikleri [Properties of Turkish Version of Subjective Vitality Scale]. *Sosyal Bilimler Enstitüsü Dergisi*, *33*, 136-146.