Original Article

The Short Stress State Questionnaire in German (SSSQ-G)

A Multi-Study Validation

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Abstract: *Background*: Although the physiological stress response is well established, self-reported stress has received less attention. Some validated measures assess task-related stress via self-report in English. However, no such measure exists in German. *Aims*: To address this research gap, we translated and validated the Short Stress State Questionnaire in German (SSSQ-G). It assesses stress-related affective states (e.g., anger) and appraisals (e.g., feelings of control). We expected to replicate the factor structure of the English SSSQ in the SSSQ-G. *Methods*: We included the SSSQ-G in five studies that induced stress either via the gold standard task for acute stress induction – the Trier Social Stress Test (TSST) – or via a novel virtual reality (VR) task. The sample consisted of 213 participants (112 women; age: 23.36 ± 3.62 years). *Results*: The SSSQ-G demonstrated sensitivity to stress-induced changes (*ps* < .01), particularly in response to the TSST compared to the VR stress induction ($p < .001$ for total scale comparison between stressors). In TSST participants, the magnitudes of stress-induced changes on the SSSQ-G were larger than those on the Positive and Negative Affect Schedule (PANAS), $p = .008$, indicating strong construct validity. Although the SSSQ-G total score was highly reliable ($\alpha = .85$, $\Omega = .86$), factor analyses revealed a six-factor solution, with the factors representing *Distress, Worry, Confidence, Negative affect, Motivation,* and *Self-evaluation. Limitations*: The SSSQ-G appears more sensitive to state changes induced by moderate-to-severe stress tasks. *Conclusion*: The SSSQ-G is a reliable and valid instrument for assessing states of subjective stress.

Keywords: stress, psychometric properties, cognition, motivation, affect

Stress can be studied at multiple levels of analysis, such as the physiological response, environmental exposure, or subjective appraisal. Various theories underlie these processes linking stressful life events to psychological disorders and physiological diseases, and these can be subsumed by the categories of biological, epidemiological, and psychological traditions (Cannon, 1929; Cohen et al., 2016; Holmes & Rahe, 1967; Lazarus & Folkman, 1984; McEwen, 1998).

In the biological tradition, the physiological stress response can be assessed via well-validated and gold-standard measures, such as heart rate or cortisol (Kuras et al., 2017; Rohleder, 2019). This tradition is usually dated back to Selye's early work (Selye, 1946), and at its center is the assumption that stressors disrupt physiological systems that are essential for homeostasis. As a detailed description of these theories and physiological processes and measures lies outside of the scope of this work, we refer the interested reader to other excellent manuscripts[1] (Dickerson & Kemeny, 2004; Kuras et al., 2017; McEwen, 1998).

In the epidemiological tradition, exposure to life stressors can be measured via comprehensive life history assessments, using tools such as the Stress and Adversity Inventory (STRAIN; Slavich & Shields, 2018; Sturmbauer et al., 2019). Again, an excellent overview of the connection of

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stressful life events and disease risk can be found elsewhere (Cohen et al., 2019).

The psychological tradition of stress can be traced back to early work by Lazarus and Folkman (1984). In their work, they focus on differences in the appraisal of potentially stressful situations and resources available to the individual appraising the situation. Subjective stress appraisals are most commonly assessed in research via the Perceived Stress Scale (PSS; Cohen et al., 1983). While this questionnaire is widely used and well-validated, it is not suited for assessing acute stress-related changes in subjective stress appraisals, as it measures perceived stress over the past 1-month period, not current states. When differentiating between enduring (i.e., trait) measures, and less stable (i.e., state) measures, some important distinctions must be made. Aside from the temporal definition, traits and states can also be distinguished by characteristics, such as reactivity (states are more reactive, while traits are continuous), abstraction (states usually can be measured directly, while traits must be inferred), or the difference of states being more situational, while traits are adapted to a personal context (Fridhandler, 1986). For this article, when we talk about stress, we refer to self-reported, psychological stress states, which are subject to changes on a situational basis.

There is less of a gold-standard measure for assessing such acute stress-induced changes in subjective appraisals and even fewer options for measures not written in English. Acute changes in subjective stress are often measured either by visual analog scales or by quantifying neighboring constructs, such as affect (e.g., via the Positive and Negative Affect Schedule; PANAS; Watson et al., 1988). While the authors of the PANAS point out that negative affect (NA) is connected to self-reported stress and shows a negative relationship with coping, negative affect is only one aspect of self-reported stress (Cohen et al., 1993). While researchers utilizing acute stress tests such as the Trier Social Stress Test (TSST; Kirschbaum et al., 1993) might find a distinct change in NA, other paradigms that focus less on social evaluation, might not result in a distinct change in negative affect, but could still produce changes in other aspects of the self-reported state stress changes, on a more cognitive level.

The area of stress research would benefit greatly from a state measure that would allow us to quantify stress changes, not only pre- to post-task, but also regarding more aspects of the psychological experience of participants, such as affect, cognition, and motivation.

The Dundee Stress State Questionnaire (DSSQ; Matthews et al., 1999) was developed to permit the assessment of state subjective stress. However, it consists of 90 items, which severely limits its usability in laboratory stress studies. To address this issue, the 24-item Short Stress State Questionnaire (SSSQ; Helton, 2004) was developed, based on the DSSQ. The English version of the SSSQ is reliable and valid: It is sensitive to stress-induced changes across a three-factor structure with the factors "Distress," "Engagement," and "Worry" (Helton & Näswall, 2015). Moreover, the three factors of the SSSQ fit well with the known effects of stress on affect, motivation, and cognition, respectively (Helton, 2004). The SSSQ's brevity, validity, and reliability make it an ideal candidate for assessing acute, stress-related changes in subjective stress appraisals. To date, however, its use has been restricted to English-speaking samples.

To address this, we translated the SSSQ into German according to standard practice (Harkness & Schoua-Glusberg, 1998). The purpose of the work reported here was to assess the psychometric properties of the German SSSQ (SSSQ-G) across five stress studies with German participants. Two of these studies induced stress using the Trier Social Stress Test (TSST; Kirschbaum et al., 1993) – the gold-standard task for acute stress induction. The other three studies induced stress using the novel Virtual Reality Stroop Room (VRSR; Gradl et al., 2019), which is a challenging task that nonetheless elicits a less-pronounced physiological stress response than other, stronger stressors. For cross-validation purposes, we included the PANAS in all studies pre- and post-stressor. In line with Helton and Näswall (2015), we expected to find a three-factor structure and pre-to-post-changes driven by the utilized stress task. Further, we expected stress-related changes in the SSSQ-G to be stronger in magnitude than stress-related changes in the PANAS, given a more direct assessment of the construct of state stress in the SSSQ-G than the PANAS.

Methods

Participants and Procedure

Participants were recruited via university mailing lists, notice boards, social media platforms, flyers, and psychology and engineering lectures at Friedrich-Alexander-Universität Erlangen-Nürnberg. Individuals, mainly students of Friedrich-Alexander-Universität Erlangen-Nürnberg, included in these analyses (N = 213; 112 women; M_{age} = 23.36 years; SD_{age} = 3.62 years; $range_{age}$ = 18 to 45 years) participated in one of five acute stress induction studies. Two of these studies (n = 84) induced stress via the TSST (Kirschbaum et al., 1993), and the other three studies (n = 129) induced stress via the Virtual Reality Stroop Room (VRSR; Gradl et al., 2019). The studies were conducted at different times and with different primary interests. The two TSST studies were performed between December 2022 and May 2023 and between March 2022 and May 2022. The studies utilizing the VRSR were conducted

between April and May 2022, June and November 2022, and March and May 2023. Participants undergoing the TSST and the VRSR did not differ significantly with regard to sex or age. A chi-square test of independence indicated no significant difference in the distribution of sex between the two studies, $\chi^2(2, N = 213) = 1.81$, $p = .40$. An independent samples *t*-test revealed no significant difference in age between the two studies, $t(211) = 0.21$, $p = .84$. Participants in the TSST studies received either course credit or 50€ for their participation, and participants in the VRSR studies received course credit for their participation. Participants were asked to refrain from eating, drinking, and smoking 2 hr before testing. Because of associations between the menstrual cycle phase and hormonal stress responses (Kirschbaum et al., 1999), all individuals with a menstrual cycle participated during the second half of their cycles. The exclusion criteria used in the TSST[2] and VRSR[3] studies were taken from the recommended stress study exclusion criteria (e.g., Shields, 2020), for example, no use of prescription medication such as beta-blockers or glucocorticoid drugs. Participants completed the SSSQ-G and the PANAS before and after the respective tasks in the TSST and VRSR. All participants gave written informed consent prior to participation. All studies were approved by the ethics committee at the Friedrich-Alexander-Universität Erlangen-Nürnberg and conducted by the Declaration of Helsinki.

Trier Social Stress Test

The TSST was conducted as described previously (Janson & Rohleder, 2017; Kirschbaum et al., 1993). We invited participants to the laboratory on two consecutive days where they performed the TSST and the friendly-TSST (f-TSST; Wiemers et al., 2013) randomized in a within-design. Data was collected between 13:00 and 21:00, to minimize the impact of circadian variations in cortisol, and participants performed both conditions at similar daytimes. The TSST was performed as proposed by Kirschbaum et al. (1993) with a panel consisting of one male and one female experimenter wearing white lab coats. Only the panel member of the opposite sex interacted with the participant, while both panel members stayed neutral towards the participant, not displaying emotions or engaging in anything but pregiven instructions. The TSST consisted of three phases: Preparation, a mock job interview, and a mental arithmetic task in which participants had to count down from 2043 in steps of 17. Each phase lasted 5 min. The f-TSST consisted of the same phases, but the mock job interview was a friendly conversation with the panel about the participants' CVs, and the mental arithmetic task was simplified. Additionally, the panel showed interest in the participant and reacted with emotional and friendly responses. The two samples utilizing the (f-)TSST were part of larger studies within the framework of the subproject "Contact-Free Measurement of Stress, its Determinants and Consequences" of the collaborative research center Empatho-Kinaesthetic Sensor Technology (EmpkinS; Funded by the German Research Foundation – SFB 1483 – Project-ID 442419336, www.empkins.de). Primary data for some of these studies have already been published (Richer et al., 2024). TSST Study 1 included 41 participants (18 women; M_{age} = 24.05 years; SD_{age} = 3.54 years), and TSST Study 2 included 43 participants (24 women; M_{age} = 22.58 years; SD_{age} = 2.90 years).

Virtual Reality Stroop Room

The Virtual Reality Stroop Room (VRSR) is a relatively novel stress paradigm built by adapting the classical Stroop task (Stroop, 1935) to a challenging virtual reality (VR) implementation. Participants in the VRSR have to perform the Stroop Task, by picking a color wall in a hexagonal room, according to the instruction given in each trial. To make the task harder, the participants have to either react to the color word or the color it is written in, and this instruction changes trial by trial in an arbitrary manner. Additionally, participants have only a specific amount of time for each trial – depending on the condition either 5 sec or 3 sec. In an initial study, participants responded to the VRSR with a rise in heart rate and ambiguous results concerning salivary cortisol and alpha-amylase (Gradl et al., 2019). The three samples using the VRSR were part of larger studies assessing movement, biosignals (e.g., heart rate), wet biomarkers (e.g., cortisol), and questionnaires, and the primary data on these studies are yet to be published. For the scope of this paper, VRSR Study 1 consists of 25 participants (11 women; M_{age} = 23.32 SD_{age} = 3.3 years), VRSR Study 2 consists of 89 participants (52 women; M_{age} = 23.60 years; SD_{age} = 3.88 years), and VRSR Study 3 consists of 15 participants (7 women; M_{age} = 22.4 years; SD_{age} = 4.45 years).

[2] (1) age below 18 or above 40 years, (2) diagnosis of acute and/or chronic somatic disease, (3) use of prescription medications (especially beta-blockers or glucocorticoid drugs), (4) smoker (>5 cigarettes per day; Zimmer et al., 2019), (5) prior experience with the stress protocol, (6) for female participants: hormonal contraceptives, pregnancy or menopause, (7) individuals with a body mass index <18 or >30 kg/m^2, 8) Psychology Master's students, (9) People with experience in stress-testing, (10) a score >22 in the Allgemeine Depressionsskala (ADS; Hautzinger et al., 2012).

[3] (1) age below 18 or above 45 years, (2) color vision deficiency (e.g., red-green deficiency), (3) diagnosis of acute and/or chronic somatic disease, (4) use of prescription medications (especially beta blockers or glucocorticoid drugs), (5) smoker (>5 cigarettes per day; Zimmer et al., 2019), (6) prior experience with the stress protocol, (7) for female participants: hormonal contraceptives, pregnancy or menopause, (8) individuals with a body mass index <18 or >30 kg/m^2, (9) psychotherapeutic treatment in the last year, (10) regular night shift work (Niu et al., 2011), (11) a score >22 in the Allgemeine Depressionsskala (ADS; Hautzinger et al., 2012).

Measures

Short Stress State Questionnaire in German

The English Version of the SSSQ (Helton & Näswall, 2015) was translated to German by one of the authors, and subsequently back-translated by two bilingual speakers: One from the United States with a PhD in Sociolinguistics and English as their first language, the other a native German speaker with a proficiency level in English equivalent to a native English speaker (C2). Inconsistencies in the translation and back-translation were then discussed and resolved within the research group. The final version of the SSSQ-G was then included in the five studies described above. The pre- and post-stressor versions of the questionnaire are worded identically, except that the tense is adjusted (e.g., "I want to succeed on the task" to "I wanted to succeed on the task."). Participants answer the questionnaire on a Likert scale ranging from 1 (= *not at all*) to 5 (= *extremely*). The SSSQ-G consists of 24 items, which represent stress-task-related or stress-sensitive subjective affective, motivational, and cognitive states. Larger values represent greater subjective stress. Items 2 ("Alert"), 5 ("Active"), 11 ("I am/was committed to attaining my performance goal"), 12 ("I want/wanted to succeed on the task"), 13 ("I am/was motivated to do the task"), 17 ("I feel/felt confident about my abilities"), 21 ("I expect to perform/performed proficiently on this task"), 22 ("Generally, I feel/felt in control of things") are reverse coded in the total scale score, but these items were kept as originally coded in all other analyses and subscales. The SSSQ-G can be found in Appendix A.

Positive and Negative Affect Schedule

The German version of the Positive and Negative Affect Schedule (PANAS; Krohne et al., 1996) was used in all five samples to assess the current affect. The PANAS consists of 20 items, and responses are provided on a Likert scale ranging from 1 (= *not at all*) to 5 (= *extremely*). Ten items on the PANAS assess positive affect (PA), and 10 items assess negative affect (NA). Positive items are averaged to create a positive affect composite and negative items are averaged to create a negative affect composite. The PANAS scales exhibited good to excellent internal consistency in this study: Cronbach's αs were .80 and .86 for the pre-NA and pre-PA scales, and .83 and .90 for the post-NA and post-PA scales. Larger values on the positive or negative affect scales indicate greater positive and negative affect, respectively.

Statistical Analyses

Data aggregation and cleaning were conducted using Jupyter Lab (Version 3.4.4) in Python (Version 3.9.13). For analyses, we used R (v4.2.3; R Core Team, 2023), and RStudio (v2023.9.0.463; Posit Team, 2023) utilizing the open source package lavaan (v.0.6-16; Rosseel, 2012).

As this article reports a secondary analysis of data collected in studies yet to be published, we conducted a post-hoc power analysis using semPower (Moshagen & Bader, 2023), which showed that for a sample size of 213 with an alpha of .05 and 24 manifest variables (i.e., SSSQ-G items), we achieved 99.9% power to detect a misspecified three-factor model via RMSEA.

Internal consistency, a measure of reliability, is indicated by Cronbach's α. For Cronbach's α, >0.7 indicates adequate internal consistency, >0.8 indicates good internal consistency, >0.85 indicates very good internal consistency, and >0.90 indicates excellent internal consistency.

As the English version of the SSSQ shows a three-factor structure, we conducted a confirmatory factor analysis (CFA) according to the original publication (Helton & Näswall, 2015). Model estimation was done using the maximum likelihood approach. Comparative fit index (CFI), Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA) were used to assess model fits. Values for CFI and TLI closer to 1.0 denote a better fit, with above 0.90 being considered acceptable, whereas for the RMSEA, values closer to zero indicate a better fit, with below .08 being considered acceptable (Fabrigar et al., 1999).

Results

The SSSQ is designed as a measure assessing subjective stress appraisals and responses. Therefore, we used the change score (post-pre) for our analyses. Reliability for the total scale with 24 items was very good, $\alpha = .85$, $\Omega = .86$, Stress-related total scale change scores were significantly different from zero, $p < .001$, which will be described in detail in the section "Sensitivity to Stress-Induced Changes". Descriptive statistics for all 24 items, both pre- and post-experiment, can be found in Appendix B.

Factor Structure

We first conducted an exploratory factor analysis (EFA), beginning with a three-factor solution, as was found in the English version of the SSSQ (Helton & Näswall, 2015). Importantly, though, we did not constrain the loadings of the items onto specific factors, as would have been done in a confirmatory factor analysis. Instead, we permitted EFA to determine the loading structure, beginning with three factors and increasing the number of factors if need be. Although the structure of the items loading on the three exploratory factors was similar to the English version

Table 1. Change scores loading on the six factors of the SSSQ-G

Item	Distress	Worry	Confidence	Negative affect	Motivation	Self-evaluation
Dissatisfied	**0.32**	0.23	−0.22	0.29	0.01	0.00
Alert (-)	0.11	0.08	**0.61**	−0.12	0.01	−0.09
Depressed	0.10	0.07	−0.10	**0.70**	0.06	−0.08
Sad	−0.07	−0.02	0.06	**0.81**	−0.05	0.05
Active (-)	0.09	0.06	**0.58**	−0.12	0.17	−0.07
Impatient	**0.36**	0.05	−0.01	−0.18	0.02	0.20
Annoyed	**0.83**	0.04	0.10	0.04	−0.13	0.04
Angry	**0.58**	−0.01	0.03	0.16	−0.07	0.04
Irritated	**0.88**	−0.08	−0.10	−0.01	0.07	0.02
Grouchy	0.30	−0.01	−0.09	**0.48**	−0.01	0.00
I am/was committed to attaining my performance goals (-)	−0.04	0.05	0.11	−0.05	**0.54**	0.15
I want/wanted to succeed on the task (-)	−0.02	−0.01	0.03	−0.01	**0.72**	−0.01
I am/was motivated to do the task (-)	−0.06	−0.12	0.02	0.01	**0.68**	0.00
I'm trying/tried to figure myself out	0.13	0.12	−0.06	0.10	0.25	**0.28**
I'm reflecting/reflected about myself	0.09	0.18	0.00	0.02	0.08	**0.71**
I'm daydreaming/daydreamed about myself	0.07	−0.09	−0.05	−0.04	−0.07	**0.55**
I feel/felt confident about my abilities (-)	−0.16	−0.15	**0.44**	0.03	0.11	0.20
I feel/felt self-conscious	0.12	**0.45**	−0.33	0.01	−0.05	0.13
I am/was worried about what other people think of me	−0.07	**0.82**	−0.04	−0.01	−0.03	0.11
I feel/felt concerned about the impression I'm making	−0.01	**0.80**	0.04	0.07	−0.07	0.00
I expect to perform/performed proficiently on this task (-)	−0.15	−0.21	**0.50**	0.06	0.10	0.07
Generally, I feel/felt in control of things (-)	−0.22	−0.18	**0.44**	0.05	−0.02	0.10
I thought about how others have done on this task	0.23	**0.29**	−0.01	0.06	0.24	−0.26
I thought about how I would feel if I were told how I performed	0.08	**0.44**	0.04	−0.04	0.26	−0.12
SS loadings	2.65	2.30	1.94	1.75	1.66	1.18
Proportion of Variance Explained	.23	.20	.17	.15	.14	.10

Note. SSSQ-G = Short Stress State Questionnaire in German. The bold type indicates the highest loading for each item. Reverse-coded items are indicated by (-).

loadings, the fit indices indicated a poor fit (RMSEA = .084, 90% CI [.076, .094]; TLI = .726).[4] We therefore increased the number of factors until a solution with acceptable fit was obtained. That is, we increased the number of factors estimated in the exploratory factor analysis until the empirical χ^2 was nonsignificant, indicating an acceptable fit of the factor structure to the data.

The first acceptable fit to the data was a six-factor solution using the change score (post-pre) with the factors "Distress", "Worry", "Confidence", "Negative affect", "Motivation", and "Self-evaluation", RMSEA = .047, 90% CI [.033, .060]; TLI = .914, empirical $\chi^2(147, N = 213) = 142.42$, $p = .59$. Factor loadings can be seen in Table 1. We expected correlations among the factors and thus presented the oblimin-rotated loadings. As can be seen in Table 2, several, but not all, correlations between the factors were relatively high, which supports the use of the total 24-item scale.

For the remainder of the analyses, we computed subscale scores by summing the bolded items in Table 1 for each factor (i.e., we created a simple sum score for each factor, as could be done easily in future work). Correlations between these subscales are presented in Figure 1.

The subscales using the change score (post-pre) all showed acceptable reliability, Cronbach's αs .73 to .75, Ωs = .74 to .80, with the exception of the subscale "Self-evaluation", which had a Cronbach's α of .56, Ω = .64.

Subscale Analyses Pre- and Post-Stress

Descriptive statistics, internal consistencies, and correlations among scales at both pre-and post-stress are presented in Table 3. Correlations between the subscales and the PANAS are presented in Table 4. In line with previous research, stress facets, such as "Distress" or "Worry" were strongly positively correlated with the NA scale of the PANAS, while the invertedly coded scales "Confidence"

[4] The confirmatory factor analysis constraining the model to the three factors from the original SSSQ (Helton & Näswall, 2015) showed that both fit indices indicating incremental fit (CFI = .649; TLI = .611) as well as the fit index for absolute fit (RMSEA = .117) were not adequate for the three-dimensional model ($\chi^2(249, N = 213) = 976.33$, $p < .001$).

Table 2. Factor correlations among the six factors of the SSSQ-G

	Distress	Worry	Confidence	Negative affect	Motivation
Worry	.34				
Confidence	−.36	−.37			
Negative affect	.34	.22	−.30		
Motivation	−.09	−.12	.30	−.17	
Self-evaluation	.12	.24	.01	.06	.03

Note. SSSQ-G = Short Stress State Questionnaire in German.

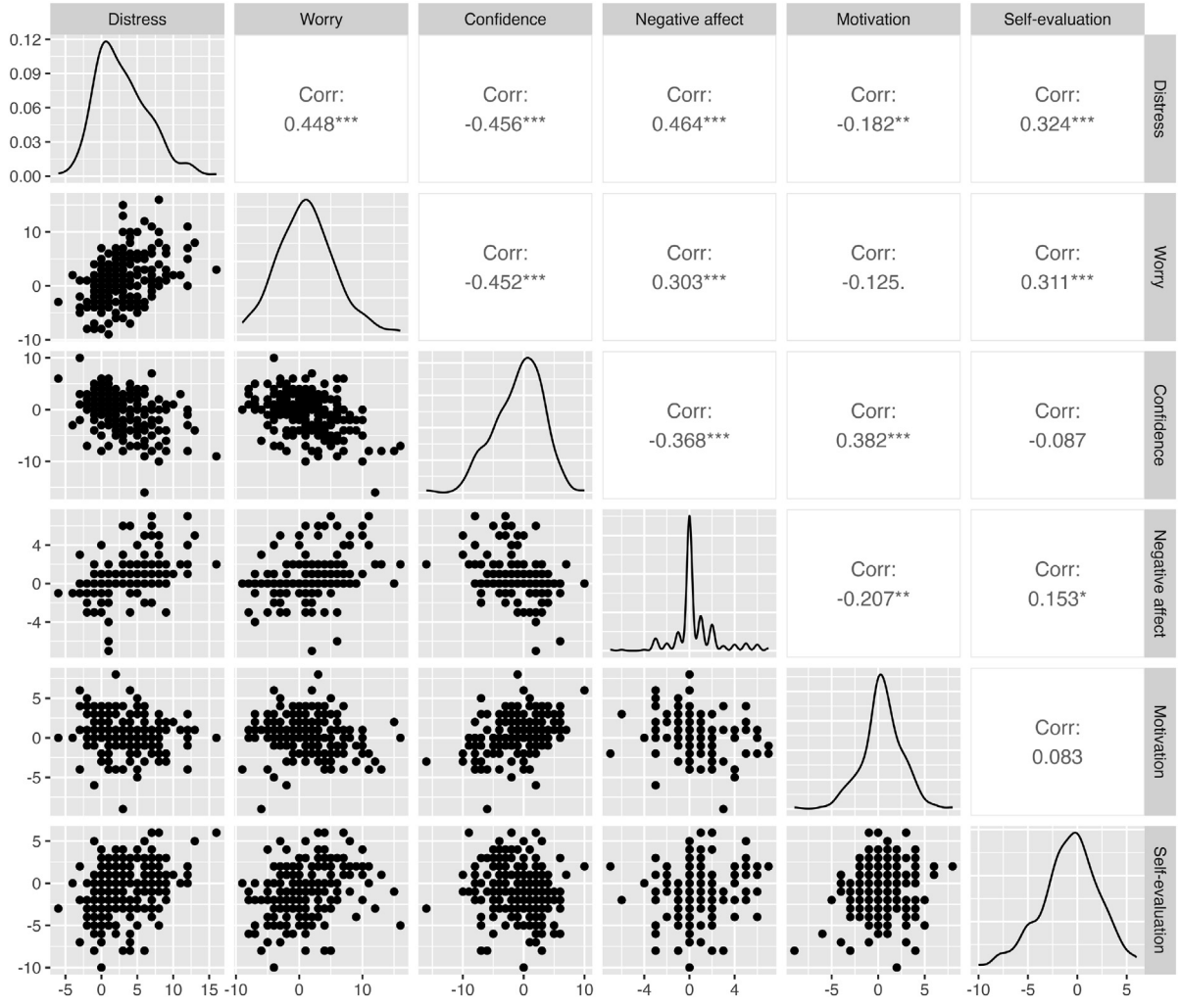

Figure 1. Correlations among the subscales of the Short Stress State Questionnaire in German. Scatter plots, histograms, and correlation coefficients using change scores. Each dot in the scatter plots represents a participant's sum score for the respective factor. Correlation significance: *$p < .05$; **$p < .01$; ***$p < .001$.

and "Motivation" showed a positive relationship with the Positive affect scale (Table 4).

Sensitivity to Stress-Induced Changes

To examine the criterion validity of the SSSQ-G, we assessed the extent to which change scores from pre- to post-stress differed from zero, as well as whether these scores differed across stress induction types (Table 5). We found that the total scale (especially for the TSST participants) and each subscale were sensitive to stress-induced change, indicating criterion validity. Further, we found that the TSST participants showed significantly larger increases in total scale stress-induced changes and that each subscale differed between conditions. The results of these analyses therefore indicate that each subscale assesses stress-relevant subjective states that are sensitive to stress-related change.

Table 3. Descriptive statistics for and correlations between pre- and post-SSSQ-G subscales

		M (*SD*)	α	1	2	3	4	5	6	7	8	9	10	11
1	Pre-Distress	1.3 (0.35)	.60											
2	Pre-Worry	2.1 (0.92)	.84	.31***										
3	Pre-Confidence	3.4 (0.61)	.74	−.10	−.22**									
4	Pre-Negative affect	1.2 (0.41)	.80	.56***	.04	−0.05								
5	Pre-Motivation	3.7 (0.71)	.80	−.12	.15*	.48***	−.12							
6	Pre-Self-evaluation	2.5 (1.00)	.76	.26***	.34***	.19**	.09	.33***						
7	Post-Distress	1.9 (0.73)	.80	**.23*** **	.10	.01	.11	−.01	.00					
8	Post-Worry	2.3 (1.1)	.87	.21**	**.60*** **	−.14*	−.02	.12	.21**	.44***				
9	Post-Confidence	3.2 (0.82)	.81	−.03	−0.1	**.43*** **	.03	.24***	.10	−.41***	−.42***			
10	Post-Negative affect	1.3 (0.55)	.73	.15*	.25***	−0.1	**.07**	.02	.03	.52***	.48***	−.45***		
11	Post-Motivation	3.9 (0.83)	.88	.01	.12	.38***	−.01	**.55*** **	.19**	−.19**	.00	.51***	−.14*	
12	Post-Self-evaluation	2.2 (0.85)	.62	.07	.17*	.13	−.01	.20**	**.47*** **	.25***	.34***	−.05	.17*	.14*

Note. SSSQ-G = Short Stress State Questionnaire in German. The following notation is used to indicate statistical significance: *p < 0.05, **p < 0.01, ***p < 0.001. The bold type indicates prefactor loadings with their corresponding post-factor loadings.

Table 4. Correlations between the pre- and post-scales of the PANAS and the SSSQ-G factors of the 6-factor solution

	PANAS_PA_pre	PANAS_NA_pre	PANAS_PA_post	PANAS_NA_post
PANAS NA_pre	.01			
PANAS PA_post	**.59*** **	.13		
PANAS NA_post	.08	**.30*** **	−.19**	
SSSQ-G Pre-Distress	−.05	.64***	.06	.19**
SSSQ-G Pre-Worry	.00	.43***	.03	.23***
SSSQ-G Pre-Confidence	.67***	−.17*	.44***	.01
SSSQ-G Pre-Negative affect	−.17*	.50***	−.02	.10
SSSQ-G Pre-Motivation	.54***	−.04	.41***	.07
SSSQ-G Pre-Self-evaluation	.34***	.30***	.30***	.18**
SSSQ-G Post-Distress	−.03	.16*	−.29***	.63***
SSSQ-G Post-Worry	.03	.26***	−.13	.62***
SSSQ-G Post-Confidence	.31***	−.02	.63***	−.44***
SSSQ-G Post-Negative affect	−.03	.20**	−.31***	.59***
SSSQ-G Post-Motivation	.37***	.01	.45***	−.15*
SSSQ-G Post-Self-evaluation	.30***	.08	.20**	.35***

Note. PANAS = Positive and Negative Affect Schedule. SSSQ-G = Short Stress State Questionnaire in German. PA = Positive Affect. NA = Negative Affect. The following notation is used to indicate statistical significance: The bold type indicates prefactor loadings with their corresponding post-factor loadings. *p < .05, **p < .01, ***p < .001.

To further examine the criterion validity of the SSSQ-G, we computed a standardized change index, with each person's post-stress value in the SSSQ-G or PANAS negative affect *Z*-scored using the respective variable's premanipulation mean and *SD* (i.e., $[\text{post}_i - M_{\text{pre}}]/SD_{\text{pre}}$ separately for SSSQ-G and PANAS negative affect). This allows us to compare magnitudes of increases across scales using a common metric. Although the VRSR participants did not differ in changes between the PANAS and SSSQ-G, $t(128) = 1.02$, $p = .310$, the TSST participants showed greater standardized increases in subjective stress as indicated by the SSSQ-G ($M = 1.31$, $SE = 0.16$) than standardized increases in negative affect assessed by the PANAS ($M = 1.00$, $SE = 0.15$), $t(83) = 2.70$, $p = .008$. These analyses therefore show that the SSSQ-G is more sensitive to TSST-related changes in subjective states than the PANAS, supporting the use of this scale for future stress work.

Finally, we also conducted an item change analysis, assessing the mean difference in change for each SSSQ-G item within and between the high-stress (i.e., TSST) and low-stress (i.e., VRSR) conditions. These analyses are shown in Appendix C.

Discussion

Taken together, these results show that the SSSQ-G is a reliable and valid scale for assessing acute changes in stress-related states and appraisals. This is the first study evaluating the German translation of the SSSQ. We examined the

Table 5. *T*-tests using SSSQ-G change scores for the whole sample and grouped by induction

	t statistic			
	$All_{post-pre}$	$TSST_{post-pre}$	$VRSR_{post-pre}$	$MDiff_{TSST-VRSR}$
	N = 213	*n* = 84	*n* = 129	*N* = 213
24-item Total Score	4.84***	10.27***	−1.27	9.03***
Distress	11.60***	11.27***	6.50***	5.11***
Worry	3.90***	8.33***	−1.86	8.27***
Confidence	−2.91**	−5.72***	1.20	−5.62***
Negative affect	3.51***	3.76***	1.52	1.97*
Motivation	2.82**	−1.07	5.59***	−3.99***
Self-evaluation	−3.65***	1.51	−6.24***	5.08***

Note. SSSQ-G = Short Stress State Questionnaire in German. M_{diff} = Mean difference. TSST = Trier Social Stress Test. VRSR = Virtual Reality Stroop Room. Items that comprised the Confidence and Motivation scales were reverse coded in the 24-item total score. *$p < .05$, **$p < .01$, ***$p < .001$.

factor structure, reliability, and validity of this scale across five studies that induced stress either by the gold-standard acute stress induction (i.e., the TSST) or by a newer mild stress induction (i.e., the VRSR). The results of this study indicate that the total scale change score of the SSSQ-G is a reliable and valid measure of acute stress-related subjective appraisals and that six interrelated factors underpin total scale change scores. Further, we found that the TSST produced larger change scores on the SSSQ-G than on the PANAS, whereas the VRSR did not differentially influence the two scales. This highlights the relatively greater sensitivity of the SSSQ to moderate-to-severe stress used in most stress studies.

Our results show that the SSSQ-G is a valid and reliable tool for measuring stress changes from pre-task to post-task and allows for analysis of specific facets of stress – namely "Distress", "Worry", "Confidence", "Negative affect", "Motivation", and "Self-evaluation". Therefore, although our data did not support the three-factor structure present in the English SSSQ, the factor solution we obtained still fits within the proposed stress-related trilogy of affect, motivation, and cognition (Helton & Näswall, 2015; Hilgard, 1980).

The subscale change analysis revealed that subscales indexing challenge-related appraisals (e.g., motivation) showed stronger changes from pre- to post-VRSR, whereas subscales indexing more threat-related appraisals (e.g., worry) showed stronger changes from pre- to post-TSST. Both the TSST and VRSR samples displayed a significant change in the general distress factor, which highlights the usefulness of the questionnaire for different stress tasks. Compared to the TSST, the VRSR appears to elicit a less pronounced physiological stress response, while also heightening task engagement and a state of flow (Gradl et al., 2019). Our results capture this difference in stress task quality between the TSST and VRSR.

Although the concept of stress has been under critique for being used too ambiguously (e.g., Epel et al., 2018), recording only physiological measures of stress will not result in a complete understanding of this construct. Stress is more than stress biology, and a full understanding of stress also requires an understanding of people's internal states and circumstances (Kagan, 2016; McEwen, 1998). One questionnaire that is frequently used to assess changes in internal states related to stress is the PANAS. We compared the SSSQ-G to the PANAS and found that the SSSQ-G exhibited greater changes from pre- to post-TSST than the PANAS. Compared to the PANAS, an affect-only measure, the SSSQ-G captures not only affective changes but also cognitive and motivational dimensions, which may be why the SSSQ-G changes were larger in magnitude than the PANAS changes. Thus, we urge further studies to utilize a stress-focused inventory such as the SSSQ(-G) rather than the emotion-focused PANAS when intending to measure stress.

Although this study has a number of strengths in the validation of the German SSSQ, such as the use of standard translation protocols, a large sample size, and the use of gold-standard stress induction, some limitations of this study should be noted. First, self-reporting is always in danger of response bias. However, this holds for questionnaire data in general, and subjective states cannot be assessed outside of self-report. Second, our data show that the SSSQ-G is a highly useful instrument for stress research using moderate-to-severe manipulations like the TSST, but that the total scale may be no more sensitive to more subtle changes, such as emerging in the VRSR, than the PANAS. What is more, the sensitivity to stress-induced changes differs between the VRSR and TSST, which might be because the TSST, as the gold-standard task to induce acute stress, leads to stronger stress reactivity, while the VRSR has a more game-like set-up and thus, does not evoke an as strong stress response as the TSST. Specifically, the changes in "Motivation" and "Self-evaluation" were not significant in the TSST sample, while they were in the VRSR sample. In contrast, the subscales "Worry", "Confidence", and "Negative affect" showed significant changes in the TSST sample, yet not in the sample utilizing the VRSR.

Nevertheless, both the TSST and VRSR samples showed significant changes in "Distress" pre- and post-task, which highlights the usefulness of the SSSQ-G. We surmise that the TSST evokes stronger negative feelings, as opposed to the VRSR, which future studies should address. However, it is important to keep in mind that the study validating the English SSSQ utilized various samples in different contexts, which led to our choice of applying the SSSQ-G in different task contexts as well, to ensure comparability. Researchers therefore must be conscientious when designing stress studies and should ensure that stress, rather than negative affect or arousal, is the latent construct they are measuring. Third, roughly one-third of the study participants completed the gold-standard stress induction task, the TSST, whereas two-thirds of participants completed the VRSR. This heterogeneity might have led to lower internal validity. However, in return, study-specific systematic error (e.g., generated by the experimenters or the task) is much less likely to have contributed to our results than a single-paradigm study, resulting in higher external validity. In other words, because we included five participant samples, which were collected at different points in time, in different contexts, and different studies, the conclusions we make about the SSSQ-G are less likely to be due to study-specific effects (Baribault et al., 2018). However, another participant-related limitation is that the participants were mostly college students in their early twenties. This might have influenced the variance in stress reactivity, which would also explain the floor effects that we found when examining the data on an item-basis (Appendix B), specifically with regard to items concerned with strong negative emotions, such as anger or annoyance. The TSST participants showed significantly larger increases in stress-induced changes in the total scale, and in those scales subsuming negative states. Thus, we conclude that future work should ensure to capture these larger effects by utilizing a task that induces stress, as opposed to addressing related constructs such as mental load or negative affect, specifically when it comes to planning a study to generate a normative sample for the SSSQ-G.

Fourth, the authors of the SSSQ employed a cut-off of .35 for an item to be considered to load on one of the three factors, and kept one item in the final questionnaire, despite a lower loading of .32 on its factor (Helton & Näswall, 2015). Three of our translated items depict loadings on their respective factors below that threshold (.28–.32) and it is noteworthy that the item that loads lowest on its factor (Worry) in the SSSQ, also loads lowest on the same factor in our data. Various possible explanations present themselves: First, our overall sample, which incidentally also is smaller than that of the publication by Helton and Näswall (2015) utilized a gold-standard acute stress task (TSST) and a novel mild stress induction (VRSR). The SSSQ was validated using five separate samples, none inducing acute stress through a standardized stress task in a laboratory context. Second, we conducted the factor analysis using the change score, while the authors of the SSSQ used the pre- and post-scores to determine the three factors postulated in their paper. Third, a 6-factor solution best fits our data, compared to the three factors from the SSSQ. Each of the original three factors was split into two factors in our data: "Distress" and "Negative affect", which form the Distress subscale of the English SSSQ; "Confidence" and "Motivation", which can be summed into the Engagement factor; and "Worry" and "Self-evaluation", which comprise the Worry factor of the SSSQ. These differences between the SSSQ and the SSSQ-G will have contributed to the item loadings being different between the studies. We decided to leave the overall item pool as is for the scope of this manuscript, as other researchers may want to employ the 3-factor solution found by Helton & Näswall (2015), despite our findings.

Future studies should utilize the SSSQ-G in a large sample, preferably also with a wider age distribution, using moderate-to-severe stress inductions, such as the TSST, and attempting to replicate the 6-factor solution that we found in the sample at hand. We further recommend that future studies would not only use the gold-standard task for acute stress induction (TSST) but also a control condition in a within-subject design, to allow a deeper understanding of processes surrounding self-reported changes in task-related stress.

Additionally, we propose the concurrent assessment of wet biomarkers, such as salivary alpha-amylase and cortisol – as well as biosignals, which would allow for a more temporal understanding of the connection of the biological and psychological stress reaction – , both of which would further improve our knowledge of the SSSQ-G's validity. Such work would strengthen conclusions about a possible connection between self-report measures and these psychophysiological measures (Schlotz et al., 2008). Further, establishing age- and gender-specific norms for stress-induced changes under rest and stressful conditions would significantly enhance the utility of the SSSQ-G. Finally, examination of SSSQ-G differences by other stressors – for example, comparing the TSST, cold-pressor test, and the socially evaluated cold-pressor test (Hines & Brown, 1936; Schwabe et al., 2008) – would be a useful future direction for work on the measure.

Conclusion

In summary, the SSSQ-G is a valid and reliable questionnaire for assessing task-related changes in subjective stress. With only 24 items, it is easy to administer, providing an economic instrument for researchers in the field interested

in participants' stress experience. This manuscript provides a detailed analysis of the psychometric properties of this newly translated questionnaire and allows researchers to make an informed decision about how to use and analyze this measure.

Electronic Supplementary Materials

The following electronic supplementary material is available with this article at https://doi.org/10.1027/2512-8442/a000160

ESM 1. Short Stress State Questionnaire in German (SSSQ-G).

ESM 2. Descriptive statistics for SSSQ-G items pre- and post-experiment for the total sample (N = 213).

ESM 3. Item analysis for stress-related SSSQ-G differences (post-pre) in and between TSST and VRSR samples.

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Conflict of Interest
The authors declare no conflicts of interest.

Publication Ethics
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Data and Code used for the analyses in this manuscript can be found at https://osf.io/4sdqv (Ringgold et al., 2024). The SSSQ-G can be found in Appendix A.

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