The World Dangerous it is – The Scrambled Sentences Task in the Context of Posttraumatic Stress Symptoms

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Author Note

Data availability

This study's design was pre-registered and the registration protocol, the anonymized dataset generated and analyzed, as well as the used analysis script and material (excluding standardized questionnaires), are available on the Open Science Framework (OSF) via the following link: <https://osf.io/bnzp3/>

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Conflicts of interest disclosure

We have no known conflicts of interest to disclose.

Ethics approval statement

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Abstract

The Scrambled Sentences Task (SST) is a robust measure of interpretational processes in psychopathology. However, there is little evidence of its utility in measuring dysfunctional appraisals (DAs) of potentially traumatic events. We developed a novel SST for trauma-related DAs and examined its psychometric properties including convergent validity (correlations with PTSD-related symptoms and self-reported DAs), divergent validity (e.g., symptoms of depression and eating disorders) and retest-reliability via an online study. Our sample (T1: $N=214$, T2: $N=145$) included participants who reported a potentially traumatic life event still eliciting distress. We found high correlations between the SST, PTSD-related symptoms ($r=.37-.51$), and self-report measures of DAs ($r=.41-.58$), indicating good convergent validity. Internal consistency (split-half $=.78-.90$) and retest-reliability (ICC(3,1) $=.73-.81$) were also good. However, moderate to large correlations with symptoms of other disorders ($r=.17-.58$) indicated limited divergent validity. Finally, the SST explained unique variance in PTSD-related symptoms above self-report measures of DAs. The results demonstrate the promise of the SST as a valid and reliable tool to assess DAs in the context of potentially traumatic life events. Further research should investigate the transdiagnostic role of trauma-related DAs in psychopathology and the relationship between the SST and self-report measures of DAs.

Keywords: *Dysfunctional appraisals, Interpretation bias, Trauma, PTSD, Scrambled Sentences Task*

The World Dangerous it is – The Scrambled Sentences Task in the Context of Posttraumatic Stress Symptoms

Dysfunctional appraisals (DAs) are a central element in cognitive models of the development and maintenance of Posttraumatic Stress Disorder (PTSD) (Daggleish, 2004; Ehlers & Clark, 2000; Foa et al., 1989). For example, the model of Ehlers & Clark (2000) suggests a causal pathway from DAs of the trauma and its sequelae to other aspects of PTSD, such as a current feeling of threat and reoccurring, intrusive memories of the traumatic event. The key role of DAs in PTSD has been further underscored by the inclusion of negative cognitive changes following a trauma as a criterion in the diagnosis of PTSD in the Diagnostic and Statistical Manual of Mental Disorders – Fifth edition (DSM-5) (American Psychiatric Association, 2013).

Dysfunctional appraisals can be understood as negative evaluations of an event or stimulus. In the context of PTSD, dysfunctional appraisals reflect the patients' idiosyncratic appraisals/beliefs about their reactions to the event and their trauma symptoms. To illustrate, patients may appraise their reactions during the traumatic event as a sign of personal weakness, or consider their intrusive memories as a proof that they are losing control (e.g., Ehlers & Clark, 2000). Accordingly, DAs in the context of PTSD reflect the evaluation of the meaning of a trauma-relevant stimulus, and may involve extrapolations to broader, more wide-ranging themes, with implications for oneself, the world, or one's future. As such, DAs are distinct from other cognitive phenomena in the context of emotional psychopathology, such as interpretation biases. Although interpretation biases are also the product of an evaluative process, they focus more specifically on the evaluation of ambiguous stimuli or situations (cf. Mathews & MacLeod, 2005), and are restricted to narrower themes.

Evidence for a central role of DAs in PTSD comes from several strands of research. To illustrate, studies have found that DAs are associated with symptoms of PTSD, both cross-sectionally (Gómez de La Cuesta et al., 2019), and longitudinally (Bryant & Guthrie, 2005;

Ehring et al., 2008; Kleim et al., 2007). Further, the reduction of DAs during treatment has been shown to predict subsequent symptom reduction, but not vice versa (Brown et al., 2019; Kleim et al., 2013). Additional evidence comes from studies with an experimental focus, e.g., manipulating DAs in order to test their potential causal effect on analog or actual PTSD-related symptoms. For example, Cheung & Bryant (2017) induced DAs about intrusions via informing participants that intrusive memories of distressing films were indicative of poor psychological functioning. This induction in turn led to more frequent intrusive memories of the films than a non-dysfunctional induction (Schartau et al., 2009). Studies using computerized paradigms developed in the context of Cognitive Bias Modification-Appraisal (CBM-App; MacLeod et al., 2009; McNally & Woud, 2019; Woud & Becker, 2014), however, have revealed more mixed findings. One study (Woud et al., 2012) found fewer intrusions of an analog trauma following training aiming to induce a functional (positive) appraisal style compared to training aiming to induce a dysfunctional (negative) appraisal style (positive vs. negative CBM-App). Other studies found an effect only on intrusion distress, with less distress in the positively trained group compared to the negatively trained group (Woud et al., 2013; Woud, Cwik, et al., 2018) or no effects at all on analog trauma symptoms (Vermeulen et al., 2019; Würtz et al., 2021). In a recent randomized controlled trial (RCT) amongst inpatients diagnosed with PTSD the effects of positive CBM-App as an adjunct to treatment as usual were compared to a sham-control training. Positive CBM-App, compared to the control condition, successfully reduced DAs and led to a reduction in PTSD symptoms (Woud et al., 2021). However, in another recent RCT, CBM-App did not reduce DAs in comparison to a neutral control condition, and there was no between-group difference in PTSD symptoms after CBM-App (de Kleine et al., 2019). An important note here is, however, that the latter RCT delivered the CBM-App training online, to outpatients with PTSD while they waited for therapy, and this could partly explain the deviating results.

In summary, there is substantial evidence that DAs are a core feature of PTSD, and this evidence is consistent with the proposal that DAs can causally affect trauma symptoms, supporting key assumptions of cognitive models of PTSD. However, past research has mainly used self-report questionnaires such as the Posttraumatic Cognitions Inventory (PTCI) (Foa et al., 1999) to assess DAs (for exceptions, see Blackwell et al., 2021; Boffa et al., 2018; Lindgren et al., 2013), and it is unclear to what extent this may or may not be a problem. For example, self-report measures are associated with several disadvantages such as response or demand effects (MacLeod et al., 2009). Further, actively evaluating the questionnaires' statements might conceal aspects of DAs that are difficult to verbalize (Brewin et al., 1996), or that are prone to be actively suppressed (Ehlers & Clark, 2000; Rosebrock et al., 2019). Finally, DAs may involve automatically activated counterparts, as assumed by cognitive models (e.g., Ehlers & Clark, 2000), which self-report questionnaires may not be able to capture. The findings of Lindgren et al. (2013), for example, provide some evidence for the idea that self-report measures might not fully capture DAs relevant to PTSD. In their study an indirect measure of DAs based on the reaction time of participants to categorize self-related words as either traumatized or non-traumatized (an implicit association test) explained additional variance in PTSD-related symptoms beyond that explained by a self-report measure of DAs (the PTCI).

Importantly, other research areas in psychopathology are also characterized by such limitations, and this has led to the development of various novel assessment tasks. Such tasks can include e.g., measuring responses to ambiguous stimuli (Hirsch et al., 2016; Schoth & Liossi, 2017). As different kinds of tasks may tap into slightly different aspects of a process under investigation, examining new ways of measuring a phenomenon such as DAs can help in delineating the conditions under which the DA is or is not expressed. Further, having access to a broad range of measures can also provide a form of triangulation, increasing our confidence that results found are robust rather than an artefact of one measurement method

(Munafò & Davey Smith, 2018). One example of a measure with potential utility in the context of DAs and PTSD is the Scrambled Sentences Task (SST) (Wenzlaff & Bates, 1998), which was initially developed to assess interpretational processes in the context of depression. During the SST, participants are instructed to sort words into grammatically correct sentences (e.g., bright the future very dismal looks), and each set of words is designed such that it can be formed into either a disorder-congruent (The future looks very dismal) or -incongruent (The future looks very bright) sentence. To reduce the impact of active evaluation of the chosen words, the SST is applied with a short time limit and participants are simultaneously engaged in a cognitively demanding task, usually retaining a 6-digit number in mind. The SST is most commonly scored by calculating the percentage or proportion of correctly formed sentences that were unscrambled in a disorder-congruent manner. Performance on the SST has been shown to be associated with symptoms of depression (Lee et al., 2016; O'Connor et al., 2021), and to predict a subsequent diagnosis of Major Depression (Rude et al., 2010). Recent research has successfully adapted the stimuli used in the SST to other psychopathology contexts such as Anorexia Nervosa or body dissatisfaction (Bradatsch et al., 2020; Brockmeyer et al., 2018), Paranoia (Savulich et al., 2020), anxiety sensitivity (Zahler et al., 2020), symptoms of social anxiety (de Voogd et al., 2017), Female Sexual Dysfunction (Zahler et al., 2021), or Generalized Anxiety Disorder (Krahé et al., 2022). Across all these studies, the SST score was associated with symptoms of the target disorder, supporting the validity of the SST as a measure of dysfunctional interpretational processes in various disorders. Further, a recent meta-analysis has shown that the average correlation between the SST score and symptoms of the targeted disorder is moderate ($r = .46$ [.41, .51]; Würtz et al., 2022). In addition, there is evidence that the SST is a sensitive measure for the assessment of change in interpretational processes in experimental research using CBM-paradigms in both clinical (Yiend et al., 2014) and analog samples (Bradatsch et al., 2020; Würtz et al., 2022). Finally, the recent study by O'Connor et al., (2021) showed that the SST was strongly

associated with symptoms of depression, even after taking an explicit measure of dysfunctional interpretational processing into account. However, reaction times derived from the Word-Sentence-Association Paradigm, which is another indirect measure and uses reaction times to infer interpretational processing, failed to predict depressive symptoms.

Moving in a more trauma-related direction, the SST has also been successfully adapted to assess DAs in the context of negative life events (Viviani, Mahler, et al., 2018). In the study by Viviani et al., the SST score was associated with questionnaire measures of DAs related to the event and symptoms of depression. However, that SST was specifically designed to be feasible in an fMRI setting and thus differed from the usual version (Viviani, Dommes, et al., 2018). Specifically, participants unscrambled the sentences in their mind to avoid artifacts of hand movement, and no cognitive load was applied since the alternative task instruction already presented a cognitive challenge. Further, the SST stimuli neither referred to a potentially traumatic life event nor targeted directly related cognitions, enabling its application in a sample that was not necessarily exposed to such an event. As such, findings from this study might not be fully generalizable to the SST in its common computerized form or the context of an actual potentially traumatic life event.

To summarize, the SST is a potentially valuable tool to assess DAs in different areas of psychopathology. However, there has only been limited research into its applicability to the kind of DAs relevant to PTSD, that is, DAs in relation to potentially traumatic life events. Given its robust findings in a broad range of disorders, the SST might offer a promising approach also for the assessment of DAs in this context. The current study therefore aimed to develop a novel, computerized version of the SST to assess DAs in relation to a potentially traumatic life event, examining the SST's psychometric properties including its two-week test-retest reliability. A second aim was to test whether the SST would be a useful predictor of PTSD-related symptoms over and above self-report. Finally, considering the necessity for measures in experimental research to assess changes in cognitive processing pre-post a

manipulation, we aimed to develop two parallel SST versions. These were presented in an online study to a sample of participants who reported a potentially traumatic life event that was still causing distress and therefore potentially the object of negative appraisals. Further, we included different questionnaires that were either directly related to PTSD, as measures of convergent validity, or (relatively) unrelated, as measures of divergent validity. To allow an estimation of test-retest reliability, participants were invited to a second assessment session in which we applied the SST again, together with measures of convergent validity.

Our hypotheses were as follows: We expected the SST score to be strongly correlated with both PTSD-related symptoms and DAs measured via self-report (convergent validity). Correlations with measures not directly related to PTSD symptoms, however, were expected to be relatively weak (divergent validity). Further, we expected that the SST would explain unique variance in symptoms, i.e., would be a significant predictor of PTSD-related symptoms after controlling for DAs as measured via self-report and other relevant variables (unique variance)¹.

Methods

Recruitment

Prior to the start of participant recruitment, the study was pre-registered by uploading the study protocol to the Open Science Framework (OSF; <https://osf.io/bnzp3/>). Participants were recruited by distributing the study's link via social media and the participant noticeboard of Ruhr-University Bochum. Inclusion criteria were: Age ≥ 18 and prior exposure to a potentially traumatic life event still causing distress (and therefore being potentially subject to negative appraisals). Participants were included when they rated their current distress caused by the event as ≥ 3 on a 10-point scale ranging from 1 (*not distressing at all*) to 10 (*highly distressing*) (for a similar approach, see (Schartau et al., 2009; Woud et al., 2019). Further,

¹ Unique variance was labeled 'specificity' in the pre-registration. For analyses concerning predictive validity, specified in the pre-registration, see Supplementary Material.

participants could only take part using either a laptop or desktop computer to avoid potential artefacts from the touchscreens of mobile devices. In the study advertisements, participants were informed that high fluency in German (e.g., being a native speaker) was necessary to take part in the study, however, no participants were excluded based on this criterion. Participants received course credit for participation and could take part in a prize draw for a 10€ voucher.

We aimed to recruit a total sample of $N = 170$ for T1, expecting a dropout of $\sim 15\%$ which would have provided a sample of $N = 145$ for T2. This sample size was informed by an a priori power analysis (Erdfelder et al., 2009) aiming to achieve 80% power to find a small to medium effect size ($f^2 = .055$) of a single predictor in a multiple regression model with ten predictors in total at an alpha level of $\alpha = .05$. However, during recruitment it became apparent that the dropout was larger than expected and that some participants would have to be excluded due to technical problems. As a consequence, we recruited a larger sample for T1 than initially planned. Specifically, we did not use the sample size at T1 as a stopping criterion but stopped the recruitment at a time-point when $N = 145$ participants had provided complete data of both T1 and T2. However, after the recruitment was stopped, participants who had already taken part at T1 could still complete T2.

Material

Scrambled Sentences Task (SST)

The SST (Wenzlaff & Bates, 1998) was implemented as a web application programmed using JavaScript on a designated university-based website (Blackwell et al., 2021), and participants completed the SST in their preferred web browser. During the SST, participants were presented with sets of six words and were instructed to sort these into grammatically correct sentences by selecting five of them. Each trial started with a fixation-cross that was presented for 1s in the middle of the screen. After the fixation-cross disappeared, the word set was presented, and participants could sort the words by clicking on

them. After clicking on a word, a number appeared above it, indicating the position of that word in the sentence formed². Participants could not correct their responses. For each trial there was a time limit of 12s and a trial ended automatically either after the time limit or after five words had been clicked on. As in previous studies, the SST was presented with a cognitive load to reduce participants' deliberate evaluation of the presented stimuli: At the start of the SST a 6-digit number was presented for 7s, and participants were instructed to keep the number in mind during the task since they would be asked to recall it afterwards. Stimuli for the two SST versions were created based on the German version of the PTCI (Ehlers, 1999; Foa et al., 1999). Each SST version consisted of 20 stimuli, of which 12 were based on the 'self', six on the 'world', and two on the 'self-blame' subscale of the PTCI. After the initial stimuli development, the sets were independently discussed with two clinicians outside of the study team who were experienced in the treatment of PTSD. Stimuli were then further adapted to resemble typical trauma-related appraisals of PTSD patients. Word sets were designed such that two words were target words of which one had to be omitted to form a grammatically correct sentence. Depending on which word was omitted, the sentence formed represented either a trauma-related functional or dysfunctional appraisal (example for world subscale: "*dangerous* the *safe* is very world" - functional appraisal: the world is very *safe*, or a dysfunctional appraisal: the world is very *dangerous*; target words in italics). The order of the two SST versions was counterbalanced (A first or B first) based on the participant number assigned after providing consent, and the order was the same for T1 and T2 (participants receiving version A first at T1 also received version A first at T2 and vice versa).

² The web application was programmed to be compatible with common web browsers yet was optimized for Mozilla Firefox. In other browsers than Firefox the numbers remained on the screen for a short interval after the buttons disappeared (~ 500ms) yet disappeared before the fixation cross for the next trial. In Firefox, the numbers immediately disappeared with the buttons. However, while we consider this to be a limitation, we do not consider this to be a threat to the validity of the data as all trials were separated by the presentation of a fixation cross (1 s) and thus the attention of participants was directed towards the center of the screen before each trial, irrespective of the used browser. Further, while we found slight differences in the error rates between browsers, SST scores did not differ. For analyses comparing browsers, see Supplementary Material. An improved version of the SST that fixes this issue is available on the OSF alongside the original version used in this study.

After each SST version participants were asked to type in the memorized number, received feedback on whether it was correct, and were invited to take a break. Prior to the first version, five neutral practice trials were presented to make participants familiar with the procedure. During the practice trials, participants were also instructed to keep a 6-digit number in mind which had to be recalled after the practice sentences.

The SST score was calculated by dividing the number of correctly generated, dysfunctional sentences by the total number of correctly formed sentences, resulting in a negativity score between 0 and 1, with higher values indicating a more dysfunctional appraisal style. Grammatically incorrect sentences, sentences formed as questions, and sentences with fewer than five words were counted as errors. A list of correct solutions was uploaded together with the pre-registration. However, some additional correct solutions were added after manual inspection of collected data (all materials including the stimuli, the correct solutions, and the source code of the web application can be found on the OSF (<https://osf.io/bnzp3/>)).

Convergent validity

Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5). PTSD-related symptoms were assessed using the German translation of the PCL-5 (Krüger-Gottschalk et al., 2017; Weathers, Litz, et al., 2013). The PCL-5 consists of 20 items with each item representing a PTSD-symptom as specified in the DSM-5. Participants were instructed to rate how much distress was caused by each symptom in the past two weeks on a 5-point scale ranging from 0 (*not at all*) to 4 (*very strongly*). A total score of ≥ 33 has been suggested as a cut-off for a potential PTSD diagnosis (Krüger-Gottschalk et al., 2017). Internal consistency (Cronbachs' α) was .94 [.93, .95] at T1 and .95 [.94, .97] at T2, and the test-retest reliability was ICC (3, 1) = .79 [.73, .84].

Posttraumatic Cognitions Inventory (PTCI). DAs related to PTSD were assessed via the German version of the PTCI (Ehlers, 1999; Foa et al., 1999). The PTCI consists of 33

statements representing typical PTSD-related appraisals. Participants were instructed to rate their agreement with each statement on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) with higher values indicating more dysfunctional DAs. Internal consistency at T1 was, .94 [.93, .96], and at T2 .96 [.95, .97]. Test-retest reliability was ICC (3, 1) = .83 [.78, .87].

Divergent validity

Quick Inventory of Depressive Symptomatology (QIDS). Symptoms of depression were assessed via the QIDS (Roniger et al., 2015; Rush et al., 2003). This questionnaire consists of 16 items grouped in nine depression-related domains. Each domain consists of one item except for the domains *sleep*, *appetite*, and *psychomotor agitation/restlessness*, consisting of two to four items. Participants rated how strongly they were affected by each symptom in the past week using a 4-point scale ranging from 0 to 3 with higher scores indicating more severe symptoms. The questionnaire is scored by calculating the sum score of each disorder domain, using the highest score for domains with more than one item (Roniger et al., 2015). Total scores of ≤ 5 are indicative of no depression, 6 – 10 of mild, 11 – 15 of moderate, 16 – 20 of severe, and ≥ 21 of very severe depression, respectively (Rush et al., 2003). Internal consistency for the full scale was .83 [.80, .86]³.

Ambiguous Scenarios Test for Depression (AST). Depression-related interpretation biases were assessed using version A of the German AST (Berna et al., 2011; Rohrbacher & Reinecke, 2014). The AST consists of 15 ambiguous scenarios describing everyday life situations, e.g., having an oral examination. Participants were instructed to briefly imagine each scenario and to rate its pleasantness on an 11-point Likert-scale ranging from -5 (*very unpleasant*) to 5 (*very pleasant*), with higher scores indicating a more positive interpretation bias. The AST's internal consistency was .81 [.77, .84].

³ Due to an administration error, for one item (item 11 - self-image) the answer option for '2' was presented for both the answers '2' and '3'. This error was accounted for by recoding answers with the value '3' to '2' (three participants) as the correct option was only presented for the latter.

Acrophobia Questionnaire - Anxiety Subscale (AQ). Fear of heights was assessed via the German translation of the Anxiety subscale of the AQ (Cohen, 1977). The Anxiety subscale consists of 20 height-related items. Participants were instructed to rate how anxious they would feel in each situation using a 7-point Likert-scale ranging from 0 (*not anxious at all*) to 6 (*very anxious*). The AQ's internal consistency was .93 [.91, .94].

Fear of Spiders Screening (FSS). Fear of spiders was assessed via the FSS (Rinck et al., 2002), assessing both fear and avoidance of spiders. The questionnaire consists of 4 statements concerning fear of spiders, associated body symptoms, avoidance, and distress, respectively. Each item is rated on a 7-point Likert-scale ranging from 0 (*does not apply at all*) to 6 (*fully applies*). Internal consistency was .91 [.89, .93].

Eating Disorder Examination Questionnaire (EDEQ). Symptoms of eating disorders in the past four weeks were assessed via the German translation of the EDEQ (Fairburn & Beglin, 1994; Hilbert et al., 2007). The EDEQ is a 28-item scale, consisting of four subscales: *Restrain* (5 items), *Eating concerns* (5 items), *Weight concerns* (5 items), and *Shape concerns* (8 items), and five additional items that are not used in scoring. Participants were instructed to answer each item on a 7-point scale ranging from 0 to 6 with higher scores indicating more severe eating disorder symptoms. The EDEQ is scored by calculating the mean score of each subscale and then calculating the overall mean of all subscales. Internal consistency for the full scale was .96 [.95, .96]⁴.

Additional measures

Demographic data. Participants were first asked to indicate their age and their gender (male, female, or non-binary), and whether they were a native German speaker. Further they were asked to indicate their self-rated language fluency ('*How secure are you in reading German*

⁴ Please note that item 8 is included in both the 'shape concern' and 'weight concern' subscales. Due to an administration error, items 19-21 were not presented to participants. These items are part of the 'Eating concerns' subscale and thus the mean for this subscale was calculated using only 2 items (item 7 and 9).

texts') on a 5-point scale ranging from 0 (*very insecure*) to 4 (*very secure*). Finally, participants were asked for their highest level of formal education.

Life event Checklist for DSM-5 (LEC-5) and distress ratings. Exposure to potentially traumatic negative life events was assessed via the German translation of the LEC-5 (Weathers, Blake, et al., 2013). The LEC-5 is a checklist assessing the exposure to 17 traumatic events following the criteria of DSM-5. For each traumatic event participants were instructed to indicate whether (i) it happened to them, (ii) they witnessed it, (iii) learned about that it happened to someone close, (iv) it happened in an occupational context, (v) they are not sure whether it happened to them, or (vi) they were not exposed to it. For each item, multiple answers were possible, and we scored the LEC by counting the number of events to which participants select another answer than 'not exposed'⁵. Scores on the LEC were calculated to help better characterize the sample in terms of trauma exposure, but not used in analyses. To assess further information about the distressing event, we supplemented the LEC with additional questions. That is, participants were asked to indicate which of the selected events caused the most distress, and when the event happened. Further, they had to rate how much distress the event caused when the event happened, and how distressing the event is now, using a 10-point scale ranging from 1 (*not distressing at all*) to 10 (*highly distressing*).

Procedure

Prior to participation, all participants were informed that they would be asked about a traumatic event during the study and recommended not to take part if they would anticipate experiencing too much distress from questions related to the event. Participants then gave informed consent by completing an online form. Next, they were asked whether they were using a built-in laptop mouse or external mouse to take part in the study. This was followed by the LEC and the additional questions related to the potentially traumatic event. Participants

⁵ When participants indicated that they were not exposed to an event in addition to another option (e.g., by checking both "not sure whether it happened" and "not exposed"), this was still counted as "exposed". This procedure was decided on after data inspection to take all potential traumatic events into account.

who rated their current distress < 3 were excluded from further participation (Schartau et al., 2009; Woud et al., 2019). Subsequently, participants completed the SST, after which they were asked for their e-mail address in order to be able to contact them for the second assessment. Next, participants were directed to another survey platform where the questionnaire measures were administered, in the following order: Demographic data, PTCI, PCL-5, QIDS, AST, EDEQ, AQ, FSS. Two questionnaires assessing resilience and emotion regulation were included at the end of T1 for potential exploratory analyses, however, these are not further analyzed in the present paper (see Supplementary Material for details). Two weeks later, participants received an e-mail containing a link to the second assessment. During this second assessment, participants were asked again to indicate what type of mouse they were using, followed by assessing the current distress caused by the potentially traumatic negative event and the application of the SST. Next, the PTCI and the PCL-5 were completed, again using a separate survey platform. Finally, participants were debriefed, received their course credit, and could enter their information for the prize draw. At the end of each assessment time point, participants were provided with information on an online platform with contact details for (trauma-specialized) psychotherapists. All study procedures were approved by the local ethics committee of the Psychology department at Ruhr-University Bochum (approval number: 596).

Statistical approach

For convergent and divergent validity, bivariate correlations were calculated. However, upon visual inspection, both the SST and questionnaire data were found to be positively skewed and not normally distributed. Therefore, we calculated Spearman's rank correlations with bootstrapped 95%-confidence intervals (CIs; 10,000 resamples) instead of the Pearson correlations planned in the pre-registration, in order to obtain a more robust estimation of the examined associations (de Winter et al., 2016). As the investigation of our hypotheses concerning con- and divergent validity depended on multiple significance tests,

the significance level of $\alpha = .05$ was adjusted via Bonferroni correction and thus was $\alpha = .008$ for convergent validity ($.05 / \text{number of versions (full SST, v. A, v. B)} = 3 \times \text{number of questionnaires (PTCI, PCL)} = 2$) and $\alpha = .003$ for divergent validity ($.05 / \text{number of versions} = 3 \times \text{number of questionnaires (QIDS, AST, EDEQ, FSS, AQ)} = 5$). Whether the SST would explain unique variance in current PTSD-related symptoms above self-report was examined via a series of multiple regression models with the PCL total score of the relevant time point as the outcome. In a first regression step we controlled for basic characteristics of the participants and the event: age, gender (female vs. non-female⁶), distress caused by the negative life event when it occurred, and time passed since the event (in months). In a second step we then added scores on the SST to examine how much variance in PTSD symptoms it explained above these basic variables. In a third step we added scores on the PTCI, allowing us to examine whether SST scores explained additional variance in PTSD symptoms above that explained by self-report DAs. Analyses were run separately for both assessment time points⁷. For all regression models, full models were examined for influential outliers, (standardized residuals > 3 and Cook's distance > 1 , (Field et al., 2012) and multicollinearity (variance inflation factors; VIF). Bootstrapped 95% CIs (10.000 resamples) for regression coefficients were calculated as robustness checks.

In exploratory analyses we investigated Spearman's rank correlations between the PCL-5 and the PTCI and measures of con- and divergent validity at T1 to investigate the association between the symptoms of different disorder domains and compare the results for the SST to those for the PTCI. Further, we analyzed whether participants who dropped out for

⁶ Gender was assessed using 3 categories (female, male, and non-binary/diverse) with one participant in the third category. For the inclusion of Gender as a variable in regression models we therefore collapsed the categories 'male' and 'non-binary' to the category 'non-female' to avoid estimating gender differences based on one data-point.

⁷ We note that in the pre-registered protocol we planned to add both PTCI and QIDS scores together in the third regression step. However, based on reviewer feedback, we noticed that the inclusion of depressive symptoms as a predictor would obscure our conclusions on whether the SST would explain variance beyond self-report in PTSD-related symptoms. We therefore did not include the QIDS as a predictor. Results of the regression including the QIDS as a predictor can be found in the Supplementary material.

T2 differed from participants who did not drop out on their age, self-reported language fluency, number of correct solutions on the SST or their bias score, depressive symptoms, PTSD symptoms, or the PTCI using two-sample t-tests or Welch's tests where appropriate. Finally, we investigated rehearsal effects and differences between the two SST versions. Specifically, we investigated whether participants were more likely to make errors or to form sentences in a dysfunctional way in the first compared to the second application at each timepoint, or on one or other of the versions. This was done by fitting mixed model logistic regression with fixed effects of 'application' (first, second) and 'version' (version A, version B) with random intercepts for 'participant' and 'stimulus'. Outcomes were 'incorrect = 1 vs. correct = 0' and 'dysfunctional = 1 vs. functional = 0', respectively. Models were fitted separately for T1 and T2 data⁸. We further investigated whether participants were more likely to make errors on the SST or to form sentences in a dysfunctional way, based on how many times the SST had already been applied. This was investigated by fitting mixed model logistic regression with the fixed effect 'time' (first, second, third, or fourth application) and random intercepts for 'participant' and 'stimulus' using Maximum Likelihood estimation with the outcomes 'incorrect = 1 vs. correct = 0' and 'negative = 1 vs. positive = 0', respectively. Tukey pairwise post-hoc comparisons were applied. For additional analyses (such as predictive validity analyses and analyses concerning rehearsal effects, the associated statistical approach and the results, see Supplementary Material).

All analyses were run in R version 4.0.0 (R Core Team, 2021) using RStudio version 1.4.1106 (RStudio Team, 2022). Spearman's rank correlations and CIs were calculated using the R-package 'rcompanion' (Mangiafico, 2021) and the package 'stats' (R Core Team, 2021) was used for p-values. Linear regression models were estimated and compared using the package 'stats' and bootstrapped CIs for the regression coefficients were calculated using the

⁸ First, analyses were carried out including also the effect of 'time' (T1, T2) and all two- and three-way interactions. However, due to convergence problems we decided to analyze error rates/negativity rates between versions separately for T1 and T2.

package ‘car’ (Fox & Weisberg, 2019). Mixed model logistic regression was computed using the package ‘lme4’ (Bates et al., 2015) and the package ‘stats’ for CIs. All reliability indices were calculated using the package ‘psych’ (Revelle, 2019).

Results

Sample

In total, $N = 318$ participants took part in T1. Out of these, 83.33% ($N = 265$) rated the current distress caused by the negative life event to be ≥ 3 and were therefore eligible to proceed with the study. Of those, 31 participants then were excluded at T1 as they did not complete any of the questionnaires. Further, two participants were excluded as they dropped out after the demographic questionnaire. Additionally, at T1 a further 14 participants were excluded due to technical difficulties with the saving of the SST data⁹. Finally, we excluded all participants at T1 who formed no grammatically correct sentence in one of the two SST versions (excluding practice trials) (1.83%, $n = 4$ participants) (Hirsch et al., 2020) resulting in a final sample of $N = 214$ for T1. For T2, a total of $N = 158$ participants took part (dropout rate: 31.60% from T1 to T2)¹⁰. Of these, three participants were excluded as they did not answer the questionnaires at T2, and a further nine participants were excluded due to technical difficulties with the saving of the SST data. Finally, one participant (0.7%) was excluded as they did not form a grammatically correct sentence on either one of the SST versions, resulting in a final sample of $N = 145$ for T2¹¹. In total, 3 participants (partially) took part

⁹ The error was found to be associated with the server settings. As all data was generated on the client side, the technical difficulties led to data loss yet did not impair the validity of the data.

¹⁰ The dropout rate was calculated as the percentage of participants who answered at least the PTCI on T1 but did not start the survey on T2.

¹¹ The procedure for excluding participants based on their error rate deviated from the protocol. Based on the laboratory based study by (Brockmeyer et al., 2018), we planned to exclude participants with error rates $> 30\%$ which would have resulted in 33 excluded participants for T1 (15.14%) and 9 for T2 (6.16%). However, after data inspection we decided to apply a more liberal criterion, excluding only participants with no valid trials in one of the SST versions which was similarly applied in other online studies (Hirsch et al., 2020). Results of analyses applying the 30% criterion did not differ from results presented here if not otherwise indicated. For additional results, see Supplementary Material.

twice in the study. Their data of the first participation was included in all analyses, yet data for the second participation was excluded.

On average, participants at T1 reported mild symptoms of depression on the QIDS, $M = 6.59$, $SD = 4.62$, and a subthreshold level of PTSD-related symptoms on the PCL-5, $M = 18.66$, $SD = 15.49$. The most common index event was ‘life-threatening illness’ (19.16%, $n = 41$), followed by ‘other’ (16.36%, $n = 35$), ‘severe human suffering’ (11.21%, $n = 24$), ‘unwanted sexual experiences’ (9.81%, $n = 21$), ‘physical or sexual assault’ (7.94%, $n = 17$, respectively), and ‘sudden accidental death’ or ‘transportation accidents’ (7.01%, $n = 15$, respectively) with each other category being endorsed by fewer than 10 participants. Further, the index event was most commonly personally experienced (39.25%, $n = 84$), followed by witnessed (20.56%, $n = 44$), learned that it happened (12.15%, $n = 26$), happened in an occupational context (2.34%, $n = 5$), or participants were not sure whether the event happened to them (1.87%, $n = 4$). The remaining participants (23.36%, $n = 50$) endorsed multiple exposure forms for the index event, such as that they personally experienced the event but also witnessed it. For sample characteristics including questionnaire data, see Table 1.

Psychometric properties of the SST

Internal consistency at T1 was Split-half [95%-CI] = .88 [.84, .91] for the full SST, .78 [.71, .84] for version A, and .80 [.73, .85] for version B. Internal consistency at T2 was .90 [.86, .93] for the full SST, .80 [.73, .85] for version A, and .82 [.76, .87] for version B. Test-retest reliability (mean re-test interval: 16.39 days¹²) was ICC (3, 1) [95%-CI] = .81 [.75, .85] for the full SST, .75 [.68, .81] for version A, and .73 [.65, .79] for version B. Parallel versions reliability was .71 [.65, .76] for T1 and .84 [.79, .87] for T2. Reliability between versions across time points was the following: For version A at T1 and B at T2, ICC (3,1) [95%-CI] = .75 [.68, .80] and for version B at T1 and A at T2, .67 [.59, .74]. The cognitive load retention

¹² Five participants completed T2 thirty or more days after T1. Repeating the analyses on the test-retest reliability excluding these participants did not affect the results.

rates at T1 were: 77.57% after the practice trials, 50.47% after the first application, 61.68% after the second application, and for T2: 78.62% after the practice trials, 56.55% after the first application, and 57.24% after the second application. Finally, the error rates and thus the rate of excluded trials were the following at T1: 19.15% for the full SST, 16.75% for version A, 21.54% for version B. At T2 the error rates were: 14.40% for the full SST, 13.28% for version A, and 15.52% for version B. For further details on error rates and analyses on stimulus-level, see the section Exploratory analyses and the Supplementary Material.

Convergent validity (T1 and T2) and divergent validity (T1)

As expected, for convergent validity we found that the SST total score was strongly and positively correlated with both the PCL-5, $r_s = .37 - .51$, and the PTCI, $r_s = .41 - .58$, indicating that generating a higher proportion of dysfunctional sentences was associated with both more severe PTSD-related symptoms and a more maladaptive, trauma-related appraisal style. This pattern was found for both assessment time-points, i.e., T1 and T2. Unexpectedly, for divergent validity, we found the SST score to be strongly and positively correlated with the QIDS, $r_s = .40 - .48$, and strongly and negatively correlated with the AST, $r_s = -.58 - -.53$, showing that higher, dysfunctional scores on the SST were associated with more severe depressive symptoms and a more maladaptive, depression-related interpretation bias. For other measures of divergent validity, namely the EDEQ, $r_s = .26 - .30$, the FSS, $r_s = .17 - .24$, and the AQ, $r_s = .29 - .32$, correlations with the SST total score were positive, indicating that higher scores on the SST were associated with more severe symptoms of eating disorders, spider phobia, and fear of heights. However, as expected, these correlations were relatively weak. The pattern of results concerning divergent and convergent validity was the same for the SST total score, version A, and B. For detailed correlations see Table 2.

Unique variance explained at T1 and T2

For T1 we found that in step 1, there were no significant predictors of concurrent PTSD-related symptoms. As expected, adding the SST total score in step 2 significantly

increased the explained variance. Next, in line with our expectations, the SST remained a significant predictor after adding the PTCI total score¹³. Results for T2 mirrored those for T1 as such that the SST was a significant predictor of PTSD-related symptoms and remained significant after including the PTCI total. There were no influential outliers and an investigation of VIFs indicated that the influence of multicollinearity on the model interpretability was negligible (VIFs < 1.85). For details, see Table 3.

Exploratory analyses – PTCI correlations

The PCL was found to be strongly associated with the PTCI and the QIDS, and moderately correlated with the AST, the EDEQ, and the AQ. A weak correlation was found for the FSS. The same pattern of correlations was found for the PTCI. For details, see Table 4. In summary, the pattern of correlations between the PCL, the PTCI and other questionnaire measures followed the same pattern as for the SST.

Exploratory analyses - Analyses of dropout

Further exploratory analyses comparing participants who dropped out for T2 with participants who did not, revealed that they did not differ in age, self-reported language fluency, their SST bias score, or their severity of depressive symptoms. However, participants who dropped out of the study had overall lower rates of correct solutions at T1, slightly higher PTSD symptom levels, and showed higher PTCI scores, compared to those who completed both T1 and T2. For descriptive statistics of analyses as well as results of the significance tests concerning dropout, see Table 5.

Exploratory analyses - Rehearsal effects

In further exploratory analyses we examined rehearsal effects. Investigating error rates at T1, we found that the chance for participants making an error was lower in the second than in the first application of the SST, as indicated by a significant main effect of application, OR

¹³ Applying the pre-registered 30% error-rate exclusion criterion, the SST did not remain a unique predictor of PTSD-related symptoms in step 3 when taking the PTCI into account. However, at T2 results did not differ applying either exclusion criterion.

[95%-CI] = .62 [.46, .81], $SE = .14$, $p = .001$ (error rate first application: 21.92%, second application: 16.38%). This effect did not differ between the two SST versions as indicated by a non-significant main effect of version, $OR = 1.53$ [.62, 3.80], $SE = .46$, $p = .356$, and a non-significant version x application two-way interaction, $OR = 1.01$ [.62, 1.65], $SE = .25$, $p = .968$, (error rate version A: 16.75%, version B: 21.54%). On T2 there were no significant main effects or interactions ($ps > .074$) indicating that error rates did not differ between the first or second application, or between versions (overall error rate: 14.40%).

Investigating the rates of dysfunctional sentences at T1, we found no significant main effects or interactions ($ps > .220$), indicating that the chance that participants generated sentences in a dysfunctional way did not differ between the first and second application (First: 25.94%, Second: 25.23%) or between versions (Dysfunctional sentences: Version A: 25.85%, version B: 25.28%) on T1. The same pattern of results was found for T2 ($ps > .341$, overall percentage of dysfunctional sentences: 27.21%). In summary, we found that on T1 there was an initial decrease in the error rate after the first application. This effect was not found at T2. Further, rates of dysfunctional sentences did not differ between versions or applications within each assessment timepoint.

Investigating error rates across time, we found that participants were more likely to make errors on the SST in the first application (error rate first application: 21.92%), compared to the later applications: Application 2 (error rate: 16.38%), OR [95%-CI] = 1.60 [1.37, 1.87], $SE = .10$, $p < .001$, application 3 (error rate: 14.90%), $OR = 1.63$ [1.35, 1.96], $SE = .12$, $p < .001$, application 4 (error rate: 13.90%), $OR = 1.82$ [1.50, 2.20], $SE = .13$, $p < .001$. However, after the initial decrease the error rate remained relatively stable as indicated by non-significant pairwise comparisons between the other applications ($ps > .310$). We further found that participants were less likely to form negative sentences in application 2 (negativity rate: 25.23%) compared to application 4 (negativity rate: 27.51%), $OR = .83$ [.69, .99], $SE = .06$, $p = .035$. Finally, differences between the other applications were non-significant (negativity

rate application 1: 25.94%, application 3: 26.90%, $ps > .078$) indicating that there was a slight increase in negativity rates between the second application on T1 compared to the second application on T2, but not between the others.

Discussion

The aim of the present study was to develop a novel SST version to assess DAs in the context of potentially traumatic life events, and to examine its psychometric properties in a sample exposed to such an event. Further, we aimed to investigate whether the SST would explain unique variance in concurrent PTSD-related symptoms above self-report. Finally, we aimed to develop two parallel versions of the SST to be used in experimental settings.

As expected, the SST was strongly correlated with both concurrent PTSD-related symptoms and PTSD-related DAs. This pattern was found within both time points, indicating good convergent validity. Concerning divergent validity, we found the expected small correlations with symptoms of eating disorders and specific phobias. However, we also found large correlations with both symptoms of depression as well as with depression-related interpretation biases, thus questioning the SST's divergent validity. Further, the SST was a significant predictor of concurrent PTSD symptoms when taking the PTCI into account, which indicates that the SST could explain variance in PTSD symptoms beyond self-reported DAs. Concerning reliability, we found good internal consistency and test-retest reliability, and consistency between both parallel versions of the SST. In exploratory analyses, we further found that participants made fewer errors on the SST after the repeated application, yet their bias score remained stable.

To summarize, results on the SST's psychometric properties are mostly as expected, and mirror those of the earlier study in the context of negative life events. That is, Viviani, Mahler, et al. (2018) found that the SST was highly correlated with measures of PTSD-related DAs such as the PTCI, however, the association with depression was also strong. Further, our results are in line with those of a recent meta-analysis investigating the psychometric

properties of the SST (Würtz et al., 2022). Here, it was found that the SST generally had good convergent validity as indicated by overall high correlations between the SST and symptoms of the target disorders, yet correlations with unspecific symptom measures were also high. Further, our findings on the SST's reliability are in line with Würtz et al. (2022) as we replicated good internal consistency and retest-reliability. The latter is an important addition to previous research as previous findings on the temporal stability of DAs measured via the SST have been limited to only a small number of studies.

Broadening the scope of our interpretations, our results allow the examination of the SST's divergent validity in relation to the comorbidity of symptoms of certain disorders. While we found the SST to be strongly correlated with both symptoms of PTSD and depression, correlations with specific phobias and eating disorders were overall weaker. Regarding the former, both depression and PTSD are common disorders following a traumatic event and frequently occur comorbidly while sharing common symptom clusters (e.g., concentration problems or negative affect) (Ehring et al., 2006; Lewis et al., 2019; Marmar et al., 2015). Our findings might therefore indicate that this comorbidity could limit the SST's divergent validity specifically in relation to PTSD and depression. Conversely, divergent validity may be better in relation to disorders that co-occur less frequently with PTSD (Mitchell et al., 2012). However, in exploratory analyses we found similar patterns of correlations between the PTCI (and also for the PCL) and measures included for assessing divergent validity, suggesting that the limited divergent validity of the SST (in relation to PTSD vs depression) is not necessarily inherent to the SST itself but may rather reflect a general association between trauma-related DAs and symptoms of this psychopathology following a potentially traumatic life event (Ehring et al., 2006, 2008). Hence, while the aim of our study was to validate an SST assessing DAs specific to PTSD, we interpret our findings as such that our SST may currently be best conceptualized as assessing trauma-related DAs. These DAs in turn are associated with symptoms of PTSD, but also symptoms of

depression. This could be a result of comorbidity and shared symptoms between depression and PTSD. Additionally, although results of a recent network analysis amongst children and adolescents suggest that both syndromes have distinct features, trauma-related DAs were found to be equally associated with both depression and PTSD (de Haan et al., 2020). Future work using a prospective design could investigate the relative specificity of the current SST and the original depression-focused version, or specific subsets of their items, in predicting depression versus PTSD outcomes following potentially traumatic life events (for an approach to investigate the SST's specificity, see Krahé et al., 2022).

Moving on to a further aim of our study, we found preliminary evidence that the SST would predict variance in PTSD-related symptoms beyond self-report as measured via the PTCI. This finding suggests that the SST adds value to the assessment of DAs solely via self-report which is in line with other studies investigating the benefit of non-self-report measures to assess trauma-related DAs (Lindgren et al., 2013) and our results also support the SST's general value in the investigation of DAs and interpretation biases. To illustrate, in the context of depression, the inclusion of the cognitive load appears to provide the SST with benefits over simple self-report (e.g. the SST itself without a cognitive load), for example in predicting a future diagnosis of depression (Rude et al., 2003) or showing differential response to cognitive bias modification vs. CBT (Bowler et al., 2012). One explanation for this is that the cognitive load prevents suppression of dysfunctional cognitions that participants would otherwise engage in. More generally, these findings highlight the potential utility of developing DA assessments that tap into more automatic processes than self-report, such as the SST with a cognitive load, and including them in further studies. This may be particularly relevant for interventional studies where demand effects can be especially strong, or longitudinal studies where there is an interest in measuring an underlying cognitive vulnerability while someone is not currently experiencing symptoms of psychopathology. In

fact, how useful such measures are in different contexts is an empirical question that can only be addressed via including them in a range of different kinds of studies.

Overall, our findings indicate the potential value and utility of the SST as a measure of DAs in the context of potentially traumatic life events or PTSD, particularly when also taking into account the broader literature on assessing dysfunctional interpretational processing in the context of emotional psychopathology. To illustrate, in earlier studies the SST has successfully been applied together with eye-tracking measures enabling the simultaneous investigation of DAs/interpretation biases and attentional biases (Sanchez et al., 2015; Sfürlea et al., 2020). While both types of biases play an important role in PTSD (Bomyea et al., 2017) and emotional psychopathology in general, there is little evidence for their interplay. Hence, applying the SST together with measures of other cognitive biases has the potential to advance the field of PTSD and anxiety-relevant research, by facilitating the investigation of combined cognitive biases, a strain of research that has made important contributions to the investigation of other disorders (i.e. the combined cognitive bias hypothesis, see Everaert et al., 2017). Further, in a recent study (O'Connor et al., 2021), the SST was compared to purely performance-based (indirect) and self-report measures of interpretation biases. Results showed that the SST's correlation with disorder-related symptoms was stronger than for unrelated symptoms. Interestingly, the SST was uncorrelated with fully indirect and only moderately correlated with self-report measures. These results point out that the SST is a highly useful tool for the assessment of interpretational processing, while the SST seems to be neither a fully direct nor indirect measure (O'Connor et al., 2021). While these results were found in the context of depression, further studies should investigate whether similar results concerning the relationship between the SST and other measures of DAs can be found in the context of negative life events and PTSD.

Previous research has also demonstrated the SST's potential to validly assess changes in DAs, e.g., in experimental settings such as in the context of CBM (Bradatsch et al., 2020)

where it has been found that in particular the cognitive load enables the SST to be able to detect effects of CBM training paradigms (Bowler et al., 2012). This potential is further underlined by our promising findings on the psychometric properties of the SST, namely good retest-reliability and the availability of two parallel versions which can be used for the repeated assessment of DAs, and our exploratory findings that although participants make fewer errors after repeated application, their bias score remains stable in absence of a manipulation. This is especially valuable in research on the manipulation of DAs, e.g., in analog or actual trauma. While near-transfer effects, i.e., effects of CBM on an Encoding Recognition Task (Mathews & Mackintosh, 2000) are commonly found, the investigation of far-transfer effects on, for example, symptom measures provides a less consistent picture (Woud, Zlomuzica, et al., 2018; Würtz et al., 2021). This makes it necessary to cross-validate and triangulate current findings across different measures of DAs to shed light on these current issues to potentially open novel routes for the improvement of such paradigms (Munafò & Davey Smith, 2018).

Our results need to be interpreted in the context of a number of limitations. A first limitation to our study is the dropout from T1 to T2 of ~ 30%. While our estimations of test-retest reliability were based on a reasonably sized sub-sample, our findings still need to be interpreted cautiously as a potentially non-random dropout could have influenced the results. As an initial validation study, this study was carried out in an online setting to recruit a large sample. We therefore could not ensure that all participants were highly concentrated during the study, and we could not standardize the application of the SST concerning technical aspects such as screen size, the used mouse and browser. This limitation becomes more apparent considering previously mentioned differences in the presentation of the SST between the web browsers. While we do not consider this difference to be a threat to the validity of our results, which in fact indicate the robustness of the basic task given a potentially sub-optimal implementation, it is possible that a cleaner pattern of results would be found in a more

controlled lab administration of this SST. This limitation becomes also relevant considering the deviation from the pre-registered participant exclusion criterion based on the finding that the error rate was higher than expected. While most results did not differ between our pre-registered (more than 30% errors on the SST) and our post-hoc applied participant exclusion criterion (no valid sentences on the SST), our finding that the SST explains variance beyond the PTCI was only found using the more lenient post-hoc criterion. It is encouraging that a strict accuracy criterion is not required to use the measure, as excluding participants based on a strict error rate criterion poses the risk of reducing the generalizability of results obtained and the utility of the SST as a measure. However, the difference in results that this exclusion criterion made means we have to be more cautious about the robustness of our findings.

Some limitations concern our sample. Using the LEC, we aimed to include only participants who had been exposed to a self-reported, potentially traumatic negative life event, but it is unclear whether these events would always fulfill DSM-5 criteria for a traumatic event. Further, our sample was considerably homogenous, consisting mostly of female participants who were native speakers and finished at least A-level education. Results from this study therefore might not be generalizable to more diverse samples, especially samples less fluent in German. Finally, our sample consisted of participants with on average mild depression and PTSD symptoms on a subclinical level. Our results are therefore potentially not generalizable to participants with higher levels of psychopathology such as patients with PTSD and/or depression. We need to be particularly cautious in relation to the longitudinal data given our exploratory analyses indicating that participants who dropped out made on average more errors and had slightly higher symptoms of PTSD compared to those who completed the study.

In conclusion, we found that the SST for assessing DAs in the context of potentially traumatic life events had good convergent validity, while findings on the divergent validity were more mixed, especially for symptoms of depression. Further results indicated the SST's

capability of explaining variance in PTSD-related symptoms beyond self-report, and its utility was further underlined by our findings of good internal consistency and test-retest reliability. Finally, we found that the two versions were approximately parallel, and applying the SST repeatedly provided a stable assessment of DAs suggesting that the SST is a potentially valuable tool in research on the experimental manipulation of DAs in the context of potentially traumatic life and analog trauma.

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Table 1

Sample characteristics at T1 and T2.

	T1	T2 _b
	Mean (SD, Range)	Mean (SD, Range)
Age	24.95 (5.75, 18-55)	24.77 (5.75, 18-55)
Gender (Female/Male/Non-Binary)	181 / 32 / 1	119 / 24 / 1
Native speaker (Yes/No)	194 / 20	132 / 12
Fluency German	3.76 (.81, 0-4)	3.85 (.64, 0-4)
Education (N)	No degree: 1	No degree: 1
	Secondary school: 8	Secondary school: 8
	A-level: 172	A-level: 114
	Bachelor's degree: 22	Bachelor's degree: 15
	Master's degree: 11	Master's degree: 6
Technical information		
Computer mouse (Laptop/External)	144 / 70	94 / 51
Web browser (Chrome/Firefox/Safari)	96 / 63 / 55	65 / 44 / 36
Counterbalance (AB/BA)	117 / 97	80 / 65
Test-retest interval in days	-	16.39 (5.05, 14-53)
Event information		
T1 Months since event _a	75.08 (66.34, 1-350)	76.65 (65.12, 2-372)
T1 Distress then	8.45 (1.93, 1-10)	8.46 (1.95, 1-10)
T1 Current distress	5.53 (2.06, 3-10)	5.50 (2.04, 3-10)
T2 Current distress	-	4.00 (2.14, 1-9)
LEC sum score _c	7.64 (3.48, 1-17)	7.40 (3.45, 1-17)
Questionnaire measures		
T1 PTCI	78.69 (31.90, 33-182)	76.93 (30.91, 33-220)
T1 PCL	18.66 (15.49, 0-68)	17.95 (15.48, 0-79)
T1 QIDS	6.59 (4.62, 0-23)	6.30 (4.45, 0-21)
T1 AST _d	18.22 (20.56, -36-68)	19.06 (19.18, -36-60)
T1 EDEQ _d	1.56 (1.39, 0-5.62)	1.51 (1.40, 0-5.62)
T1 FSS _d	9.59 (7.67, 0-24)	9.98 (7.44, 0-24)
T1 AQ _d	22.88 (20.13, 0-87)	22.10 (19.83, 0-87)
T2 PTCI	-	78.88 (33.45, 33-202)
T2 PCL	-	17.37 (16.65, 0-75)

Note. a = Information from two participants was excluded due to implausible values as the time since the event exceeded their reported age. b = The exclusion of participants who formed no correct sentences on one of the SST versions was done separately for T1 and T2 thus some participants in the final sample in T2 are excluded in T1. c = For one participant data on the LEC did not save and is therefore missing. d = 1 participant dropped out after the QIDS, and thus the sample for further questionnaires was $N = 213$ at T1. At T2, 1 participant was included who did not answer the questionnaires on T1 and thus demographic data is missing. PTCI = Posttraumatic Cognitions Inventory. PCL = PTSD Checklist for DSM-5. QIDS = Quick Inventory of Depressive Symptomatology – Self-Report. AST = Ambiguous Scenarios Task. EDEQ = Eating Disorder Examination Questionnaire. FSS = Fear of Spiders Screening. AQ = Acrophobia Questionnaire.

SST FOR POSTTRAUMATIC STRESS

Table 2

Bivariate correlations between the SST and questionnaire measures.

	M (range)	SD	PTCI T1	PCL T1	QIDS T1	AST _a T1	EDEQ _a T1	FSS _a T1	AQ _a T1	PTCI T2	PCL T2
T1 SST full	.26 (0 - .77)	.18	.58 [.48, .67]	.51 [.39, .61]	.48 [.36, .59]	-.58 [-.68, -.47]	.30 [.16, .42]	.24 [.11, .37]	.32 [.18, .45]	.50 _b [.35, .62]	.45 _b [.30, .58]
T1 SST v. A	.26 (0 - .73)	.19	.56 [.44, .65]	.50 [.39, .61]	.49 [.37, .60]	-.53 [-.63, -.42]	.30 [.17, .42]	.23 [.10, .36]	.30 [.16, .42]	.50 _b [.36, .63]	.47 _b [.33, .59]
T1 SST v. B	.26 (0 - .92)	.20	.51 [.40, .61]	.43 [.31, .54]	.40 [.28, .52]	-.55 [-.64, -.45]	.26 [.12, .38]	.17 [.05, .30]	.29 [.15, .41]	.41 _b [.25, .54]	.37 _b [.21, .51]
T2 SST full	.27 (0 - .83)	.20	-	-	-	-	-	-	-	.57 [.43, .68]	.56 [.43, .67]
T2 SST v. A	.27 (0 - .83)	.20	-	-	-	-	-	-	-	.52 [.37, .64]	.53 [.39, .65]
T2 SST v. B	.27 (0 - .89)	.21	-	-	-	-	-	-	-	.56 [.42, .67]	.53 [.41, .65]

Note. Spearman correlations with bootstrapped 95% CIs are presented. For T1, the sample size is $N = 214$, a: $N = 213$, for T2, the sample size is $N = 145$, b: $N = 143$. All correlations $> .17$ are significant after correcting for multiple testing while the correlation $= .17$ did not remain significant. SST = Scrambled Sentences Task. v. = version., PTCI = Posttraumatic Cognitions Inventory. PCL = PTSD Checklist for DSM-5. QIDS = Quick Inventory of Depressive Symptomatology – Self-Report. AST = Ambiguous Scenarios Task. EDEQ = Eating Disorder Examination Questionnaire. FSS = Fear of Spiders Screening. AQ = Acrophobia Questionnaire.

SST FOR POSTTRAUMATIC STRESS

Table 3

Results of stepwise multiple regression testing the unique variance on the concurrent PCL explained by the SST.

T1						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
Step 1	$R^2_{adj} = .01$					.234
Age	-.16 [-.43, .16]	.19	-.06 [-.20, .08]	.07	.85	.398
Gender (Non-Female)	-3.05 [-7.61, 3.52]	2.95	-.20 [-.57, .18]	.19	1.03	.302
Event distress then	1.04 [-.05, 1.99]	.56	.13 [-.01, .27]	.07	1.86	.064
Months since event	.00 [-.02, .03]	.01	.01 [-.13, .15]	.07	.09	.928
Step 2	$\Delta R^2_{adj} = .30$					
Age	.04 [-.23, .33]	.16	.02 [-.10, .13]	.06	.27	.785
Gender (Non-Female)	-.39 [-4.90, 5.55]	2.47	-.03 [-.34, .29]	.16	.16	.876
Event distress then	.57 [-.34, 1.42]	.47	.07 [-.04, .19]	.06	1.22	.223
Months since event	.00 [-.02, .03]	.01	.01 [-.10, .13]	.06	.23	.817
SST total score (T1)	48.52 [36.69, 60.16]	5.02	.56 [.45, .68]	.06	9.67	< .001
Step 3	$\Delta R^2_{adj} = .24$					< .001
Age	-.19 [-.43, .07]	.13	-.07 [-.16, .02]	.05	1.46	.145
Gender (Non-Female)	-.26 [-2.93, 3.01]	1.99	-.02 [-.27, .24]	.13	.13	.896
Event distress then	.88 [.27, 1.56]	.38	.11 [.02, .20]	.05	2.33	.021
Months since event	.01 [-.01, .03]	.01	.03 [-.07, .12]	.05	.60	.550
SST total score (T1)	13.70 [2.96, 26.30]	5.18	.16 [.04, .28]	.06	2.65	.009
PTCI total score (T1)	.31 [.24, .37]	.03	.63 [.52, .75]	.06	10.72	< .001
T2						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
Step 1	$R^2_{adj} = .00$					.373
Age	-.25 [-.60, .23]	.25	-.09 [-.26, .08]	.09	1.02	.308
Gender (Non-Female)	.93 [-7.06, 8.71]	3.70	-.06 [-.49, .38]	.22	.25	.803
Event distress then	1.28 [-.12, 2.49]	.73	.15 [-.02, .32]	.09	1.75	.083
Months since event	.02 [-.01, .07]	.02	.09 [-.08, .26]	.09	1.00	.318
Step 2	$\Delta R^2_{adj} = .36$					< .001

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Age	.09 [-.20, .46]	.20	.03 [-.11, .17]	.07	.45	.654
Gender (Non-Female)	3.21 [-2.83, 11.23]	3.00	.19 [-.16, .55]	.18	1.07	.286
Event distress then	.65 [-.39, 1.63]	.59	.08 [-.06, .21]	.07	1.10	.272
Months since event	.02 [.00, .06]	.01	.12 [-.02, .25]	.07	1.69	.094
SST total score (T2)	52.89 [40.65, 66.47]	5.95	.62 [.48, .76]	.07	8.88	< .001
Step 3	$\Delta R^2_{adj} = .28$					< .001
Age	-.15 [-.42, .13]	.15	-.05 [-.16, .05]	.05	.97	.332
Gender (Non-Female)	.39 [-3.74, 7.58]	2.27	.02 [-.25, .29]	.14	.17	.863
Event distress then	.65 [-.03, 1.45]	.44	.08 [-.03, .18]	.05	1.47	.143
Months since event	.02 [.00, .04]	.01	.09 [-.02, .19]	.05	1.64	.103
SST total score (T2)	14.51 [3.24, 29.79]	5.83	.17 [.03, .31]	.07	2.49	.014
PTCI total score (T2)	.34 [.26, .40]	.03	.68 [.55, .81]	.07	10.31	< .001

Note. CIs for B are bootstrapped. T1: $N = 214$, T2: $N = 144$ (for T2, one participant was excluded due to missing values on 'Age' and 'Gender'). QIDS = Quick Inventory of Depressive Symptomatology - Self-Report. PTCI = Posttraumatic Cognitions Inventory. SST = Scrambled Sentences Task score across both versions.

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Table 4

Exploratory analyses of associations between the PCL-5, the PTCI, and divergent validity measures.

	PCL T1	PTCI T1
PCL T1	-	-
PTCI T1	.75 [.67, .81]	-
QIDS	.66 [.57, .74]	.64 [.55, .72]
AST _a	-.31 [-.44, -.17]	-.41 [-.53, -.28]
EDEQ _a	.37 [.25, .49]	.34 [.22, .46]
FSS _a	.18 [.06, .31]	.17 [.04, .30]
AQ _a	.34 [.21, .46]	.33 [.19, .45]

Note. Bivariate Spearman's correlations are presented. a: $N = 213$. All correlations are statistically significant at $p < .001$, with the exception of those with $r = .18$ and $r = .17$, which are statistically significant at $p < .01$ and $p < .05$, respectively. PTCI = Posttraumatic Cognitions Inventory. PCL = PTSD Checklist for DSM-5. QIDS = Quick Inventory of Depressive Symptomatology – Self-Report. AST = Ambiguous Scenarios Task. EDEQ = Eating Disorder Examination Questionnaire. FSS = Fear of Spiders Screening. AQ = Acrophobia Questionnaire.

Table 5

Descriptive statistics for the analyses of participants who dropped out.

Measure	Dropout ($N = 68$) Mean (SD)	No dropout ($N = 146$) Mean (SD)	t (df)	d [95%-CI]	p
Age	25.46 (6.09)	24.72 (5.58)	$t(121.08) = .85$	.13 [-.16, .42]	.400
Fluency German	3.60 (.99)	3.83 (.71)	$t(99.80) = 1.68$	.28 [-.01, .57]	.095
SST total score	.28 (.19)	.24 (.17)	$t(121.54) = 1.39$	.21 [-.08, .50]	.168
QIDS total score	7.34 (5.15)	6.24 (4.33)	$t(112.66) = 1.53$	.24 [-.05, .53]	.130
Number correct solutions full SST	30.87 (6.19)	33.03 (3.99)	$t(93.81) = 2.63$	.45 [.15, .75]	.010
PCL-5 total score	22.03 (17.09)	17.09 (14.47)	$t(113.38) = 2.06$	.32 [.03, .62]	.041
PTCI total score	86.25 (38.19)	75.17 (27.96)	$t(101.69) = 2.14$	.35 [.06, .65]	.035

Supplementary Material

The World Dangerous it is – The Scrambled Sentences Task in the Context of Posttraumatic Stress Symptoms

Supplementary Methods

Material

Resilience Scale – 11 (RS-11). Psychological resilience was assessed via the German translation of the RS-11 (Schumacher et al., 2005; Wagnild & Young, 1993) as a variable potentially associated with the association between PTSD-related DAs and PTSD-related symptoms. The RS-11 consists of 11 statements related to resilience and participants were instructed to rate each item on a 7-item scale ranging from 1 (*I do not agree*) to 7 (*I fully agree*). We found good internal consistency with α [95%-CI] = .89 [.87, .91].

Emotion Regulation Questionnaire (ERQ). Emotion regulation was assessed via the German translation of the ERQ (Abler & Kessler, 2009; Gross & John, 2003). This variable was also included as a potential factor associated with the relationship between PTSD-related DAs and PTSD-related symptoms. The ERQ consists of 10 items assessing emotion regulation with 6 items assessing the regulation strategy *reappraisal* and the remaining 4 items assessing the strategy *suppression*. Participants were instructed to rate each item on a 7-point scale ranging from 1 (*does not apply at all*) to 7 (*fully applies*). We found the internal consistency to be ranging from α = .71 [.65, .77] for the suppression subscale to α = .82 [.78, .86] for the reappraisal subscale.

Statistical approach

Reliability calculations. Both test-retest reliability and parallel forms reliability were estimated by computing intraclass correlations (ICC(3, 1)), using SST indices of the different

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versions of the same time point for parallel forms, indices of the same version at different time points for test-retest reliability, and indices of different versions at different time points for cross-formed reliability (Parsons et al., 2019). Here, we calculated ICCs instead of the pre-registered Pearson correlations as measures of consistency due to their superiority in case of potential rehearsal effects (Parsons et al., 2019). Internal consistency was calculated as split-half reliability using 10,000 random split-half samples and erroneous trials (i.e., grammatical errors, fewer than five words, sentences formed to be questions) were coded as missing.

Statistical approach for supplemental results

Unique variance controlling for depression

In addition to the analyses on unique variance explained via the SST that were reported in the main paper, we ran a step-wise regression model adding depressive symptoms as a predictor in a final step. This model was more similar to the pre-registration than the analyses reported in the main paper as we planned to include both the PTCI and the QIDS in a third step. However, upon reflection we noticed that this procedure would confound our aims to test whether the SST would explain variance in PTSD-related symptoms beyond self-report by also including depression in the same step. We therefore added depressive symptoms as measured via the QIDS at T1 in the final step.

Predictive validity

Predictive validity, i.e., the prediction of PTSD-related symptoms and DAs at T2 by the SST score at T1, was tested by first estimating zero order correlations between the SST at T1 and the PTCI total score and PCL total score at T2 to test whether the SST at T1 would be correlated with symptoms and DAs at T2. We then conducted multiple regression models separately for the outcomes PCL total score at T2 and PTCI total score at T2, with each regression including initial symptom levels and other relevant variables as predictors to test whether the SST would explain unique variance of symptoms and DAs at T2 (see Supplementary results section for full details).

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Exploratory analyses of rehearsal effects

Analyses concerning browser differences

Due to the difference in the presentation of the numbers in Chrome compared to other browsers (see main paper for details), we compared error rates and SST scores for the three browsers using 3x1 ANOVAS (Browser: Chrome, Firefox, Safari) using the package ‘afex’ (Singman et al., 2020). Analyses were carried out separately for T1 and T2, and significant effects were followed-up by pairwise Tukey comparisons.

Exploratory correlations

In further exploratory analyses we analyzed associations (Spearman’s rank correlations) between the rates of correctly unscrambled sentences at T1 with variables of interest, such as variables related to the negative life event, depressive symptoms, and language fluency. Finally, we compared the rate of correctly unscrambled sentences at T1 between native and non-native German speakers using an independent samples Welch-test.

Analyses including the pre-registered exclusion criterion

Further, all main analyses in the main paper were repeated applying the pre-registered participant exclusion criterion of error rates > 30%. For details on analyses, see section ‘Statistical approach’ in the main paper.

Supplementary Results

Supplementary results of analyses using the same sample as in the main paper

Unique variance controlling for depression

Results from step 1-3 are the same as in the main paper, namely the SST explained variance beyond self-report at T1 and T2, as indicated by the SST being a significant predictor after entering the PTCI. However, entering the QIDS in a fourth step showed that

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the QIDS was another significant predictor of PTSD-related symptoms at T1 and T2, as well as the PTCI, yet the SST did not remain significant. For details, see Table S1.

Our original aim in our plan to include the QIDS as a predictor in the regression was to investigate specificity of the relationship between the SST and PTSD symptoms but following reviewer comments and further reflection, we realized that these results were difficult to interpret given the overlap between PTSD and depression symptoms. Hence, we omitted this step in the main paper, but report it here for transparency.

Predictive validity for symptoms from T1 to T2

Zero order correlations between the SST at T1, and both the PTCI and PCL at T2 were positive and ranged from moderate to large, indicating that higher dysfunctional SST scores at T1 were associated with a more maladaptive appraisal style and more severe PTSD-related symptoms at T2 (see Table 2 in the main paper). However, when investigating the SST at T1 as a predictor of PCL scores at T2 including other variables, we found that only the PCL at T1 and the QIDS-SR were significant predictors, indicating that more severe initial PTSD-related symptoms and depression were associated with more severe PTSD-related symptoms two weeks later. Unexpectedly, DAs measured at T1 via both the PTCI and the SST did not predict PCL total scores at T2 above the other included predictors.

Predicting PTCI scores at T2, we found a corresponding pattern scores with only the PTCI score and the QIDS-SR measured at T1 being significant predictors which indicated that a more dysfunctional appraisal style as well as more severe depressive symptoms at T1 were associated with a more dysfunctional appraisal style at T2. However, neither the PCL score nor the SST at T1 were significant predictors in the model. See Table S2 for details.

Exploratory analyses – Browsers

On T1, participants using other browsers than Firefox were found to form fewer correct sentences on the SST than Firefox users (Firefox: $M = 33.94$, $SD = 3.51$), Safari vs.

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Firefox (Safari: $M = 31.82$, $SD = 5.22$): $t(211) = 2.39$, $p = .046$, $d = .43$ [.07, .80], Chrome vs. Firefox (Chrome: $M = 31.59$, $SD = 5.26$): $t(211) = 3.01$, $p = .008$, $d = .48$ [.15, .81].

Participants who used Chrome did not differ from participants using Safari $t(211) = .28$, $p = .960$, $d = .05$ [-.28, .37]. On T2, there was no difference in the number of correct sentences on the SST between Chrome ($M = 33.98$, $SD = 4.03$) and Firefox users ($M = 35.84$, $SD = 3.24$), $t(142) = 2.30$, $p = .059$, $d = .44$ [.05, .82]. However, the difference between Firefox and Safari users ($M = 32.75$, $SD = 5.17$) was significant, $t(142) = 3.33$, $p = .003$, $d = .72$ [.27, 1.18], indicating fewer correct sentences formed by participants using Safari than Firefox.

Importantly, participants did not differ in their SST scores as indicated by non-significant pairwise comparisons between browsers on T1 ($ts(211) < 2.21$, $ps > .072$, $ds < .41$) and T2 ($ts(142) < 1.84$, $ps > .161$, $ds < .36$).

In summary, we found that participants using Firefox made slightly fewer errors compared to the other browsers on T1, on T2 this difference was only found comparing Safari users to Firefox users. However, SST scores did not differ between the browsers neither on T1 or T2.

Exploratory analyses of error rates

We did not find significant associations between the number of correctly formed sentences on the SST at T1 and the variables of interest at T1, namely the PTCI, r_s [95%-CI] = $-.03$ [-.16, .11], $p = .704$, the PCL, $r_s = -.11$ [-.25, .02], $p = .095$, current event distress, $r_s = -.01$ [-.15, .13], $p = .885$, time since the event, $r_s = .04$ [-.09, .18], $p = .516$, or the QIDS, $r_s = .13$ [.00, .25], $p = .055$, indicating that there was no association between the number of

correctly unscrambled sentences and trauma-related variables or symptoms of depression.

However, we found that the self-reported language fluency was positively associated with the number of correctly unscrambled sentences on the SST $r_s = .19$ [.02, .34], $p = .005$, indicating that a higher self-reported language fluency was associated with more correctly unscrambled sentences on the SST. Further, we found that native speakers ($M = 32.86$, $SD = 4.32$) formed

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significantly more correct sentences than non-native speakers ($M = 27.35$, $SD = 7.06$), $t(20.49) = 3.42$, $p = .003$, $d = 1.19$ [.72, 1.67].

Exploratory analyses – 30% error criterion applied to the main analyses

Sample

Excluding participants who made more than 30% errors in the full SST led to the exclusion of 33 (15.14%) participants at T1 and of 9 (6.16%) participants at T2 based on their error rate. The analyzed sample therefore consisted of $N = 185$ at T1 and $N = 137$ at T2. For details on the exclusion of participants based on other criteria, see main paper.

Convergent and divergent validity.

The pattern of correlations between the SST and measures of con- and divergent validity did not deviate from the pattern reported in the main paper. For details, see Table S3.

Unique variance

As in the main paper, the SST was a significant predictor of concurrent PCL scores in step 2 at both T1 and T2. Further, at T2 results applying the 30%-error rate exclusion criterion mirrored those in the main paper. However, at T1 the SST total score did not remain significant when entering the PTCI in step. For details, see Table S4.

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Table S1

Results of stepwise multiple regression testing the unique variance on the concurrent PCL explained by the SST including depression as a predictor.

T1						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
Step 1	$R^2_{adj} = .01$					.234
Age	-.16 [-.43, .16]	.19	-.06 [-.20, .08]	.07	.85	.398
Gender (Non-Female)	-3.05 [-7.61, 3.52]	2.95	-.20 [-.57, .18]	.19	1.03	.302
Event distress then	1.04 [-.05, 1.99]	.56	.13 [-.01, .27]	.07	1.86	.064
Months since event	.00 [-.02, .03]	.01	.01 [-.13, .15]	.07	.09	.928
Step 2	$\Delta R^2_{adj} = .30$					
Age	.04 [-.23, .33]	.16	.02 [-.10, .13]	.06	.27	.785
Gender (Non-Female)	-.39 [-4.90, 5.55]	2.47	-.03 [-.34, .29]	.16	.16	.876
Event distress then	.57 [-.34, 1.42]	.47	.07 [-.04, .19]	.06	1.22	.223
Months since event	.00 [-.02, .03]	.01	.01 [-.10, .13]	.06	.23	.817
SST total score (T1)	48.52 [36.69, 60.16]	5.02	.56 [.45, .68]	.06	9.67	< .001

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Step 3	$\Delta R^2_{adj} = .24$					< .001
Age	-0.19 [-0.43, .07]	.13	-0.07 [-0.16, .02]	.05	1.46	.145
Gender (Non-Female)	-.26 [-2.93, 3.01]	1.99	-.02 [-.27, .24]	.13	.13	.896
Event distress then	.88 [.27, 1.56]	.38	.11 [.02, .20]	.05	2.33	.021
Months since event	.01 [-.01, .03]	.01	.03 [-.07, .12]	.05	.60	.550
SST total score (T1)	13.70 [2.96, 26.30]	5.18	.16 [.04, .28]	.06	2.65	.009
PTCI total score (T1)	.31 [.24, .37]	.03	.63 [.52, .75]	.06	10.72	< .001
Step 4	$\Delta R^2_{adj} = .08$					< .001
Age	-.18 [-.40, .05]	.12	-.07 [-.15, .02]	.04	1.57	.117
Gender (Non-Female)	1.66 [-.89, 4.94]	1.82	.11 [-.12, .34]	.12	.91	.362
Event distress then	.77 [.19, 1.35]	.34	.10 [.01, .18]	.04	2.26	.025
Months since event	.01 [.00, .03]	.01	.06 [-.03, .14]	.04	1.39	.168
SST total score (T1)	6.60 [-3.70, 18.12]	4.80	.08 [-.03, .19]	.06	1.38	.170
PTCI total score (T1)	.21 [.14, .28]	.03	.44 [.32, .55]	.06	7.22	< .001
QIDS total score (T1)	1.30 [.95, 1.63]	.19	.39 [.28, .50]	.06	6.87	< .001

T2

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Predictor	B [95%-CI]	SE_B	β [95%-CI]	SE_β	t	p
Step 1	$R^2_{adj} = .00$					.373
Age	-.25 [-.60, .23]	.25	-.09 [-.26, .08]	.09	1.02	.308
Gender (Non-Female)	.93 [-7.06, 8.71]	3.70	-.06 [-.49, .38]	.22	.25	.803
Event distress then	1.28 [-.12, 2.49]	.73	.15 [-.02, .32]	.09	1.75	.083
Months since event	.02 [-.01, .07]	.02	.09 [-.08, .26]	.09	1.00	.318
Step 2	$\Delta R^2_{adj} = .36$					< .001
Age	.09 [-.20, .46]	.20	.03 [-.11, .17]	.07	.45	.654
Gender (Non-Female)	3.21 [-2.83, 11.23]	3.00	.19 [-.16, .55]	.18	1.07	.286
Event distress then	.65 [-.39, 1.63]	.59	.08 [-.06, .21]	.07	1.10	.272
Months since event	.02 [.00, .06]	.01	.12 [-.02, .25]	.07	1.69	.094
SST total score (T2)	52.89 [40.65, 66.47]	5.95	.62 [.48, .76]	.07	8.88	< .001
Step 3	$\Delta R^2_{adj} = .28$					< .001
Age	-.15 [-.42, .13]	.15	-.05 [-.16, .05]	.05	.97	.332
Gender (Non-Female)	.39 [-3.74, 7.58]	2.27	.02 [-.25, .29]	.14	.17	.863
Event distress then	.65 [-.03, 1.45]	.44	.08 [-.03, .18]	.05	1.47	.143

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Months since event	.02 [.00, .04]	.01	.09 [-.02, .19]	.05	1.64	.103
SST total score (T2)	14.51 [3.24, 29.79]	5.83	.17 [.03, .31]	.07	2.49	.014
PTCI total score (T2)	.34 [.26, .40]	.03	.68 [.55, .81]	.07	10.31	< .001
Step 4	$\Delta R^2_{adj} = .07$					< .001
Age	-.18 [-.45, .10]	.14	-.06 [-.16, .03]	.05	1.32	.188
Gender (Non-Female)	2.84 [-1.13, 10.52]	2.10	.17 [-.08, .42]	.13	1.36	.177
Event distress then	.33 [-.34, 1.02]	.41	.04 [-.06, .13]	.05	.81	.421
Months since event	.02 [.00, .04]	.01	.09 [-.01, .18]	.05	1.86	.065
SST total score (T2)	7.63 [-2.13, 19.93]	5.40	.09 [-.04, .21]	.06	1.41	.160
PTCI total score (T2)	.25 [.17, .32]	.03	.50 [.37, .64]	.07	7.55	< .001
QIDS total score (T1)	1.35 [.83, 1.94]	.24	.36 [.23, .48]	.06	5.67	< .001

Note. CIs for B are bootstrapped. T1: $N = 214$, T2: $N = 144$ (for T2, one participant was excluded due to missing values on 'Age' and 'Gender'). QIDS = Quick Inventory of Depressive Symptomatology - Self-Report. PTCI = Posttraumatic Cognitions Inventory. SST = Scrambled Sentences Task score across both versions.

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Table S2

Prediction of PTSD symptoms and related DAs at T2.

T2 PCL						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
$R^2_{adj} = .65$						< .001
Age	-.11 [-.40, .17]	.15	-.04 [-.15, .06]	.05	.79	.433
Gender (Non-Female)	1.57 [-2.54, 5.18]	2.16	.10 [-.18, .38]	.14	.73	.468
Event distress then (T1)	-.20 [-1.10, .58]	.42	-.03 [-.13, .08]	.05	.48	.630
Months since event	.02 [.00, .04]	.01	.08 [-.02, .18]	.05	1.54	.127
QIDS (T1)	1.21 [.63, 1.83]	.28	.34 [.18, .50]	.08	4.29	< .001
PCL total score (T1)	.52 [.26, .76]	.10	.49 [.31, .68]	.09	5.35	< .001
PTCI total score (T1)	.03 [-.07, .14]	.05	.05 [-.12, .22]	.09	.56	.580
SST total score (T1)	.80 [-10.69, 12.15]	6.21	.01 [-.13, .15]	.07	.13	.898
T2 PTCI						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
$R^2_{adj} = .66$						< .001
Age	-.12 [-.61, .42]	.29	-.02 [-.12, .08]	.05	.39	.694
Gender (Non-Female)	7.67 [-.88, 16.12]	4.38	.24 [-.03, .51]	.14	1.75	.082
Event distress then (T1)	-.64 [-2.51, .97]	.85	-.04 [-.14, .06]	.05	.75	.454

SST FOR POSTTRAUMATIC STRESS

Months since event	.01 [-.03, .06]	.02	.04 [-.07, .14]	.05	.71	.479
QIDS (T1)	1.53 [.50, 2.58]	.57	.21 [.05, .36]	.08	2.68	.008
PCL total score (T1)	.00 [-.33, .41]	.20	.00 [-.18, .18]	.09	.02	.987
PTCI total score (T1)	.80 [.61, .98]	.10	.69 [.53, .86]	.08	8.24	< .001
SST total score (T1)	-.60 [-24.92, 23.79]	12.58	.00 [-.14, .13]	.07	.05	.962

Note. Confidence intervals for B are bootstrapped. $N = 138$. Only participants with valid trials on the SST at T1 and T2 and without missing questionnaire data are included. QIDS = Quick Inventory of Depressive Symptomatology - Self-Report. PCL = PTSD Checklist for DSM-5. PTCI = Posttraumatic Cognitions Inventory. SST = Scrambled Sentences Task score across both versions.

SST FOR NEGATIVE LIFE EVENTS

Table S3

Thirty percent exclusion criterion. Bivariate correlations between the SST and questionnaire measures at T1 and T2.

	M (range)	SD	PTCI T1	PCL T1	QIDS T1	AST T1	EDEQ T1	FSS T1	AQ T1	PTCI T2	PCL T2
T1 SST full	.26 (.03 - .77)	.18	.60 [.49, .69]	.50 [.37, .61]	.48 [.34, .60]	-.58 [-.68, -.46]	.29 [.15, .43]	.23* [.09, .37]	.30 [.15, .44]	.54 [.39, .66]	.51 [.37, .65]
T1 SST v. A	.26 (0 - .73)	.19	.58 [.47, .68]	.50 [.37, .61]	.50 [.36, .61]	-.54 [-.65, -.42]	.28 [.14, .42]	.21* [.07, .35]	.28 [.14, .41]	.55 [.41, .67]	.54 [.40, .65]
T1 SST v. B	.26 (0 - .92)	.19	.53 [.41, .63]	.43 [.30, .55]	.41 [.27, .54]	-.55 [-.65, -.42]	.30 [.15, .43]	.21* [.07, .33]	.27 [.12, .40]	.44 [.28, .58]	.43 [.27, .57]
T2 SST full	.28 (0 - .83)	.20	-	-	-	-	-	-	-	.57 [.42, .69]	.57 [.43, .68]
T2 SST v. A	.28 (0 - .83)	.20	-	-	-	-	-	-	-	.52 [.37, .64]	.54 [.41, .66]
T2 SST v. B	.28 (0 - .89)	.21	-	-	-	-	-	-	-	.56 [.41, .67]	.53 [.40, .64]

Note. Spearman correlations with bootstrapped 95% CIs are presented. For T1 the sample size is $N = 185$, for T2, the sample size is $N = 137$. All correlations $> .23$ are significant after correcting for multiple testing while the correlation $\leq .23$ did not remain significant. SST = Scrambled Sentences Task. v. = version., PTCI = Posttraumatic Cognitions Inventory. PCL = PTSD Checklist for DSM-5. QIDS = Quick Inventory of Depressive Symptomatology – Self-Report. AST = Ambiguous Scenarios Task. EDEQ = Eating Disorder Examination Questionnaire. FSS = Fear of Spiders Screening. AQ = Acrophobia Questionnaire.

SST FOR NEGATIVE LIFE EVENTS

Table S4

Thirty percent exclusion criterion.

Results of stepwise multiple regression testing the unique variance on the concurrent PCL explained by the SST.

T1						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
Step 1	$R^2_{adj} = .01$					.241
Age	-.17 [-.46, .18]	.20	-.07 [-.21, .08]	.08	.87	.387
Gender (Non-Female)	-4.28 [-9.46, 4.49]	3.48	-.27 [-.71, .17]	.22	1.23	.221
Event distress then (T1)	1.06 [-.13, 2.06]	.60	.13 [-.02, .28]	.07	1.76	.080
Months since event	.00 [-.02, .04]	.01	.01 [-.14, .16]	.08	.18	.861
Step 2	$\Delta R^2_{adj} = .29$					
Age	.05 [-.21, .37]	.17	.02 [-.11, .14]	.06	.28	.779
Gender (Non-Female)	-1.81 [-6.92, 5.76]	2.95	-.12 [-.49, .26]	.19	.62	.539
Event distress then (T1)	.65 [-.30, 1.53]	.51	.08 [-.04, .21]	.06	1.27	.205
Months since event	.00 [-.02, .03]	.01	.02 [-.11, .14]	.06	.26	.799
SST total score (T1)	47.59 [34.40, 60.77]	5.51	.55 [.42, .67]	.06	8.64	< .001
Step 3	$\Delta R^2_{adj} = .25$					

SST FOR NEGATIVE LIFE EVENTS

Age	-.23 [-.49, .05]	.14	-.09 [-.19, .02]	.05	1.64	.104
Gender (Non-Female)	-1.06 [-4.12, 2.85]	2.38	-.07 [-.37, .23]	.15	.45	.655
Event distress then (T1)	1.00 [.34, 1.73]	.41	.12 [.02, .23]	.05	2.43	.0161
Months since event	.01 [-.01, .03]	.01	.03 [-.07, .14]	.05	.67	.506
SST total score (T1)	10.15 [-1.52, 23.43]	5.84	.12 [-.02, .25]	.07	1.74	.084
PTCI total score (T1)	.32 [.24, .39]	.03	.65 [.52, .78]	.07	9.88	< .001
T2						
Predictor	<i>B</i> [95%-CI]	<i>SE_B</i>	β [95%-CI]	<i>SE_β</i>	<i>t</i>	<i>p</i>
Step 1	$R^2_{adj} = .00$					.343
Age	-.22 [-.58, .29]	.27	-.07 [-.24, .10]	.09	.83	.407
Gender (Non-Female)	-.21 [-6.66, 10.59]	3.96	-.01 [-.48, .45]	.23	.05	.958
Event distress then (T1)	1.40 [.03, 2.61]	.75	.16 [-.01, .34]	.09	1.87	.064
Months since event	.02 [-.01, .07]	.02	.10 [-.07, .27]	.09	1.14	.257
Step 2	$\Delta R^2_{adj} = .37$					< .001
Age	.13 [-.17, .52]	.21	.04 [-.10, .18]	.07	.61	.542
Gender (Non-Female)	3.84 [-2.88, 12.90]	3.18	.23 [-.15, .60]	.19	1.21	.230
Event distress then (T1)	.70 [-.33, 1.68]	.60	.08 [-.06, .22]	.07	1.17	.243

SST FOR NEGATIVE LIFE EVENTS

Months since event	.03 [.00, .07]	.01	.13 [-.01, .27]	.07	1.90	.059
SST total score (T2)	53.76 [41.42, 67.39]	6.10	.63 [.49, .77]	.07	8.81	< .001
Step 3	$\Delta R^2_{adj} = .27$					< .001
Age	-.16 [-.45, .16]	.16	-.05 [-.16, .05]	.05	.98	.330
Gender (Non-Female)	1.09 [-3.24, 9.60]	2.42	.06 [-.22, .35]	.14	.45	.654
Event distress then (T1)	.65 [-.03, 1.47]	.45	.08 [-.03, .18]	.05	1.43	.155
Months since event	.02 [.00, .05]	.01	.09 [-.01, .20]	.05	1.78	.077
SST total score (T2)	15.35 [3.82, 30.80]	6.01	.18 [.04, .32]	.07	2.55	.012
PTCI total score (T2)	.34 [.26, .40]	.03	.67 [.54, .81]	.07	9.95	< .001

Note. CIs for B are bootstrapped. For T1 $N = 185$, for T2 $N = 136$.