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Scrambled but valid? The Scrambled Sentences Task as a Measure of Interpretation

Biases in Psychopathology: A Systematic Review and Meta-Analysis

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Abstract

The Scrambled Sentences Task (SST) is frequently used to assess interpretation biases (IBs). However, neither the range of its applications nor the quality of the empirical evidence it provides has been systematically examined. This systematic review investigates the types of samples and disorders in which the SST has been applied and evaluates its psychometric properties via a meta-analysis. The databases PubMed and EBSCOhost (including PsycINFO, PsycARTICLES, PSYINDEX, MEDLINE) were examined (last search: September 2021) and 93 studies from 91 manuscripts were included. Results showed that the SST has been applied predominantly in unselected samples or those with elevated levels of subsyndromal symptoms, with about a third of the studies employing the SST in a clinical population. While the SST was initially developed to assess depression-related IBs, it has now been extended to other disorders, in particular anxiety disorders. Results of the meta-analyses indicated good convergent validity and reliability across disorders, albeit in the context of substantial heterogeneity. Findings concerning divergent validity were mixed with high correlations across disorders between the SST and trait anxiety in particular, questioning its specificity. Future research should consider developing standardized SST versions and investigating its relationships with other measures of IB.

Keywords: Scrambled Sentences Task, Interpretation Bias, Multilevel Meta-Analysis, Validity, Reliability

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Scrambled but valid? The Scrambled Sentences Task as a Measure of Interpretation Biases in Psychopathology: A Systematic Review and Meta-Analysis

Interpretation biases (IBs) play a central role in many cognitive models of psychopathology (e.g., Beck, 1976; Clark, 1986); how we measure them is therefore a crucial aspect of psychopathology research. IBs are the tendency to interpret ambiguous information in a systematically biased manner, for example consistently negatively, and are observed across many mental disorders (for reviews, see Everaert, Podina, et al., 2017; Hirsch et al., 2016; Mathews & MacLeod, 2005). Research has found that IBs not only often correlate with symptoms of psychopathology (e.g., Korn, Dietel, & Hartmann, 2020; Lee, Mathews, Shergill, & Yiend, 2016), but also predict future symptoms and even the onset of a disorder (Kleim et al., 2013; Woud et al., 2014). Further, experimental manipulation of IBs can lead to changes in analog, and over time, actual symptoms of psychopathology (e.g., Hirsch et al., 2018; Joormann et al., 2015; Van Bockstaele et al., 2020) albeit not consistently across the literature (Fodor et al., 2020; Jones & Sharpe, 2017). In summary, for some disorders at least, there is accumulating evidence that IBs may fulfil the criteria to be considered causal factors in psychopathology (Kraemer et al., 1997). Their assessment therefore has relevance across all areas of research, from theory testing and development through to treatment.

A large number of methods has been developed to measure IBs (for an overview, see Table S1, Supplementary Material; for review, see Hirsch et al., 2016), and one that is widely used is the Scrambled Sentences Task (SST; Wenzlaff & Bates, 1998). The SST typically requires participants to sort five out of six words into a grammatically correct sentence. Depending on the omitted word, the resulting sentence represents a particular (valenced) interpretation of the original ambiguous stimulus (e.g., in the context of depression: winner a born I am loser; positive interpretation: I am a born *winner*; negative interpretation: I am a born *loser*). The SST is usually

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completed with a time limit and under cognitive load, e.g., retaining a 6-digit number in mind, which is intended to interfere with controlled stimulus processing and thus reduce deliberate response biases (Bowler et al., 2012; Rude et al., 2003). The SST was first developed and applied in the context of depression (Wenzlaff & Bates, 1998), and meta-analyses indicate strong associations between scores on the SST, for example the percentage of sentences completed negatively, and symptoms or diagnosis of depression (Everaert et al., 2017; Phillips et al., 2010). Beyond depression, the SST has been increasingly applied in other disorder contexts such as Generalized Anxiety Disorder (GAD; Krahé, Whyte, Bridge, Loizou, & Hirsch, 2019), psychosis (Savulich et al., 2015), and anxiety sensitivity (Zahler et al., 2020). In summary, the SST is a commonly applied measure of IBs that is designed to overcome some limitations of self-report measures such as response or demand effects.

While research using the SST suggests its utility and promise as a measure of IB across many different disorders, the SST has not yet been systematically examined. We therefore aimed to provide a systematic overview of the different ways in which the SST had been applied, including types of samples, disorder domains, and other characteristics (e.g., language). We also aimed to examine and evaluate the SST's psychometric properties such as its validity and reliability. To this end we conducted a systematic literature review of studies using the SST together with disorder-specific and unspecific symptom measures, across various areas of psychopathology. Further we conducted two meta-analyses, one for indices of convergent validity and one for those of internal consistency.

Methods

This review was conducted in accordance with the PRISMA guidelines (Liberati et al., 2009). A study protocol was uploaded prior to the literature search (retrievable from the Open Science Framework: osf.io/4fkjs). After the full-text screening, however, an amendment was made to the

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protocol, to also include doctoral dissertations if they met the eligibility criteria. The decision to synthesize the information extracted via a meta-analytic approach was made based on reviewer feedback during peer-review and was not part of the original protocol. All procedures deviating from the protocol are labeled as such. The OSF also includes all other relevant materials, e.g., the extracted information, the analysis scripts (excluding scripts involving unpublished data from other authors), and the data extraction template.

Eligibility criteria

Studies were considered eligible when they were written in English or German, and when the SST was used to measure IBs in combination with disorder-relevant symptom measures. There were no eligibility criteria regarding the studies' publication year. Further, studies were included independently of their current publication status (e.g., we also included data of papers in preparation) to reduce the impact of a potential publication bias.

Information sources and search strategy

The databases PubMed and EBSCOhost (including PsycINFO, PsycARTICLES, PSYINDEX, and MEDLINE) were used for the literature search, using the following search strings—*PubMed*: (((Scrambled Sentence Task) OR Scrambled Sentences Task) OR Scrambled Sentence Test) OR Scrambled Sentences Test) OR SST; *EBSCOhost*: TX SST OR TX scrambled sentences task OR TX scrambled sentences test OR TX scrambled sentence test OR TX scrambled sentence task. Additionally, potential studies were identified through reference lists of other (eligible) publications. To include further (e.g., unpublished) studies, an e-mail using the mailing lists of the German Psychological Society (DGPs) was sent in July 2019. Further, we contacted colleagues who we knew were working with the SST. The first search was run in July 2019. During the review's further preparation and revision, the searches were then updated four

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times using the same search string and starting from the timepoint of the prior search, with the last and fifth search being run on September 10th 2021.

Study selection

The selection process was as follows: Two authors independently scanned the titles and abstracts of the identified studies during the initial searches. All titles were scanned separately for EBSCOhost and PubMed after which duplicates were removed by the Mendeley duplicate detection. Remaining duplicates were removed manually. Second, the studies' eligibility was discussed and if no consensus was achieved, the third author (SEB) was consulted. Next, this procedure was repeated for the full texts. After inclusion of the full texts, two authors extracted the relevant data for each study (e.g., correlation coefficients, sample sizes, etc.) independently. Deviations between the extracted data were resolved through discussion.

For the PRISMA Flow Diagram of the selection process, see Figure 1. Studies were counted as individual studies when they reported data of a unique sample. Thus, multiple papers reporting data of one sample were counted as one study and multiple samples reported within one paper were counted as multiple studies.

Extracted data and analytical approach meta-analysis

In line with our first aim, i.e., providing a systematic overview of how the SST has been applied so far, we extracted information related to the overall study design and the general application of the SST (e.g., language or application format). In line with our second aim, i.e., examining the SST's psychometrics via a meta-analysis, we extracted the relevant psychometric indices per study. That is, for convergent validity, we extracted correlations between SST scores and the symptom measures of the corresponding target disorder. For divergent validity, we extracted correlations between the SST and disorder-unspecific symptom measures and transdiagnostic symptoms (e.g., trait-anxiety). Importantly, these correlations were only included

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if (a) the SST and the other measure were assessed at the same time point (e.g., during the same laboratory or online session), (b) no manipulation (e.g., a mood induction, treatment, CBM etc.) was delivered before or between the assessment of both measures, and (c) no instruction was given as to which type of sentences participants should form (e.g., the instruction to only form positive sentences). Further, we included only zero order correlations¹. The procedure for the extraction of the reliability indices was as follows: If a study reported reliability for multiple time points or different sets of sentences these studies were counted multiple times. When reliability indices were not reported, we contacted authors to request these indices or corresponding raw data and, when available, calculated the split-half reliability (following recommendations of Parsons et al., 2019) using the R package ‘psych’ (Revelle, 2019), using the brute force method and coding grammatical errors or unfinished sentences as missing values. Next, we conducted two meta-analyses, one for the convergent validity indices and one for the reliability (internal consistency) indices. To account for multiple validity/reliability indices reported within individual studies, we conducted a multilevel-meta analysis using Maximum Likelihood estimation including random effects for within- (level 2) and between-study variability (level 3), using the *rma.mv* function of the R-package ‘metafor’ (Viechtbauer, 2010) and following the procedure specified by Assink & Wibbelink, (2016). For convergent validity, we used correlations between the SST and symptom measures of the respective target disorder, and for internal consistency, we used Cronbach’s alpha and split-half reliabilities. We did not conduct a meta-analysis on divergent validity since the included studies used rather heterogeneous sets of questionnaires to assess symptoms not directly related to the target disorder. As a consequence of this, the results of a meta-analysis would be very difficult to interpret.

¹ Please note that these restrictions were not part of the pre-registered protocol but were decided on after the study selection procedure.

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All data was extracted separately for different disorder domains. When IBs of different domains were targeted via the SST in a single study (i.e., trials targeting worry or depression, or paranoia and general emotional content in the same study) and separate correlations/reliability indices were reported, this study was included in each suitable disorder-domain. Therefore, when grouping the studies by disorder, the sum of studies and participants exceeds the corresponding total number.

Risk of bias assessment

The risk of bias (ROB) of individual studies was assessed using a modified version of the study quality assessment checklist for cross-sectional studies of the National Institute of Health (National Heart Lung and Blood Institute, 2021). Adaptations were made as such that items were removed that did not fit this review's focus, and additional items concerning the reporting of technical aspects of the SST were added. The ROB was assessed independently by two authors and deviations were resolved through discussion (the modified checklist is available on the OSF (osf.io/4fkjs)². For further details on the ROB assessment see Supplementary Material.

Results

Populations and samples

We included 93 individual studies from 91 published papers, unpublished manuscripts, preprints, or doctoral dissertations in our review, including a total sample of $n = 9913$ participants. These studies were conducted between 1998 and 2021. The majority of studies investigated depression related IBs, with fewer than ten studies in both Generalized Anxiety Disorder (GAD) and Social Anxiety Disorder (SAD) and single studies in other disorder domains. The majority of studies investigated adult samples ($k = 87$, $n = 9414$), but there were

² The assessment of the ROB deviates from the procedure specified in the pre-registration as the planned procedure was identified as suboptimal during peer-review.

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also a few studies including children and adolescents ($k = 4$, $n = 343$) and one study ($k = 1$, $n = 156$) included children and their parents. Further, a third of the studies ($k = 30$, $n = 2159$) included clinical samples, i.e., participants who were either in- or out-patients at a mental health service or had been diagnosed with a psychological disorder assessed via a clinical interview, and these participants were then compared to a non-diagnosed, non-clinical control group. The samples of the remaining studies ($k = 63$, $n = 7754$) were not formally diagnosed (e.g., community samples or participants above a questionnaire cut-off). Finally, 56.99% of the studies ($k = 53$, $n = 5548$) used an English version of the SST³ and 39.78% of the studies ($k = 37$, $n = 4067$) applied the SST in a fully computerized form (for a detailed overview, see Table 1).

Validity of the SST

Convergent validity

We extracted 95 indices representing convergent validity from 53 studies of which one index was excluded due to missing sample size information (see Table 1 for a detailed overview). Results of our meta-analysis showed that the overall correlation for convergent validity was moderate to high, r [95%-CI] = .46 [.41, .51], $p < .001$. The overall heterogeneity was high, $Q(93) = 662.25$, $p < .001$, and the variance within studies was significant (level 2: $\sigma^2 = .008$, 22.58%), $\chi(1) = 37.28$, $p < .001$, as well as the variance between studies (level 3: $\sigma^2 = .022$, 64.10%), $\chi(1) = 19.39$, $p < .001$. Finally, 13.32% of the variance was accounted for by random sampling (level 1)⁴. Given these high levels of heterogeneity, we conducted exploratory post-hoc moderation analyses to better understand whether the relationship between SST and target

³ If the language in which the SST was applied was not explicitly mentioned, this information was derived from either the in-/exclusion criteria concerning language fluency or the language in which other tasks and questionnaires were applied.

⁴ The high amount of between-study heterogeneity was likely not a result of us investigating convergent validity across disorders, as indicated by nearly identical heterogeneity when we restricted our analyses to depression only. See Supplementary Results for details.

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symptom measures was related to specific study characteristics (as recommended by Assink & Wibbelink, 2016). We found that the application format (computerized vs. other) was a significant moderator of the overall correlation, $F(1, 92) = 9.62, p = .003$, with higher coefficients in the fully computerized version with an estimated difference in r [95%-CI] = .14 [.05, .24], $SE = .05$. However, the type of disorder (depression vs. other disorder) was not associated with differences in convergent validity, $F(1, 92) = .50, p = .482$, and neither was the language in which the SST was applied (English vs. other), $F(1, 92) = 3.50, p = .065$, nor the application of a cognitive load⁵ (i.e., present vs. absent), $F(1, 91) = .24, p = .629$, or the type of sample (partly diagnosed participants versus non-diagnosed participants)⁶, $F(1, 92) = .48, p = .490$. Finally, the number of trials on the SST was not associated with differences in the convergent validity, $F(1, 92) = 2.43, p = .122$.

Comparing the intercept only model to the full model including the application format as a moderator significantly reduced the heterogeneity, $\chi(1) = 9.03, p = .003$, although it remained high ($Q(92) = 585.62, p < .001$, level 3: $\sigma^2 = .02, 59.84\%$). For the funnel and forest plot, see Supplementary Material, Figure S1 and S2.

Divergent validity

In total, we extracted 65 correlations reflecting divergent validity from 33 individual studies (see Table 1 for a detailed overview). Across disorders, medium correlations were most frequent while small and large correlations were equally frequent. This pattern was also found

⁵ One study only reported a joint index for the SST with and without load and was thus excluded from this analysis.

⁶ Except for two studies, the clinical studies, i.e., studies that included diagnosed participants who were compared to a non-diagnosed, non-clinical group, only reported correlations across the entire sample. As such, it was not possible to obtain separate correlation coefficients for diagnosed vs. non-diagnosed participants from these clinical studies. Hence, as a proxy for this moderator variable, we thus created a variable that differentiates between the samples from the clinical studies including diagnosed participants versus samples from the non-clinical studies fully consisting of non-diagnosed participants.

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when focusing on disorders other than depression, for example SAD, GAD or Psychosis, where only few indices resembling divergent validity could be extracted. Finally, for depression small and medium correlations were most frequent with large correlations being slightly rarer.

Reliability

We extracted 53 indices of internal consistency from 31 studies (see Table 1 for a detailed overview). Results of our meta-analysis showed that the overall reliability coefficient in the intercept only model was good, α_{overall} [95%-CI] = .79 [.74, .84], $SE = .03$ (see Table 1 for a detailed overview). However, the overall heterogeneity was high, $Q(52) = 1405.16$, $p < .001$, and the variance within studies was significant (level 2: $\sigma^2 = .003$, 14.31%), $\chi(1) = 101.90$, $p < .001$, as well as the variance between studies (level 3: $\sigma^2 = .019$, 84.54%), $\chi(1) = 28.46$, $p < .001$. Finally, 1.15% of the variance were accounted for by random sampling (level 1). Accordingly, we also conducted post-hoc exploratory moderation analyses for the internal consistency data. We found the application format to be a significant moderator, such that using a computerized version of the SST was associated with slightly higher reliability indices compared to studies using other application formats, $F(1, 51) = 5.35$, $p = .025$, with an estimated difference in $\alpha_{\text{overall}} = .12$ [.02, .22], $SE = .05$. Further, comparing the disorders in which the SST was applied (depression vs. other), the reliability was slightly higher for depression, $F(1, 51) = 4.45$, $p = .04$, with a difference in the overall internal consistency of $\alpha_{\text{overall}} = .06$ [.00, .12], $SE = .03$. However, language (English vs. other) was not a significant moderator, $F(1, 51) = .48$, $p = .493$, as well as the application of a cognitive load, $F(1, 51) = .62$, $p = .433$, the sample's diagnostic status (partly diagnosed participants versus non-diagnosed participants), $F(1, 51) = .14$, $p = .708$, or the number of trials, $F(1, 51) = 1.44$, $p = .235$. When comparing the intercept only model to the model containing the application format and the type of disorder as moderators of the overall reliability, heterogeneity was significantly reduced yet remained high, $\chi(1) = 9.14$, $p = .01$, $Q(50) = 894.16$,

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$p < .001$, level 3: $\sigma^2 = .02$, 88.87%) (see supplementary material for the funnel and forest plot, Figure S3 and S4).

Further, we extracted four reliability indices concerning test-retest reliability from three individual studies. Here, all indices fell within an acceptable range, ranging from $r = .76$ to $ICC = .93$ (see Table 1).

Risk of bias

We found the overall quality of the included studies to be high in relation to the data relevant for our review and there were only a few studies that presented unclear inclusion criteria, used a non-valid disorder assessment or did not report the percentage of missing data. However, across many studies researchers administering the SST may not have been blind to participants' symptom levels and/or group allocations (e.g., they may have been aware that the participant came from a clinical sample, or a paper-based symptom questionnaire may have been administered and collected by the researcher prior to administering the SST). Further, not many studies conducted formal power analyses to justify their sample sizes. Importantly, only a few studies reported on technical aspects of the SST such as the retention rate of the cognitive load or the number of excluded trials due to (grammatical) errors. For a summary, see Table 2, for information on the ROB of individual studies, see Table S2 in the Supplementary Material.

Discussion

The aim of the current review was twofold: (i) providing a systematic overview of the SST's application, including e.g., types of samples and disorder domains, and (ii) evaluating the SST's psychometric properties, i.e., its validity and reliability, from a meta-analytic perspective. In the following, we will present a summary of our main results and their implications and provide some directions for future research.

Samples, disorder domains, and application characteristics

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The SST has been applied mostly in undiagnosed samples, such as unselected student samples or samples including individuals with elevated symptom levels. About a third of the included studies applied the SST in a clinical study setting, testing samples that e.g., included diagnosed or remitted patients, or recruited participants from healthcare centers. This distribution emphasizes the applicability of the SST across different disorder severities. This is further supported by our moderation analysis, indicating that the SST's psychometric properties did not differ between the different types of samples. While the SST was initially developed for research on IBs in depression, it is now applied more broadly, mostly in the context of GAD and SAD, but also in the context of Bipolar Disorder (I/II), Borderline Personality Disorder, Eating Disorders, Female Sexual Dysfunction, Panic Disorder, Psychosis, and Posttraumatic Stress Disorder. Further, the SST has been used in different age ranges, i.e., in older adults, children, and adolescents. According to our results there are two main application formats, fully computerized or pencil & paper application. While most of the studies applied the SST in English, the SST has also been used in Chinese, Dutch, Persian, French, German, Polish, Serbian, and Spanish.

Convergent validity

Results of our meta-analysis suggest that the SST is moderately to strongly correlated with symptoms of the corresponding target disorder, indicating good convergent validity. However, this conclusion needs to be treated with caution due to the high level of heterogeneity between the included studies. Via exploratory post-hoc analyses, we tried to better understand this heterogeneity and tested the moderating effects of a number of variables. Here, results showed that application format, but not the use of a cognitive load, was a significant moderator, with better validity indices for computerized SST versions. Further, the SST's convergent validity depended neither on the type of sample included nor on the targeted disorder. While these results do not explain the studies' heterogeneity, they do underline the broad applicability of the SST.

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Divergent validity

For divergent validity indices, we found mostly medium size correlations, with small correlations being relatively rare. When examining trait anxiety as a correlate, only medium to large correlations were found. While this potentially suggests that the SST is a rather unspecific measure of IBs, this needs to be interpreted cautiously. First, although small correlations were rare, the studies generating these indices included larger samples compared to those studies finding large correlations. Hence, large correlations may be overrepresented. Another important issue relates to the medium to large correlations between the SST and trait anxiety. Trait anxiety was assessed via the State-Trait Anxiety Inventory (Trait version; STAI-T; Spielberger et al., 1983). A recent meta-analysis, however, has indicated that the STAI-T could be also interpreted as a measure of negative affectivity, rather than a specific measure of trait anxiety (Knowles & Olatunji, 2020). Hence, our findings may thus represent an association between the broader concept of negative affectivity and IBs, instead of a lack of specificity of the SST.

Another reason for our mixed findings concerning divergent validity could be that the abundance of medium sized correlations might represent a methodological artifact of the general design of the studies included. That is, there were only a few formal validation studies including a heterogeneous questionnaire battery also assessing symptoms of disorders not directly linked to the targeted one. Hence, the reported correlations may represent comorbidity rather than a lack of divergent validity. This is further supported by the result that large correlations in some symptom domains were found in studies including patients but not in healthy samples. For example, in anorexia nervosa, the correlation with depression was large for participants with anorexia but small for healthy controls (Brockmeyer et al., 2018), and in relation to depression, correlations with paranoid thinking and delusions were medium or large when the sample consisted partly of patients or participants at risk (Savulich et al., 2017; Yiend et al., 2019), but small when the

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sample consisted of students (Savulich et al., 2015). As such, the question of whether the SST is capable of assessing disorder specific IBs in the context of comorbidities remains a key challenge for future research.

Reliability

Results of our meta-analysis results showed that overall, the SST's internal consistency was good. However, similar to our conclusions regarding the convergent validity indices, this conclusion concerning the SST's reliability should be treated with caution due to high levels of heterogeneity. Via our exploratory post-hoc moderation analyses, two potential sources of the studies' heterogeneity could be identified statistically: First, the application format, with slightly higher reliability indices for computerized compared to other formats. Second, the reliability of the SST was slightly higher when applied in depression compared to other disorders. However, none of the other moderators were significant, with the lack of significance for the number of trials being one of the most surprising findings. Another important note when interpreting the overall internal consistency is the computational process of the reliability indices itself. Only a few studies reported reliability indices, especially for test-retest reliability, and we supplemented the published data with our own calculations based on data provided by the studies' authors. As a consequence, our reliability indices cannot be generalized and are only representative of a certain small set of studies. Hence, and in line with Parsons et al., (2019), we strongly recommend that if computationally possible, the split-half reliability should always be reported, and in case this index is not computable (e.g., due to a high ratio of missing/erroneous trials), this should itself be reported and explained.

Considering re-test reliability, we could only extract four indices (one for GAD, one in Posttraumatic Stress Disorder, two for depression). While these indices indicated sufficient reliability for a time period of two weeks and 50 days, the generalizability of these results is

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clearly limited. Therefore, more research is needed investigating the SST's test-rest reliability, to ensure that experimental, clinical, and longitudinal studies can apply the SST as a reliable tool to investigate IBs, and to ensure findings are not distorted by random fluctuations.

The SST in context of other measures of IBs

Our findings can be integrated into the broader literature on the psychometric properties of IB measures (a summary of such measures can be found in Table S1 in the Supplementary Material). A useful reference point is provided by the systematic review by Gonsalves et al., (2019), which investigated the psychometric properties of another well-established measure of IBs, the Word-Sentence-Association Paradigm (WSAP; Beard & Amir, 2009). Across various disorders, Gonsalves et al. (2019) found that small correlations for convergent validity were most common while large correlations were rare; this contrasts with the moderate to large correlations more common for the SST as found in the present review. However, findings for reliability of the WSAP and SST appear comparable, with Gonsalves et al. (2019) noting that acceptable reliability indices were most frequent for the WSAP, but also that this information was seldom reported. To the best of our knowledge, the present review and the review by Gonsalves et al. are the only published systematic overviews of the psychometric properties of measure of IBs across different types of disorders. Within a disorder-specific context, Everaert, Podina, et al. (2017) investigated the relationship between IB measures, including the SST, and depression symptoms. They found an overall large association between measures of IB and symptoms, but only when using either self-report measures or the SST, and not when using measures relying fully on reaction times, for example semantic priming paradigms.

Although a meta-analysis such as that by Everaert et al. (2017) can compare different IB measures, this relies largely on between-study comparisons. However, when the SST has been compared to other IB measures within one study, similar results have often been found. For

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example, a recent study by O'Connor, Everaert, & Fitzgerald, (2021) found that the SST showed the highest correlation with symptoms of depression compared to other measures of IBs including questionnaires and non-self-report measures, as well as the highest reliability. Further, the SST was the only measure to explain unique variance in depression symptoms, while its correlation with the other IB measures was weak to moderate. In another study, Rohrbacher (2016) found that both the convergent validity and reliability of the self-report Ambiguous Scenarios Test for Depression (AST-D; Rohrbacher & Reinecke, 2014) were slightly better than those of the SST, but that the AST and the SST were highly correlated. However, other non-questionnaire based measures showed only poor psychometric properties and were weakly correlated with the SST. In the context of subclinical panic disorder, Zahler et al., (2020) found that the interpretation bias questionnaire and the SST showed the most convincing psychometric properties of the IB measures administered and were highly correlated. Meanwhile other non-self-report IB measures demonstrated only weak convergent validity and small correlations with the SST. Finally, in a recent study in the context of Female Sexual Dysfunction (Zahler et al., 2021), the SST showed a higher correlation with sexual distress than an open ended scenario task to which it was only moderately correlated.

In summary, in the context of research on other IB measures, our findings indicate that the SST shows validity and reliability indices that are comparable to self-report measures, but there is evidence that its psychometric qualities are better than other measures that are not based on self-report. However, these conclusions are drawn largely from indirect comparisons across different studies, and the relationship between the SST and other IB measures will be important to investigate and synthesize more systematically in future research (see below).

Future directions

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In the following, we present some perspectives for future research, building on both the specific results of this review and broader considerations, including current challenges and opportunities. First, considering our promising findings for convergent validity and mixed findings for divergent validity, systematic validation studies are necessary, ideally including disorder-specific and disorder non-specific measures, and evaluating a range of psychometric indices. These studies could compare different SST versions to investigate which correlate most strongly with symptoms of the target disorder and most weakly with symptoms of other disorders. This could in turn inform subsequent modifications of the SST to enhance its specificity and increase divergent validity. A second and equally important consequence of such validation studies could be the development of ‘gold standard’ SSTs, within and across different disorder domains. Development of such standardized task versions (e.g., in terms of number of trials or stimuli) could help reduce the task’s heterogeneity and enhance comparability across studies. In fact, it is likely that the high levels of heterogeneity in terms of SST versions used had a negative impact on the validity and reliability indices we found. Unfortunately, the results of our post-hoc moderation analyses did not help explain this heterogeneity, with the exception that computerized administration format was associated with higher convergent validity and reliability indices than other (e.g., pen-and-paper) formats. Accordingly, we would recommend that future studies use fully computerized versions of the SST. In fact, computerized versions of the SST offer a number of additional advantages. For example, via online administration of the SST larger and more diverse samples can be tested more easily over longer time-periods. Further, computerized versions allow the implementation of an exact time limit for each trial instead of defining a total time available for all stimuli, increasing the SST’s standardization. While standardization of the SST and its administration would be helpful in enhancing comparability across studies, standardization is also important in relation to reporting. As previously mentioned,

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only a few studies reported details of SST performance such as the error rate and the cognitive load retention rate. However, this information is crucial for two reasons: First, while participants' performance on the SST itself and the correct recall of the cognitive load depend on many factors, both aspects are likely related to participants' engagement with the task and the task's difficulty. As such, task performance and correct recall provide valuable indicators of the results' validity. A second aspect relates to the number of error trials. The SST's analysis usually only includes correct trials, and it is therefore important to know how many trials the actual analysis included. This is particularly important from a reliability perspective, since reliability indices can fluctuate and can be strongly influenced by the number of trials. As such, we would encourage standardized reporting for the SST, including not only reliability indices but also information about the error and the cognitive load retention rates. We would also encourage researchers to make item-by-item individual participant response data on the SST available as this would allow other researchers to investigate response patterns or alternative scoring methods in more detail (e.g., mixed models with random intercepts at participant and stimulus levels, as is common in other areas of psychology, DeBruine & Barr, 2020).

Finally, although we investigated test-retest reliability in the current review, there was little data available; hence this is an area where much further research is warranted. Such research is necessary to estimate correlation indices between two SST assessments both within one laboratory session and over longer time-scales, to allow better interpretation of the effects of experimental manipulations and treatment interventions, and of longitudinal data. Optimally, this should be combined with investigation of how best to administer the SST repeatedly over time, since this poses a number of challenges (e.g., variations in stimuli).

While the above future directions arise directly from the results of our systematic review, consideration of the literature included raises some broader suggestions for future research. One

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of these concerns language and cross-cultural considerations. While there is preliminary evidence that the SST can be applied in different languages and alphabetical systems (e.g., in Chinese or Farsi), it is unclear to what extent the SST is comparable across different languages and cultures. Another consideration for future research is the question of which processes (on a continuum ranging from controlled to automatic IBs) the SST targets. Initially, the SST was designed to tap into more automatic processes when investigating IBs in comparison to self-report, namely by applying a cognitive load and a time limit (Wenzlaff & Bates, 1998). However, in some studies the SST has been considered to be a measure of more controlled IBs as participants are still required to evaluate the presented words (Everaert et al., 2017). Additionally, the SST has been considered to be a rather transparent measure in terms of what it assesses (cf. Phillips & Hine, 2013), which in turn could enable participants to control their answers. Our own meta-analytic results do not support the idea that the cognitive load alters the validity or reliability of the SST, at least in relation to cross-sectional data. However, there is data from longitudinal (e.g. Rude et al., 2002; Rude et al., 2003) and interventional (e.g., Bowler et al., 2012) studies indicating that the cognitive load may enable the SST to assess more automatic aspects of IBs, with prevention of thought suppression suggested as a mechanism (Geiger et al., 2014). This would argue in favor of using a cognitive load when administering the SST, and against categorizing the SST under cognitive load as equivalent to pure self-report measures. In fact, it seems most plausible that if the SST indeed captures critical aspects of interpretational processing, this includes some aspects of both automatic and controlled processes.

While the current review has considered the SST as a behavioral measure of IBs in isolation, some particularly promising future directions concern how the basic SST may be combined with other methods. For example, the SST has been adapted so that eye-movement data can be tracked to assess participants' visual attention during the task (e.g., Sanchez et al.,

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2015; Sfärlea et al., 2020). This enables the simultaneous investigation of both attentional and interpretational biases. Given that the participant's choice of words is potentially influenced by their attentional processing of the words (e.g., fast engagement with certain types of words), it is also possible that the SST may reflect attention biases. This offers intriguing new research avenues, especially since it is unlikely that attentional and interpretation biases occur in isolation in psychopathology (Everaert et al., 2013). More recently, the SST has also been tested in an fMRI setting (e.g., Viviani et al., 2018) by adapting the instructions so that participants are instructed to form the sentences in their mind and then press a button to indicate the sentence's valence instead of clicking words or writing them down. Given the promising results found for the SST by Viviani et al., the application of the SST in an fMRI setting could be a valuable tool to investigate the neural substrates of IBs, offering additional markers for interpretation biases.

Limitations of the review

This review is not without limitations. First, the interpretation of the convergent and divergent validity indices relied on the strength of the correlations between the SST and disorder-specific and -nonspecific symptom questionnaires, respectively. While we chose symptom questionnaires as the criterion against which the SST was validated (due to their well-established psychometric properties and common application), this operationalization of convergent validity assumes a strong theoretical relationship between IBs and symptoms. For disorders where there is a wealth of data supporting a relationship between other measures of IB and symptoms this may not in itself be problematic, but it makes it more difficult to compare the convergent validity indices across disorders; it may be that e.g., small correlations between the SST and symptoms of a particular disorder do not reflect poor validity of the measure, but rather that IBs do not play such a central role in that disorder. Ultimately, questions about the role or importance of IBs in particular disorders cannot be answered via cross-sectional studies, but rather require longitudinal

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and interventional designs, and this is a crucial area for future research. However, this consideration also highlights the potential utility of including multiple IB measures in single studies. As a second limitation, the validity and reliability indices were summarized across different sample types such as patients, healthy college students, adolescents etc., which may have introduced heterogeneity to the results. Despite our attempt to explain the between-study heterogeneity through moderation analyses, the large amount of unaccounted heterogeneity poses a clear limitation to the interpretability of our meta-analytical findings. In relation to these moderation analyses, it should be noted that the moderators were chosen post-hoc, based on face-validity given the context of the present review and meta-analysis. Finally, our Risk of Bias Assessment (ROB) comes with some caveats: Although we used an established measure as the basis for assessing ROB we had to make some adaptations given the specific aims of this review. Further, this was not the original ROB process specified in our pre-registration but rather adopted as an improvement upon this during the review process.

Conclusion

The SST is a widely applied measure of IBs across a broad range of samples and disorders. Overall, convergent validity and internal consistency are promising, with more mixed findings for divergent validity. While the SST offer promising routes for future research, variability between studies highlights the importance of standardization of both the SST itself and the reporting of its results.

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Figure 1.

PRISMA flow diagram.

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Table 1. Study characteristics, reliability & validity data.

Study	Type of sample (N)	Study design, SST type of application (sentences per block), scoring, and language	Reliability	Convergent validity Low/Medium/High: k indices (% indices, n participants)	Divergent validity Low/Medium/High: k indices (% indices, n participants)
<i>Bipolar Disorder I/II</i>	N = 76				
Miklowitz, Alatiq, Geddes, Goodwin, & Williams, (2010)	Remitted Bipolar Disorder and MDD patients, and HC (76)	Cross-sectional, 4 SST blocks (29) Paper & Pencil, Negativity and Hyperpositivity score, English	-	-	-
<i>Borderline Personality Disorder (BPD)</i>	N = 181			Low: 0 (0%) Medium: 2 (100%, n = 181) High: 0 (0%)	-
Geiger, Peters, & Baer, (2014)	Students with varying levels of BPD features (181)	Cross-sectional, 2 SST blocks (25) Paper & Pencil, Positivity score, English	-	<i>Cognitive load:</i> PBQ-BPD: $r = -.47^{**}$ <i>No cognitive load:</i> PBQ-BPD: $r = -.45^{**}$	-
<i>Eating disorders</i>	N = 103			Low: 0 (0%) Medium: 0 (0%) High: 5 (100%, n = 113)	Low: 1 (50%, n = 33) Medium: 0 (0%) High: 1 (50%, n = 37)
Bradatsch et al., (2020)	Women with elevated body dis-satisfaction (33)	Pre-Post, 1 SST block (20) at pre- and post, Computerized, Negativity score, German	-	<i>Pre-cue-exposure:</i> BISS pre-cue-exposure: $r = -.79^{***}$	-

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Brockmeyer et al., (2018)	Female individuals with Anorexia (37) and HC (33) (Total 70)	Cross-sectional, 1 SST block (20) Computerized Negativity score, German	-	<i>Anorexia group:</i> BShQ: $r = .66^{***}$ EDE-Q: $r = .57^{***}$ <i>Healthy controls:</i> BShQ: $r = .54^{***}$ EDE-Q: $r = .57^{***}$	<i>Anorexia group:</i> PHQ-9: $r = .61^{***}$ <i>Healthy controls:</i> PHQ-9: $r = .27$
Psychosis	N = 259		-	Low: 2 (15.38%, $n = 70$) Medium: 6 (46.15%, $n = 198$) High: 5 (38.46%, $n = 201$)	Low: 1 (11.11%, $n = 70$) Medium: 5 (55.56%, $n = 198$) High: 3 (33.33%, $n = 140$)
Savulich et al., (2020) Experiment 1	Healthy participants with differing levels of paranoid thinking (70)	Cross-sectional, 2 SST blocks (20), Paper & Pencil, Negativity score, English	Cronbach's $\alpha = .64$	GPTS: $r = .47^{***}$ PS: $r = .62^{***}$ PDI: $r = .28^*$ CAPS: $r = .20$	BDI-II: $r = .45^{***}$ STAI-T: $r = .58^{***}$
Savulich, Freeman, Shergill, & Yiend, (2015)	Students with varying levels of paranoid thinking (70)	Cross-sectional, 2 SST blocks (20) Paper & Pencil Negativity score, English	Split-Half = .83	<i>Paranoia related trials:</i> GPTS: $r = .47^{***}$ PS: $r = .64^{***}$ PDI: $r = .31^*$ CAPS: $r = .36^{**}$	<i>Paranoia related trials:</i> BDI-II: $r = .47^{***}$ DASS: $r = .49^{***}$ STAI-T: $r = .67^{***}$ PSWQ: $r = .52^{***}$ CWI: $r = .12$ LSAS: $r = .44^{***}$
Savulich, Shergill, & Yiend, (2017)	Paranoid and non-paranoid schizophrenia patients, and HC (61)	Cross-sectional, 2 SST blocks (20), Paper & Pencil, Negativity score, English	Split-Half = .82	<i>Paranoia related trials:</i> GPTS: $r = .59^{***}$ PS: $r = .55^{***}$ PDI: $r = .74^{***}$	-

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Yiend et al., (2019) _a	HC, at risk for psychosis and first episode psychosis patients (58)	Cross-sectional, 1 SST block (20), NA, Positivity score (Adaptive bias in the study), English	-	<i>Paranoia related trials:</i> <i>Adaptive bias:</i> GPTS: $r = -.39^{**}$ PS: $r = -.40^{**}$	<i>Paranoia related trials:</i> <i>Adaptive bias:</i> DASS: $r = -.39^{**}$
Posttraumatic Stress Disorder (PTSD)	N = 270		-	Low: 0 (0%) Medium: 0 (0%) High: 1 (100%)	Low: 1 (25%, $n = 214$) Medium: 3 (75%, $n = 214$) High: 0 (0%)
Viviani, Mahler, et al., (2018) Behavioral study	Unselected students (36)	Cross-sectional, 1 SST block (48), Computerized Positivity score German	-	No zero order correlations presented	No zero order correlations presented
Viviani, Mahler, et al., (2018) Neuroimaging study	Unselected students (20)	Cross-sectional, 1 SST block (48), Computerized Positivity score German	-	No zero order correlations presented	No zero order correlations presented
Würtz, Blackwell, Margraf, & Woud, (2021)*	Participants with a distressing life event (214)	Longitudinal, 2 SST blocks (20), Computerized, Negativity score, German	T1: Split-Half = .88 T2: Split-Half = .90 Test-Retest (14 days): ICC = .81	<i>All trials, T1:</i> PCL-5: $r = .51^{***}$	<i>All trials, T1:</i> QIDS-SR: $r = .48^{***}$ EDEQ: $r = .30^{***}$ FSS: $r = .24^{***}$ AQ: $r = .32^{***}$
Social Anxiety	N = 478	-	-	Low: 0 (0%) Medium: 1 (25%, $n = 60$) High: 3 (75%, $n = 119$)	Low: 0 (0%) Medium: 1 (100%, $n = 60$) High: 0 (0%)

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Bowler et al., (2012)	Socially anxious students (63)	Pre-Post, 2 SST blocks (20) pre and post, Paper & Pencil, Negativity score, English	-	-	-
Burnett Heyes et al., (2017) <i>Pilot study* cited in Burnett Heyes et al., (2017)</i>	Unselected young adults (60)	Cross-sectional, 1 SST block (20), Paper & Pencil, Negativity score, English	-	LSA: $r = .35^{**}$	STAI-T: $r = .41^{***}$
Burnett Heyes et al., (2017)	Unselected adolescents (57)	Pre-Post, 1 SST block (20) post and at follow-up, Paper & Pencil, Negativity score, English	-	SST assessed after CBM paradigm	SST assessed after CBM paradigm
de Voogd et al., (2017)	Adolescents with elevated anxiety/depression (119)	Pre-Post, 3 SST blocks (10) pre and post, Computerized, Negativity score, Dutch	Set 1: Split-Half = .87 Set 2: Split-Half = .71	<i>Depression & social anxiety related trials:</i> SCARED: $r = .62^{***}$ CDI: $r = .75^{***}$	-
Krans, Bosmans, Salemink, & De Raedt, (2019)	Unselected students (120)	Pre-Post, 1 SST block (20) at post, Computerized, Positivity score, Dutch	Social: Cronbach's $\alpha = .88$ Future related: Cronbach's $\alpha = .82$	SST assessed after CBM paradigm	SST assessed after CBM paradigm
Standage, (2009) <i>pilot study* cited in Standage, Ashwin, & Fox, (2010)</i>	N/A	Cross-sectional, NA (NA), N/A, Positivity score, English	-	FNE: $r = -.64^{***}$	-

REVIEW SCRAMBLED SENTENCES TASK

Standage, Ashwin, & Fox, (2010) Experiment 1	Unselected students (30)	Pre-Post, 1 SST block (20) pre and post, Paper & Pencil, Positivity score, English	-	-	-
Experiment 2	Unselected students (29)	Pre-Post, 1 SST block (20) pre and post, Paper & Pencil, Positivity score, English	-	-	-
Generalized Anxiety Disorder (GAD)	N = 1132	-	-	Low: 4 (36.36%, $n = 343$) Medium: 2 (18.18%, $n = 77$) High: 6 (45.45%, $n = 546$)	Low: 0 (0%) Medium: 3 (75%, $n = 420$) High: 1 (25%, $n = 88$)
Deschênes, Dugas, Anderson, & Gouin, (2015)	Unselected students (77)	Pre-Post, 1 SST block (20) pre and post, NA, Negativity score, English	-	PSWQ: $r = .30^{**}$ STICSA-T: $r = .34^{**}$	CES-D: $r = .42^{***}$
<i>Donegan, (2016) Dissertation*</i>	Individuals with GAD (29)	Pre-Post with 1-week follow-up, 1 SST block (20) per session, Computerized, Negativity score French	-	-	-
Hirsch et al., (2018) _b	MDD and GAD patients (130)	Pre-Post, 1 SST block (20) pre and post, NA, Positivity score, English	-	-	-

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Hirsch et al., (2021)	Community volunteers with GAD (183)	Pre-Post, 1 SST block (20) pre and post, Computerized, Positivity score, English	Set 1, Pre: Cronbach's $\alpha = .77$ Set 2, Pre: Cronbach's $\alpha = .79$ Set 1, Post: Cronbach's $\alpha = .82$ Set 2, Post: Cronbach's $\alpha = .88$	PSWQ: $r = -.08$ GAD-7: $r = -.24^{**}$	PHQ-9: $r = -.41^{**}$
Hirsch et al., (2020)	Community sample with elevated rumination/worry (160)	Pre-Post, 1 SST block (20) pre and post, Computerized, Positivity score, English	-	Worry related trials: PSWQ: $r = -.20^*$ GAD-7: $r = -.17^*$	Worry related trials: PHQ-9: $r = -.30^{**}$
Hirsch, Meeten, et al., (2020)	Community sample of pregnant and non-pregnant women (237)	Cross-sectional, 1 SST block (20), Computerized, Positivity score, English	Cronbach's $\alpha = .86$	Full sample: Depression and worry related trials: PSWQ: $r = -.67^{***}$ PHQ-9: $r = -.62^{***}$ GAD-7: $r = -.63^{***}$	-
Krahé, Meeten, & Hirsch, (2020)*	Community sample (88)	Cross-sectional with re-test after 2 weeks, 1 SST block (20) per session, Computerized, Positivity score, English	Test-retest (14 days): ICC = .89 List 1, time 1: Cronbach's $\alpha = .77$ List 2, time 1: Cronbach's $\alpha = .82$ List 1, time 2: Cronbach's $\alpha = .89$ List 2, time 2: Cronbach's $\alpha = .87$	Worry related trials: PSWQ: $r = -.64^{**}$ GAD-7: $r = -.64^{**}$	Worry related trials: PHQ-9: $r = -.56^{**}$

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Krahé, Whyte, Bridge, Loizou, & Hirsch, (2019) _b	Individuals with GAD or MDD, and HC (221)	Cross-sectional, 1 SST blocks (20), Paper & Pencil, Positivity score, English	-	PSWQ: $r = -.72^{**}$	-
McNally, (2014) Dissertation*	GAD patients (7)	Pre-Post-Follow-up, 1 SST block at baseline, 1 pre-CBM, 1 post-CBM, 1 at follow-up (1 week), Paper & Pencil, Negativity score, English	-	-	-
Panic Disorder	N = 54	-	-	Low: 0 (0%) Medium: 1 (100%) High: 0 (0%)	Low: 0 (0%) Medium: 1 (33.33%, $n = 54$) High: 2 (67.67%, $n = 54$)
Zahler et al., (2020)	Students with differing levels of anxiety sensitivity (54)	Cross-Sectional, 1 SST block (24), Computerized, Negativity score, German	Split-Half = .73	BSeQ: $r = .38^{**}$	DASS: $r = .57^{**}$ STAI-S: $r = .47^{**}$ STAI-T: $r = .54^{**}$
Female Sexual Dysfunction	N = 263	-	-	Low: 1 (50%) Medium: 0 (0%) High: 1 (50%)	Low: 1 (100%, $n = 263$) Medium: 0 (0%) High: 0 (0%)
Zahler et al., (2021)	Female community sample (263)	Cross-Sectional, 1 SST block (20), Computerized, Negativity score, German	Split-Half = .86	All participants, all trials: SIDI-F: $r = -.56^{***}$ FSDS: $r = .29^{***}$	All participants, all trials: PHQ-9: $r = .18^{**}$
Depression	N = 7534	-	-	Low: 16 (28.57%, $n = 1101$) Medium: 22 (39.29%, $n = 1881$) High: 18 (32.14%, $n = 2428$)	Low: 15 (36.59%, $n = 1341$) Medium: 14 (34.15%, $n = 1825$) High: 12 (29.27%, $n = 487$)

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Beevers, (2002) <i>Dissertation*</i>	Remitted and never depressed students (116)	Pre-Post, with 6-8 weeks follow-up and 50 days follow-up, 1 SST block (15) pre and post, Computerized/Pen & Paper, Negativity score, English	No cognitive load: Test-Retest (50 days): $r = .76$	No cognitive load: BDI-II: $r = .51^{***}$	-
Beevers & Meyer, (2008)	Non-depressed students (65)	Post manipulation, 1 SST block (60), Computerized/Pen & Paper, Negativity score, English	-	SST assessed after an experimental manipulation	-
Bibi, Margraf, & Blackwell, (2020)	Depressed students (55) Intention to treat sample	Pre-Post-Follow-Up, 1 SST block (20) pre and post, Paper & Pencil, Negativity score, English	Pre, Set A: Split-Half = $-.21$ Pre, Set B: Split-Half = $-.35$ Post, Set A: Split-Half = $.30$ Post, Set B: Split-Half = $-.13$	QIDS-SR: $r = -.03$ DASS-Depression: $r = .05$	DASS-Anxiety: $r = .13$
Blackwell & Holmes, (2010)	Depressed individuals (7)	Baseline-Pre-Post, 1 SST block (20), baseline, pre and post, Paper & Pencil, Negativity score, English	Baseline: Split-Half = $.72$ Pre: Split-Half = $.64$ Post: Split-Half = $.87$	BDI-II: $r = .06$	-

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Blackwell et al., (2015); Ji, Holmes, & Blackwell, (2017); Blackwell & Holmes, (2017)	Depressed individuals (150)	Pre-Post, 1 SST block (20) pre and post, Paper & Pencil, Negativity score, English	Pre: Split-Half = .83 Post: Split-Half = .82	BDI-II: $r = .51^{***}$	-
Blanco, Boemo, & Sanchez-Lopez, (2021)	Unselected adults (80)	Cross-sectional, 1 SST block (15), Computerized, Negativity score, Spanish	Split-Half = .86	<i>No cognitive load</i> CES-D: $r = .62^{***}$	GAD-7: $r = .49^{***}$
Brockmeyer et al., (2012)	Remitted and never depressed (40)	Pre-Post, 1 SST block (20) pre and post, Paper & Pencil, Negativity score, German	-	<i>No cognitive load</i> BDI-II: $r = .27$ HDRS: $r = .13$	-
Cowden Hindash & Rottenberg, (2017a)	Dysphoric and non-dysphoric students (160)	Cross-sectional, 1 SST block (20), Paper & Pencil, Negativity score, English	Split-Half = .90	BDI-II: $r = .47^{***}$	STAI-S: $r = .27^{***}$ STAI-T: $r = .39^{***}$
Cowden Hindash & Rottenberg, (2017b)*	Dysphoric and non-dysphoric students (162)	Pre-Post, 1 SST block (20) at post, Paper & Pencil, Negativity score, English	Split-Half = .92	SST assessed after a CBM paradigm	SST assessed after a CBM paradigm
Dickson, (2015) Dissertation*	Remitted depressed & never depressed (38)	Cross-sectional, 2 SST blocks (20), Paper & Pencil, Negativity score, English	-	<i>Joint index for load- and no load:</i> BDI-II: $r = .37^*$	-

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Everaert, Mogoşe, David, & Koster, (2015) Experiment 2a _c	Non-depressed students (38)	Pre-Post, 1 SST block (24) pre and post, N/A, Negativity score, Dutch	-	BDI-II: $r = .41^*$	STAI-T: $r = .50^{**}$
Experiment 2b	Non-depressed students (39)	Pre-Post, 1 SST block (24) pre and post, N/A, Negativity score, Dutch	-	-	-
Everaert, Tierens, Uzieblo, & Koster, (2013)	Students with varying levels of depressive symptoms (64)	Cross-sectional, 1 SST block (20), Computerized, Negativity score, Dutch	-	BDI-II: $r = .77^{***}$	-
Everaert, Duyck, & Koster, (2014)	Students with varying levels of depressive symptoms (71)	Cross-sectional, 10 SST blocks (10), Computerized, Negativity score, Dutch	Split-Half = .86	BDI-II: $r = .61^{***}$	-
Everaert, Grahek, Duyck, et al., (2016) Everaert, Grahek, & Koster, (2016)	Students with varying levels of depressive symptoms (112)	Cross-sectional, 4 SST block (10), Computerized/Verbal, Negativity score Dutch	Split-Half = .82	BDI-II: $r = .49^{***}$	DASS Anxiety: $r = .29^{**}$
Gill, Miller, Haner, & Rude, (2017) Study 2	Remitted depressed (53)	Cross-sectional, 2 SST blocks (7), Paper & Pencil, Proportion of Big-Picture-Appraisal related sentences, English	-	CES-D: $r = -.43^{***}$	-

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Hedlund & Rude, (1995)	Patients, remitted depressed and HC (53)	Cross-sectional, 2 SST blocks (30), Computerized / Paper & Pencil, Negativity score, English	-	SST assessed after a self-focus manipulation	-
Holmes, Lang, & Shah, (2009), Experiment 1	Community sample (38)	Pre-Post, 1 SST block (20) post, Paper & Pencil, Negativity score, English	-	-	-
Hirsch et al., (2020)	Community sample with elevated rumination/worry (160)	Pre-Post, 1 SST block (20) pre and post, Computerized, Positivity score, English	-	<i>Depression related trials</i> PHQ-9: $r = -.31^{**}$	<i>Depression related trials</i> PSWQ: $r = -.12$ GAD-7: $r = -.21^{**}$
Krahé, Meeten, & Hirsch, (2020)*	Community sample (88)	Cross-sectional with re-test after 2 weeks, 1 SST block (20) per session, Computerized, Positivity score, English	Test-retest (14 days): ICC = .93 List 1, time 1: Cronbach's $\alpha = .92$ List 2, time 1: Cronbach's $\alpha = .92$ List 1, time 2: Cronbach's $\alpha = .96$ List 2, time 2: Cronbach's $\alpha = .97$	<i>Depression related trials:</i> PHQ-9: $r = -.62^{**}$	<i>Depression related trials:</i> PSWQ: $r = -.64^{**}$ GAD-7: $r = -.61^{**}$
Krejtz, Holas, Rusanowska, & Nezlek, (2018)	Depressed individuals (51 for SST data)	Pre-Post, 1 SST block (20) pre and post, Computerized, Positivity score, Polish	Split-half = .86	CES-D: $r = -.33^{**}$ HADS-Depression: $r = -.42^{***}$	STAI-T: $r = -.53^{***}$ HADS-Anxiety: $r = -.20$

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Lang, Blackwell, Harmer, Davison, & Holmes, (2012)	Depressed individuals (26)	Pre-Post, 1 SST block (20) pre and post, Computerized, Negativity score, English	-	BDI-II: $r = .53^{**}$ HDRS: $r = .44^*$	STAI-T: $r = .43^*$
Lee, Mathews, Shergill, & Yiend, (2016)	Depressed individuals (71)	Cross-sectional, 1 SST block (20), Paper & Pencil, Negativity score, English	-	BDI-II: $r = .33^{**}$	-
LeMoult et al., (2018)	Depressed adolescents (46)	Pre-Post, 1 SST block (20) pre and post, N/A, Positivity score, English	-	-	-
Lin et al., (2020) Study 1	Unselected students (145)	Cross-sectional, 4 SST blocks (10), Computerized, Negativity score, Chinese	Split-Half = .63	PHQ-9: $r = .30^{***}$	GAD-2: $r = .22^{**}$
Lo, (2009) Dissertation*	Remitted and never depressed (40)	Cross-sectional, 6 SST blocks (20), Computerized, Negativity score German	-	-	-
Marchetti, Koster, & De Raedt, (2012)	Unselected students (79)	Pre-Post, 1 SST block (20) pre and post, Paper & Pencil, Negativity score Dutch	-	<i>Mind wandering induction between BDI-II and SST</i>	-

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<i>Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 1*</i>	Remitted and never depressed (109)	Cross-sectional, 2 SST blocks (20), Paper & Pencil, Negativity score, Spanish	-	<i>Cognitive load:</i> BDI-II: $r = .41^{**}$ DID: $r = .30^{***}$ <i>No cognitive load:</i> BDI-II: $r = .39^{**}$ DID: $r = .28^{***}$	<i>Cognitive load:</i> BAI: $r = .27^{***}$ <i>No cognitive load:</i> BAI: $r = .28^{***}$
<i>Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 2*</i>	Depressed, remitted, never depressed (409)	Cross-sectional, 1 SST block (20), Paper & Pencil, Negativity score, Spanish	-	BDI-II: $r = .38^{***}$	BAI: $r = .28^{***}$
<i>Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 3*</i>	Currently and never depressed (80)	Cross-sectional, 1 SST block (20), Paper & Pencil, Negativity score, Spanish	-	BDI-II: $r = .65^{***}$	BAI: $r = .43^{***}$
Miller, Rude, & Haner, (2015)	Unselected students (137)	Pre-Post, 2 SST blocks (8) post, Computerized, Training congruent vs. incongruent sentences, English	-	SST assessed after an experimental manipulation	-
Moon & Lord, (2006), Study 1	Unselected students (91)	Cross-sectional, 1 SST block (40), Paper & Pencil, Negativity score, English	-	SST assessed after an experimental manipulation	-
Moon & Lord, (2006), Study 3	Unselected students (100)	Cross-sectional, 1 SST block (40), Paper & Pencil, Negativity score, English	-	SST assessed after an experimental manipulation	-

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Murphy et al., (2015)	Healthy older adults (77)	Pre-Post-Follow-up, 1 SST block (20) pre post, and follow-up, Paper & Pencil, Negativity score, English	-	BDI-II: $r = .34^{**}$	STAI-T: $r = .43^{**}$
Novović, Mihić, Biro, & Tovilović, (2014)	Unselected students (1071)	Cross-sectional, 2 SST blocks (28), Paper & Pencil, Negativity score, Serbian	<i>Cognitive load</i> Split-Half = .62 <i>No cognitive load:</i> Split-Half = .64	<i>Joint index for load- and no load:</i> DASS-Depression: $r = .54^{***}$	<i>Joint index for load- and no load:</i> DASS-Anxiety: $r = .35^{***}$
O'Connor, Everaert, & Fitzgerald, (2021)	Unselected students (82)	Cross-sectional, 1 SST block (60), Computerized, Negativity score, English	Split-Half = .95	BDI-II: $r = .80^{***}$	STAI-T: $r = .64^{***}$
Penton-Voak et al., (2020) Study 2	Depressed individuals (190)	Post-Follow-Up-Follow-Up, 1 SST block (20) per assessment, N/A, Negativity score, English	-	SST assessed after an experimental manipulation	-
Phillips, Hine, & Bhullar, (2012)	Unselected students (306)	Cross-sectional, 1 SST block (20), Computerized, Negativity score, English	-	SST assessed after sad mood induction	-
Phillips & Hine, (2013)	Unselected students (355)	Cross-Sectional, 1 SST block (20), Computerized, Negativity score, English	-	SST assessed after sad mood induction	-

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Rohrbacher, (2016) <i>dissertation*</i>	Students with varying levels of depressive symptoms (70)	Cross-Sectional, 1 SST block (20), Paper & Pencil, Negativity score German	Cronbach's alpha = .57	BDI-II: $r = .47^{**}$	-
Romero, Sanchez, & Vazquez, (2014)	Remitted and never depressed students (70)	Cross-sectional, 1 SST block (20), Paper & Pencil, Negativity score, Spanish	-	BDI-II: $r = .25^*$ DID: $r = .19$	BAI: $r = .11$
Rude, Covich, Jarrold, Hedlund, & Zentner, (2001)	Remitted patients and never depressed (41)	Pre-Post, 2 SST blocks (20) at post, Computerized, Negativity score, English	-	SST assessed after experimental manipulation	-
Rude, Durham-Fowler, Baum, Rooney, & Maestas, (2010); Maestas et al., (2008)	Remitted or never depressed women (73)	Longitudinal (6-18 months), 2 SST blocks (25) at first session, Paper & Pencil, Positivity score, English	<i>Cognitive load:</i> Split-Half = .53	<i>Cognitive load:</i> BDI-II: $r = -.43^*$ <i>No cognitive load:</i> BDI-II: $r = -.29^{**}$	-
Rude, Durham-Fowler, Baum, Rooney, & Maestas, (2010); cited in Maestas et al., (2008)*	Male partners of women from the same study (73)	Longitudinal (6-18 months), 2 SST blocks (25) at first session, Paper & Pencil, Positivity score, English	<i>Cognitive load:</i> Split-Half = .61	<i>Cognitive load:</i> BDI-II: $r = -.23$	-
Rude, Mazzetti, Pal, & Stauble, (2011)	Students with a recent rejection experience (196)	Pre-Post, 1 SST block (25) at post, Paper & Pencil, Negativity score, English	-	SST assessed after experimental manipulation	-

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Rude, Wenzlaff, Gibbs, Vane, & Whitney, (2002); Rude, Valdez, Odom, & Ebrahimi, (2003)	Unselected Students (339), Subsample of the first sample tested again (84)	Longitudinal (4 -6 weeks, and 18-28 months for the subsample), 2 SST blocks (20) at first session, Paper & Pencil, Negativity score, English	-	<i>Cognitive load:</i> BDI-II: $r = .51^{**}$ IDD: $r = .25^{**}$ <i>No cognitive load:</i> BDI-II: $r = .55^{**}$ IDD: $r = .27^{**}$	-
Sanchez, Duque, Romero, & Vazquez, (2017)	Currently and never depressed (58)	Cross-sectional, 1 SST block (20), Computerized, Negativity score, Spanish	-	BDI-II: $r = .62^{***}$	BAI: $r = .44^{***}$
Sanchez, Everaert, De Putter, Mueller, & Koster, (2015)	Students with varying levels of depressive symptoms (52)	Cross-sectional, 5 SST blocks (8), Computerized, Positivity score, Dutch	Split-Half = .88	<i>No valence instruction:</i> <i>No cognitive load:</i> BDI-II: $r = -.75^{**}$	STAI-T: $r = .44^{***}$
Sanchez, Everaert, & Koster, (2016)	Students with varying levels of depressive symptoms (36)	Cross-sectional, 1 SST block (21), Computerized, Negativity score for correlations (Positivity in the paper), Dutch	Split-Half = .89	<i>Before manipulation:</i> <i>No cognitive load:</i> BDI-II: $r = -.60^{***}$ DASS-Depression: $r = -.51^{***}$	DASS-Anxiety: $r = -.42^{**}$
Sanchez-Lopez, De Raedt, van Put, & Koster, (2019)	Unselected students (41)	Cross-sectional, 1 SST block (12), Computerized, NA, NA	-	-	-

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Sanchez-Lopez, Everaert, Van Put, De Raedt, & Koster, (2019)	Unselected students (66)	Cross-sectional, 2 SST blocks (18), Computerized, NA, NA	-	-	-
Savulich, Freeman, Shergill, & Yiend, (2015)	Students with varying levels of paranoid thinking (70)	Cross-sectional, 2 SST blocks (20) Paper & Pencil Negativity score, English	-	Generally emotional trials: BDI-II: $r = .34^{**}$	Generally emotional trials: STAI-T: $r = .53^{***}$ GPTS: $r = .27^*$ PDI: $r = .16$ CAPS: $r = .21$ PS: $r = .40^{**}$ PSWQ: $r = .37^{**}$ LSAS: $r = .33^*$ CWI: $r = .25^*$
Savulich, Shergill, & Yiend, (2017)	Paranoid and non-paranoid schizophrenia patients, and HC (61)	Cross-sectional, 2 SST blocks (20), Paper & Pencil, Negativity score, English	-	-	Generally emotional trials: GPTS: $r = .61^{***}$ PDI: $r = .60^{***}$ PS: $r = .55^{***}$
Seeds, (2012) Dissertation*	Unselected female students (180)	Longitudinal (5 weeks), 2 SST blocks (20) at first time point, Computerized, Negativity score, English	-	Cognitive load: BDI-II: $r = .42^{***}$ IDD-L: $r = .22^{***}$ No cognitive load: BDI-II: $r = .43^{***}$ IDD-L: $r = .20^{**}$	-

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Sfärlea et al., (2019) _d	Parent (remitted & never depressed) - Children Dyads (156 (78 dyads))	Cross-sectional, Parents: 7 SST blocks (10) Children: 5 SST blocks (10), Computerized, Negativity score German	Children: Split-Half = .53 Adults: Split-Half = .78	SST assessed after a mood manipulation	-
Sfärlea et al., (2020) _d ; (Sfärlea et al., 2021)	Children and adolescents, either depressed, or at high or low familial risk for depression (121)	1 SST block (50), Computerized, Negativity score, German	Split-Half = .94	SST assessed after a mood manipulation	SST assessed after a mood manipulation
Torkan et al., (2014)	Depressed, patients (39)	Pre, Post, Follow-Up, 1 SST block (20) per session, Paper & Pencil, Negativity score, Persian	-	BDI-II: $r = .31$	STAI-T: $r = .59^{***}$
Van der Does, (2005)	Remitted patients and never depressed individuals (46)	Cross-sectional, 3 SST blocks (20), Computerized, Negativity score, Dutch	-	SST assessed after a mood manipulation	-
Van der Does, Manthey, & Hermans, (2012)	Remitted and never depressed individuals (64)	Pre-Post, 2 SST blocks (20) at post, Paper & Pencil, Negativity score Dutch	-	After a mood manipulation/thought suppression task	-

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Viviani, Dommes, Bosch, Stingl, & Beschoner, (2018) Behavioral study	Unselected students (43)	Cross-sectional, 1 SST block (80), Computerized, Positivity score, German	-	No zero order correlations presented	No zero order correlations presented
Viviani et al., (2010)	Unselected students (60)	Cross-sectional, 6 SST blocks (20-22) Paper & Pencil / Computerized Negativity score, German	-	No zero order correlations presented	No zero order correlations presented
Watkins & Moulds, (2007)	Currently or remitted depressed patients and HC (60)	Cross-sectional, 2 SST blocks (20), Paper & Pencil, Negativity score, English	-	-	-
Wells, Vanderlind, Selby, & Beevers, (2014)	Non-depressed students (155)	Longitudinal (6 months), 2 SST blocks (20) at first session, Paper & Pencil, Negativity score, English	-	<i>Cognitive load:</i> CES-D: $r = .14$ <i>No cognitive load:</i> CES-D: $r = .07$	-
Wenzlaff & Bates, (1998)	Non-depressed, at-risk and depressed students (90)	Cross-sectional, 3 SST blocks (20), Paper & Pencil, Negativity score, English	-	-	-
Westermann et al., (2021)	Patients (57)	Pre-Post, 1 SST block (20) Pre and Post, Paper & Pencil, Negativity score German	Pre: Split-Half = .90 Post: Split-Half = .87	QIDS-SR: $r = .58$	GAD-7: $r = .40$

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Williams, Blackwell, Mackenzie, Holmes, & Andrews, (2013)	Depressed individuals (69)	Pre-Post, NA SST block (NA) Pre and Post, Paper & Pencil, Computerized, Negativity score, English	-	-	-
Yiend et al., (2014)	Depressed individuals (36)	Pre-Post, 1 SST block (20) pre and post, Paper & Pencil, Negativity score, English	-	Stressor task for a subset of participants before SST assessment	-
Yiend et al., (2019) _a	HC, at risk for psychosis and first episode psychosis patients (58)	Cross-sectional, 1 SST block (20), Paper & Pencil, Positivity score, English	-	<i>Generally emotional trials:</i> <i>Adaptive bias:</i> DASS-Depression: $r = -.60^{***}$	<i>Generally emotional trials:</i> <i>Adaptive bias:</i> DASS-Anxiety: $r = -.54^{***}$ GPTS: $r = -.45^{***}$ PS: $r = -.51^{***}$
Overall		-		Low: 23 (24.21%, $n = 1777$) Medium: 34 (35.79%, $n = 2381$) High: 38 (40.00%, $n = 3751$)	Low: 19 (29.23%, $n = 1851$) Medium: 27 (41.54%, $n = 2643$) High: 19 (29.23%, $n = 648$)

Note. Studies with the authors' names in italics and marked with an asterisk indicate non-peer reviewed studies. a = positivity and negativity scores were presented with differing values, only one index was extracted in this table. b, d = Samples were partly drawn from larger studies; thus, some participants are included in both studies. Studies with the same subscript are derived from the same larger study. c = Raw data was provided, yet due to the number of erroneous trials which we coded as missing values, we could not estimate split-half reliability. HC: Healthy Controls (for details on sample descriptions, see Supplementary Material). AQ: Acrophobia Questionnaire – Anxiety subscale. BAI: Beck Anxiety Inventory. BDI(-II): Beck Depression Inventory (-II). BISS: Body Image State Scale. BShQ: Body Shape Questionnaire. BSeQ: Body Sensations Questionnaire. CAPS: Cardiff Anomalous Perceptions Scale. CDI: Children's Depression Inventory. CES-D: Center for Epidemiological Studies – Depression Scale. DARS: Dimensional Anhedonia Rating Scale. DASS: Depression, Anxiety, Stress Scales. DID: Diagnostic Interview for Depression. EDE-Q: Eating Disorder Examination Questionnaire. FNE: Fear of Negative Evaluation Scale. FSS: Fear of Spiders Screening. GAD-2/7: Generalized Anxiety Disorder 2/7-item. GPTS: Green Paranoid Thoughts Scale. HADS: Hospital Anxiety and Depression Scale. HDRS: Hamilton Depression Rating Scale. IDD: Inventory to Diagnose Depression. LSA: Liebowitz Social Anxiety Scale. PAI-BOR: Personality Assessment Inventory – Borderline Features Scale. PCL-5 = PTSD Checklist for DSM-5. PDI: Peter's Delusions Inventory. PHQ-9: Patient Health Questionnaire. PS: Paranoia Scale. PSWQ: Penn's State Worry Questionnaire. QIDS-SR: Quick Inventory of Depressive Symptomatology. SCARED: Screen for Child Anxiety Related Disorders. SIDI-F: Sexual Interest and Desire Inventory - Female. STAI-S/T: State Trait Anxiety Inventory (State/Trait version).

Table 2. Overall ROB across studies.

Risk of Bias item	% of studies fulfilling the criterion
1. Research question clear	100.00
2. Included population clear	98.91
3. Inclusion criteria clear	98.90
4. Power analysis conducted	18.18
5. Variance in symptoms of the targeted disorder	94.51
6. Valid disorder measure	100.00
7. Blinded SST application	23.86
8. Error rate on the SST reported	23.86
9. Load retention reported in studies applying a cognitive load	19.19
10. Excluded participants reported with reasons	95.60

Appendix A – References used in the qualitative/quantitative review

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REVIEW SCRAMBLED SENTENCES TASK

Scrambled but valid? The Scrambled Sentences Task as a Measure of Interpretation

Biases in Psychopathology: A Systematic Review and Meta-Analysis

Felix Würtz, Lisa Zahler, Simon E. Blackwell, Jürgen Margraf, Mahdi Bagheri, &

Marcella L. Woud

Supplementary Material

Supplementary Methods

Extracted data - Sample descriptions

From each study we extracted the type of sample and presented this information in Table 1 in the following way: Participants who were recruited without further screening or without giving further information on disorder-related inclusion criteria (e.g., convenience samples of students) were classified as ‘unselected’ (e.g. ‘unselected students’). Samples that were recruited to specifically include a range of symptom levels (e.g., by stratified sampling to include mildly and highly depressed students) were classified as having ‘varying levels’ of symptoms (e.g. ‘students with varying levels of anxiety symptoms’). Participants recruited from healthcare settings (e.g., in- or outpatients) were described as ‘patients’. Finally, when applicable we included further relevant information on the sample composition, e.g., for a study in which only participants with prior exposure to a negative life event were included, or only participants suffering from a certain disorder were included, this is described in the sample description.

Risk of bias

For our risk of bias assessment we investigated whether studies fulfilled the following criteria: (1) description of a clear research question, (2) description from what population their sample was drawn, (3) description of in- and exclusion criteria if such criteria were applied, (4) conducted a formal, a-priori power analysis to justify their sample size, (5) included a sample with some variability in the target disorder (e.g., included participants with differing levels of depression and did not specifically limit the range of symptoms to a narrow interval),

REVIEW SCRAMBLED SENTENCES TASK

(6) assessed symptoms of the target disorder using a valid and reliable measure, (7) potential blinding of SST assessment, i.e. the study procedures made it difficult for the assessor to know or find out the participants' symptom levels/clinical status or group allocation (e.g. blinding explicitly mentioned, or with administration automated or in large groups), (8) reported the error rate on the SST or the number of excluded trials, (9) reported the retention rate of the cognitive load if a cognitive load was applied, and (10) reported reasons for the exclusion of participants from analyses. For more information on our ROB assessment, see the applied checklist available on the OSF (osf.io/4fkjs).

Susceptibility to change

Susceptibility to change was investigated by extracting within group effect sizes describing effects of an intervention on the SST or between group comparisons after the intervention. We extracted such effect sizes separately for clinical and non-clinical groups. If necessary, effect sizes (Cohen's d) were calculated according to Lakens (2013). For consistency, all effect sizes were transformed into Hedge's g .

Supplementary Results

Meta analysis convergent validity

The funnel plot (Fig. S1) showed an approximately symmetrical distribution with a tendency that studies with lower standard errors providing slightly higher convergent validity estimates. One study was found to largely deviate from the other studies as its standard error was high and its estimated convergent validity of the SST was near to zero. Overall, the funnel plot indicated that it is unlikely that correlations were conflated by a small sample bias. These findings were mirrored by the forest plot (Fig. S2).

Meta-analysis convergent validity – exploratory analysis

Following our main convergent validity meta-analysis, we further investigated whether the high amount of between-study heterogeneity might reflect a difference in the strength of correlations between disorders, for example through a difference in the relevance

REVIEW SCRAMBLED SENTENCES TASK

of interpretation biases in particular disorders. Repeating the analysis of the intercept only model of the convergent validity meta-analysis including only studies investigating depression however produced a similar set of results, r [95%-CI] = .44 [.38, .50], with a significant amount of heterogeneity within studies (level 2: σ^2 = .008, 24.99%), $\chi(1) = 23.52$, $p < .001$, as well as between studies (level 3: σ^2 = .020, 60.33%), $\chi(1) = 6.60$, $p = .010$. Comparable to the main analysis, 14.68% of the variance was accounted for by random sampling (level 1).

Meta analysis reliability

The funnel plot for the reliability of the SST (Fig. S3) mirrored the one for the convergent validity. Studies with lower standard errors estimated the reliability to be slightly higher than studies with higher standard errors. Importantly, one study with the highest standard errors estimated the reliability of the SST to be negative and therefore introduced asymmetry to the funnel plot. In summary, the investigation of the funnel plot indicated that the reliability was unlikely to be conflated by a small sample bias, and this was also supported by the inspection of the forest plot (Fig S4).

Risk of bias

A summary of the aggregated risk of bias information can be found in the main manuscript (Table 2). For details on the risk of bias of individual studies, see Table S1.

Susceptibility to change following an intervention

As shown in Table S2, data on change in SST scores was heterogeneous, with some studies reporting only within-group effects, and some reporting only between-group differences between two interventions. Further, different control conditions were used, e.g., wait-list conditions, sham-training, or treatment as usual (TAU). The heterogeneity in effect sizes, in particular between active training conditions and controls, supports the SST being susceptible to change in that it is consistent with it changing a greater or lesser amount depending on the efficacy of the intervention. However, it is beyond the scope of this paper to discuss these data

REVIEW SCRAMBLED SENTENCES TASK

in more detail (e.g., the correspondence between SST change and change on other indices of intervention efficacy).

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Figure S1

Funnel plot for convergent validity

Figure S2
Forest plot for convergent validity

Figure S3

Funnel plot for reliability

Figure S4
Forest plot for reliability

Table S1. Selection of common interpretation bias measures in the context of psychopathology.

Task / Stimuli	Design and instructions	Derived bias index
Ambiguous Scenarios Task (AST; Berna, Lang, Goodwin, & Holmes, 2011)	Ambiguous, everyday life scenarios are presented. Participants are instructed to briefly imagine themselves in each scenario and subsequently rate the pleasantness of each scenario.	Sum pleasantness ratings collapsed across all scenarios.
Encoding Recognition Task (Mathews & Mackintosh, 2000)	Two-step procedure. In the Encoding phase, participants are presented with ambiguous scenarios, introduced by a title. Participants are asked to read the scenarios and imagine themselves in the described situation. In the recognition phase, participants are presented with the titles again, together with positive and negative sentences resolving the ambiguity of the scenario that belonged to the corresponding title. Participants are instructed to rate how close in meaning each sentence seems to the meaning of the original scenario.	Similarity ratings of positive and negative sentences, respectively.
Homophones (Mathews, Richards, & Eysenck, 1989)	Participants are presented with words (mostly aurally) that have the same pronunciation but different spelling and thus meanings, e.g., one threatening and one non-threatening. It is participants' task to report the word they heard.	Number of words using the functional/dysfunctional spelling, respectively.
Homographs (e.g., McKellar, Clark, & Shriner, 2003)	Participants are presented with written words that have the same spelling but different meanings, e.g., one threatening, one non-threatening. Participants are asked to report their interpretation of the presented word.	Functionality/Dysfunctionality of the words participants write down following the homographs.
Interpretation bias questionnaires (e.g., McNally & Foa, 1987)	Presentation of ambiguous situations, followed by various potential explanations, e.g., neutral, benign, or dysfunctional interpretations. Participants are instructed to e.g., select the explanation that fits best, rank-order the explanations in terms of likelihood, or rate each explanation in terms of plausibility.	Likelihood or plausibility ratings of the dysfunctional interpretations, or number of situations for which the dysfunctional interpretation is rated to fit best.
Lexical Decision Tasks (LDT)/Semantic priming (e.g., Hirsch & Mathews, 1997)	Each trial consists of two parts. First, a prime is presented (e.g., disorder-relevant or neutral), without participants responding to it. Next, target words are	Response latencies with which participants categorize target words following

	presented (e.g., disorder-relevant or neutral), and participants are instructed to categorize the target as quickly as possible. Depending on the specific operationalization, targets can be categorized according to their valence, e.g., positive vs. negative, or whether they are existing words or non-words.	the disorder-related primes compared to the target words following the disorder-unrelated primes.
Scenario completion tasks (e.g., Woud et al., 2019)	Presentation of open-ended, ambiguous disorder-related scenarios. Participants are instructed to complete each scenario, by writing down the first spontaneous ending that comes to their mind.	Ratio of scenario endings in a dysfunctional direction compared to the total number of scenario endings resembling an appraisal of the scenario.
Scrambled Sentences Task (SST) (Wenzlaff & Bates, 1998)	Presentation of strings of six words in random order. Per string, two target words (dysfunctional vs. non-dysfunctional) are included. Participants are instructed to form correct sentences by using five out of the six words. Depending on the chosen target word, the generated sentence turns into a dysfunctional versus non-dysfunctional sentence.	Ratio of grammatically correct dysfunctional versus all grammatically correct sentences.
Word Blends (Dearing & Gotlib, 2009)	Participants are presented with aurally merged words that differ only by one phoneme. One word has a negative/dysfunctional meaning, one a neutral meaning (e.g., sand – sad). Participants are instructed to report the word they heard.	Number of trials for which participants report the negative/dysfunctional word.
Word Sentence Association Paradigm (WSAP) (Beard & Amir, 2009)	Each trial consists of two phases. In phase one, a disorder-related benign or malign word is presented. In phase two, an ambiguous sentence is presented. Participants are instructed to indicate whether word and sentence are related.	Endorsement rates of whether word and sentence are related and reaction times to make the endorsement.

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Table S2. Risk of bias of individual studies.

Study	Question clear	Population clear	Inclusion clear	Power analysis	Disorder variance	Valid disorder measure	Blinded SST application	Error rate report	Load retention report	Excluded participants report	Overall quality rating
<i>Bipolar Disorder I/II</i>											
Miklowitz, Alatiq, Geddes, Goodwin, & Williams, (2010)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	Poor
<i>Borderline Personality Disorder (BPD)</i>											
Geiger, Peters, & Baer, (2014)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Good
<i>Eating disorders</i>											
Bradatsch et al., (2020)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Good
Brockmeyer et al., (2018)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Good
<i>Psychosis</i>											
Savulich et al., (2020) Experiment 1	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Savulich, Freeman, Shergill, & Yiend, (2015)	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Fair

Savulich, Shergill, & Yiend, (2017)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	Fair
Yiend et al., (2019)	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Fair
<i>Posttraumatic Stress Disorder (PTSD)</i>											
Viviani, Mahler, et al., (2018) Behavioral study	Yes	Yes	Yes	No	Yes	Yes	No	Yes	NA	Yes	Fair
Viviani, Mahler, et al., (2018) Neuroimaging study	Yes	Yes	Yes	No	Yes	Yes	No	Yes	NA	Yes	Fair
Würtz, Blackwell, Margraf, & Woud, (2021)*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Good
<i>Social Anxiety</i>											
Bowler et al., (2012) Pilot study* cited in Burnett Heyes et al., (2017)	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Fair
Burnett Heyes et al., (2017)	NA	NA	NA	NA	NA	Yes	NA	No	No	NA	Poor
de Voogd et al., (2017)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Good

Krans, Bosmans, Salemink, & De Raedt, (2019)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Standage, (2009) pilot study* cited in Standage, Ashwin, & Fox, (2010)	NA	No	NA	No	NA	Yes	NA	No	No	NA	Poor
Standage, Ashwin, & Fox, (2010) Experiment 1	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Poor
Standage, Ashwin, & Fox, (2010) Experiment 2	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Poor
Generalized Anxiety Disorder (GAD)											
Deschênes, Dugas, Anderson, & Gouin, (2015)	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	Fair
Donegan, (2016) Dissertation*	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Hirsch et al., (2018)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Fair
Hirsch et al., (2021)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Fair

Hirsch et al., (2020),	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Good
Hirsch, Meeten, et al., (2020)	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	Fair
Krahé, Meeten, & Hirsch, (2020)*	Yes	Yes	Yes	NA	Yes	Yes	Yes	No	No	Yes	Good
Krahé, Whyte, Bridge, Loizou, & Hirsch, (2019)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
McNally, (2014) Dissertation*	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	Fair
<i>Panic Disorder</i>											
Zahler et al., (2020)	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Fair
<i>Female Sexual Dysfunction</i>											
Zahler et al., (2021)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Good
<i>Depression</i>											
Beevers, (2002) Dissertation*	Yes	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	Fair
Beevers & Meyer, (2008)	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	Fair
Bibi, Margraf, & Blackwell, (2020)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Blackwell & Holmes, (2010)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair

Blanco, Boemo, & Sanchez-Lopez, (2021)	Yes	Yes	Yes	No	Yes	Yes	Yes	No	NA	Yes	Fair
Blackwell et al., (2015); Ji, Holmes, & Blackwell, (2017); Blackwell & Holmes, (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Good
Brockmeyer et al., (2012)	Yes	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	Fair
Cowden Hindash & Rottenberg, (2017a)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	Fair
Cowden Hindash & Rottenberg, (2017b)*	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Good
Dickson, (2015) Dissertation*	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Fair
Everaert, Mogoase, David, & Koster, (2015) Experiment 2a	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	Fair
Everaert, Mogoase, David, & Koster, (2015) Experiment 2b	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	Fair

Everaert, Tierens, Uzieblo, & Koster, (2013)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Good
Everaert, Duyck, & Koster, (2014)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Everaert, Grahek, Duyck, et al., (2016); Everaert, Grahek, & Koster, (2016)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Gill, Miller, Haner, & Rude, (2017) Study 2	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Hedlund & Rude, (1995)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Holmes, Lang, & Shah, (2009), Experiment Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Fair
Krejtz, Holas, Rusanowska, & Nezlek, (2018)	Yes	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	Fair
Lang, Blackwell, Harmer, Davison, & Holmes, (2012)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Lee, Mathews, Shergill, & Yiend, (2016)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair

LeMoult et al., (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Good
Lin et al., (2020) Study	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Good
Lo, (2009) Dissertation*	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Marchetti, Koster, & De Raedt, (2012)	Yes	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	Fair
Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 1*	NA	Yes	Yes	NA	Yes	Yes	NA	NA	NA	Yes	Fair
Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 2*	NA	Yes	Yes	NA	Yes	Yes	NA	NA	NA	Yes	Fair
Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 3*	NA	Yes	Yes	NA	Yes	Yes	NA	NA	NA	Yes	Fair
Miller, Rude, & Haner, (2015)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Moon & Lord, (2006), Study 1	Yes	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	Fair
Moon & Lord, (2006), Study 3	Yes	Yes	Yes	No	Yes	Yes	No	No	NA	Yes	Fair
Murphy et al., (2015)	Yes	Yes	No	No	Yes	Yes	No	No	No	Yes	Fair
Novović, Mihić, Biro, & Tovilović, (2014)	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Good

O'Connor, Everaert, & Fitzgerald, (2021)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Penton-Voak et al., (2020) Study 2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Good
Phillips, Hine, & Bhullar, (2012)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Good
Phillips & Hine, (2013)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Good
Rohrbacher, (2016) dissertation*	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Romero, Sanchez, & Vazquez, (2014)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Rude, Covich, Jarrold, Hedlund, & Zentner, (2001)	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Fair
Rude, Durham-Fowler, Baum, Rooney, & Maestas, (2010); Maestas et al., (2008)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Rude, Durham-Fowler, Baum, Rooney, & Maestas, (2010);	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair

cited in Maestas
et al., (2008)*

Rude, Mazzetti,
Pal, & Stauble,
(2011)

Yes

Yes

Yes

No

Yes

Yes

No

No

No

Yes

Fair

Rude, Wenzlaff,
Gibbs, Vane, &
Whitney,
(2002); Rude,
Valdez, Odom,
& Ebrahimi,
(2003)

Yes

Yes

Yes

No

Yes

Yes

Yes

No

Yes

Yes

Good

Sanchez, Duque,
Romero, &
Vazquez, (2017)

Yes

Yes

Yes

No

Yes

Yes

No

No

No

Yes

Fair

Sanchez,
Everaert, De
Putter, Mueller,
& Koster,
(2015)

Yes

Yes

Yes

No

Yes

Yes

No

No

NA

Yes

Fair

Sanchez,
Everaert, &
Koster, (2016)

Yes

Yes

Yes

No

Yes

Yes

No

No

NA

Yes

Fair

Seeds, (2012)
Dissertation*

Yes

Yes

Yes

No

Yes

Yes

No

No

Yes

Yes

Fair

Sanchez-Lopez,
De Raedt, van
Put, & Koster,
(2019)

Yes

Yes

Yes

Yes

Yes

Yes

No

NA

NA

Yes

Fair

Sanchez-Lopez,
Everaert, Van
Put, De Raedt,

Yes

Yes

Yes

No

Yes

Yes

No

NA

NA

Yes

Fair

& Koster, (2019)											
Sfärlea et al., (2019)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Good
Sfärlea et al., (2020); Sfärlea et al., (2021)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Good
Torkan et al., (2014)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Fair
Van der Does, (2005)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Van der Does, Manthey, & Hermans, (2012)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Viviani, Dommes, Bosch, Stingl, & Beschoner, (2018)											
Behavioral study	Yes	Yes	Yes	No	Yes	Yes	No	Yes	NA	Yes	Fair
Viviani et al., (2010)	Yes	Yes	Yes	No	Yes	Yes	No	Yes	NA	Yes	Fair
Watkins & Moulds, (2007)	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Good
Wells, Vanderlind, Selby, & Beevers, (2014)	Yes	Yes	Yes	No	No	Yes	No	No	No	No	Poor
Wenzlaff & Bates, (1998)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Good

Westermann et al., (2021)	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Fair
Williams, Blackwell, Mackenzie, Holmes, & Andrews, (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	Yes	Good
Yiend et al., (2014)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Good

Note. NA = Not available.

Table S3. Susceptibility to change.

Study	Type of sample (N)	SST scoring	Susceptibility to change (time since first SST assessment in pre-post designs)
<i>Bipolar Disorder I/II (BD)</i>			
<i>Clinical</i>			
Miklowitz, Alatiq, Geddes, Goodwin, & Williams, (2010)	Remitted Bipolar Disorder and MDD patients, and HC (76)	Negativity and Hyperpositivity score	
<i>Borderline Personality Disorder</i>			
<i>Non-clinical</i>			
Geiger, Peters, & Baer, (2014)	Students with varying levels of BPD features (181)	Positivity score	-
<i>Eating Disorders</i>			
<i>Clinical</i>			
Brockmeyer et al., (2018)	Female individuals with Anorexia (37) and HC (33) (Total 70)	Negativity score	
<i>Non-clinical</i>			
Bradatsch et al., (2020)	Women with elevated body dissatisfaction (33)	Negativity score	<i>Pre-Post CBM (2 weeks):</i> <i>Experimental group:</i> $g = -.47$ <i>Control group:</i> $g = -.10$
<i>Paranoia & Psychosis</i>			

<i>Clinical</i>			
Savulich, Shergill, & Yiend, (2017)	Paranoid and non-paranoid schizophrenia patients, and HC (61)	Negativity score	-
Yiend et al., (2019) _a	HC, at risk for psychosis and first episode psychosis patients (58)	Positivity score (Adaptive bias in the study)	-
<i>Non-clinical</i>			
Savulich et al., (2020) Experiment 1	Healthy participants with differing levels of paranoid thinking (70)	Negativity score	-
Savulich, Freeman, Shergill, & Yiend, (2015)	Students with varying levels of paranoid thinking (70)	Negativity score	-
<i>PTSD</i>			
<i>Non-clinical</i>			
Viviani, Mahler, et al., (2018) Behavioral study	Unselected students (36)	Positivity score	-
Viviani, Mahler, et al., (2018) Neuroimaging study	Unselected students (20)	Positivity score	-
Würtz, Blackwell, Margraf, & Woud, (2021)*	Participants with a distressing life event (214)	Negativity score	-
<i>Social Anxiety</i>			
<i>Non-Clinical</i>			

Bowler et al., (2012)	Socially anxious students (63)	Negativity score	<i>Pre-post intervention (2 weeks)</i> <i>Load:</i> CBM-I: $g = -.93$ cCBT: $g = -.34$ Control: $g = .21$ <i>No load:</i> CBM-I: $g = -.79$ cCBT: $g = -.54$ Control: $g = -.21$
Burnett Heyes et al., (2017) <i>Pilot study* cited in</i> <i>Burnett Heyes et al.,</i> (2017)	Unselected young adults (60)	Negativity score	-
Burnett Heyes et al., (2017)	Unselected adolescents (57)	Negativity score	<i>Post imagery training:</i> <i>Field perspective:</i> Positive vs. mixed: $g = -.55$ <i>Observer perspective:</i> Positive vs. mixed: $g = -.08$
de Voogd et al., (2017)	Adolescents with elevated anxiety/depression (119)	Negativity score	<i>Pre-post CBM (4 weeks):</i> Scenario condition: $g = -.10$ Picture word condition: $g = -.06$ Control condition: $g = -.26$

Krans, Bosmans, Salemink, & De Raedt, (2019)	Unselected students (120)	Positivity score	Post CBM: <i>Social situation trials:</i> Positive vs. negative: $g = .39$ <i>Future expectancy trials:</i> Positive vs. negative: $g = .18$
Standage, (2009) pilot study* cited in Standage, Ashwin, & Fox, (2010)	N/A	Positivity score	-
Standage, Ashwin, & Fox, (2010) Experiment 1	Unselected students (30)	Positivity score	Pre-post CBM (same laboratory session): Positive: $g = .71$ Negative: $g = -.63$
Experiment 2	Unselected students (29)	Positivity score	Pre-post mood induction (same laboratory session): Positive: $g = .29$ Negative: $g = .45$

Generalized Anxiety Disorder (GAD)

Clinical

Donegan, (2016) Dissertation*	Individuals with GAD (29)	Negativity score	Pre-post CBM (3 weeks): CBM: $g = -.82$ Control: $g = .22$ Pre-Follow-up CBM (4 weeks): CBM: $g = -.47$ Control: $g = -.23$
Hirsch et al., (2018) _b	MDD and GAD patients (130)	Positivity score	Pre-Post CBM (1 month): CBM: $g = .68$ Control: $g = .18$

Hirsch et al., (2021)	Community volunteers with GAD (183)	Positivity score	<i>Pre-Post CBM (1 month):</i> CBM: $g = .97$ Control: $g = .18$
Krahé, Whyte, Bridge, Loizou, & Hirsch, (2019) _b	Individuals with GAD or MDD, and HC (221)	Positivity score	-
McNally, (2014) <i>Dissertation</i> *	GAD patients (7)	Negativity score	<i>Pre-post CBM (1 week):</i> $g = -1.08$ <i>Pre-follow-up CBM (2 weeks):</i> $g = -1.37$
<i>Non-Clinical</i>			
Deschênes, Dugas, Anderson, & Gouin, (2015)	Unselected students (77)	Negativity score	<i>Pre-post anger induction (same laboratory session):</i> Anger induction: $g = .23$ Control: $g = -.31$
Hirsch et al., (2020)	Community sample with elevated rumination/worry (160)	Positivity score	<i>Pre-Post CBM (1 month):</i> CBM $g = .77$ Control: $g = .05$
Hirsch, Meeten, et al., (2020)	Community sample of pregnant and non-pregnant women (237)	Positivity score	-
Krahé, Meeten, & Hirsch, (2020)*	Community sample (88)	Positivity score	-
<i>Panic Disorder</i>			
<i>Non-Clinical</i>			
Zahler et al., (2020)	Students with differing levels of anxiety sensitivity (54)	Negativity score	-

Female Sexual Dysfunction

Non-Clinical

Zahler et al., (2021)	Female community sample (263)	Negativity score	-
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Depression

Clinical

Blackwell & Holmes, (2010)	Depressed individuals (7)	Negativity score	Pre-Post CBM (1 week): $g = -.66$
Blackwell et al., (2015); Ji, Holmes, & Blackwell, (2017); Blackwell & Holmes, (2017)	Depressed individuals (150)	Negativity score	Pre-post CBM (4 weeks): CBM: $g = -.45$ Control: $g = -.48$
Dickson, (2015) Dissertation*	Remitted depressed & never depressed (38)	Negativity score	-
Gill, Miller, Haner, & Rude, (2017) Study 2	Remitted depressed (53)	Proportion of Big-Picture related sentences	-
Hedlund & Rude, (1995)	Patients, remitted depressed and HC (53)	Negativity score	-
Krejtz, Holas, Rusanowska, & Nezlek, (2018)	Depressed individuals (51 for SST data)	Positivity score	Pre-post ABM (2 weeks): Attention training: $g = .51$ Control: $g = .12$

Lang, Blackwell, Harmer, Davison, & Holmes, (2012)	Depressed individuals (26)	Negativity score	<i>Pre-post CBM (1 week):</i> CBM condition: $g = -.59$ Control condition: $g = .17$
LeMoult et al., (2018)	Depressed adolescents (46)	Positivity score	<i>Pre-post CBM (2 weeks):</i> Positive CBM: $g = .20$ Neutral CBM: $g = -.17$
<i>Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 3*</i>	Currently and never depressed (80)	-	-
Rude, Covich, Jarrold, Hedlund, & Zentner, (2001)	Remitted patients and never depressed (41)	Negativity score	-
Rude, Durham-Fowler, Baum, Rooney, & Maestas, (2010); Maestas et al., (2008)	Remitted or never depressed women (73)	Negativity score	-
Sanchez, Duque, Romero, & Vazquez, (2017)	Currently and never depressed (58)	Negativity score	-
Sfärlea et al., (2019) _c	Parent (remitted & never depressed) -Children Dyads (156 (78 dyads))	Negativity score	-
Sfärlea et al., (2020) _c ; (Sfärlea et al., 2021)	Children and adolescents, either depressed, or at high or low familial risk for depression (121)	Negativity score	-

Torkan et al., (2014)	Depressed, patients (39)	Negativity score	<i>Pre-Post CBM (1 week):</i> Imagery CBM: $g = -.97$ Non-imagery CBM: $g = .33$ Control: $g = .18$ <i>Pre-Follow-up CBM (2 weeks):</i> Imagery CBM: $g = -1.46$ Non-imagery CBM: $g = .56$
Van der Does, (2005)	Remitted patients and never depressed individuals (46)	Negativity score	-
Van der Does, Manthey, & Hermans, (2012)	Remitted and never depressed individuals (64)	Negativity score	-
Watkins & Moulds, (2007)	Currently or remitted depressed patients and HC (60)	Negativity score	-
Westermann et al., (2021)	Patients (57)	Negativity score	<i>Pre-Post CBM (2 weeks):</i> CBM: $g = -.52$ Treatment as usual: $g = -.18$ Cognitive control training: $-.10$
Williams, Blackwell, Mackenzie, Holmes, & Andrews, (2013)	Depressed individuals (69)	Negativity score	<i>Pre-post CBM (1 week):</i> CBM + CBT: $g = -.16$ Control: $g = .01$
Yiend et al., (2014)	Depressed individuals (36)	Negativity score	<i>Pre-post CBM (same laboratory session):</i> CBM: $g = -.32$ Control: $g = .21$
<hr/> <i>Non-Clinical</i> <hr/>			
Beevers, (2002) Dissertation*	Remitted and never depressed students (116)	Negativity score	<i>Pre-post negative mood induction (same laboratory session):</i> Remitted depressed: $g = -.20$ Never depressed: $g = .14$

Beevers & Meyer, (2008)	Non-depressed students (65)	Negativity score	-
Bibi, Margraf, & Blackwell, (2020)	Depressed students (55) Intention to treat sample	Negativity score	<i>Pre-post CBM (1 week):</i> CBM: $g = 2.15$ Control: $g = .25$
Blanco, Boemo, & Sanchez-Lopez, (2021)	Unselected adults (80)	Negativity score	-
Brockmeyer et al., (2012)	Remitted and never depressed (40)	Negativity score	<i>Pre-post negative mood induction (same laboratory session):</i> Remitted depressed: $g = -.74$ Never depressed: $g = .24$
Cowden Hindash & Rottenberg, (2017a)	Dysphoric and non-dysphoric students (160)	Negativity score	-
<i>Cowden Hindash & Rottenberg, (2017b)*</i>	Dysphoric and non-dysphoric students (162)	Negativity score	<i>Post CBM:</i> CBM vs. control: $g = .86$
Everaert, Mogoșe, David, & Koster, (2015) Experiment 2a	Non-depressed students (38)	Negativity score	<i>Pre-post CBM (same laboratory session):</i> Negative: $g = -.22$ Positive: $g = -.06$
Experiment 2b	Non-depressed students (39)	Negativity score	<i>Pre-post CBM (same laboratory session):</i> Negative: $g = -.03$ Positive: $g = -.33$
Everaert, Tierens, Uzieblo, & Koster, (2013)	Students with varying levels of depressive symptoms (64)	Negativity score	-

Everaert, Duyck, & Koster, (2014)	Students with varying levels of depressive symptoms (71)	Negativity score	-
Everaert, Grahek, Duyck, et al., (2016) Everaert, Grahek, & Koster, (2016)	Students with varying levels of depressive symptoms (112)	Negativity score	-
Holmes, Lang, & Shah, (2009), Experiment 1	Community sample (38)	Negativity score	Post CBM: Imagery vs. verbal condition $g = .73$
Lee, Mathews, Shergill, & Yiend, (2016)	Depressed individuals (71)	Negativity score	-
Lin et al., (2020) Study 1	Unselected students (145)	Negativity score	-
Lo, (2009) Dissertation*	Remitted and never depressed (40)	Negativity score	-
Marchetti, Koster, & De Raedt, (2012)	Unselected students (79)	Negativity score	Pre-post mind wandering induction (same laboratory session): $g = .27$
Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 1*	Remitted and never depressed (109)	Negativity score	-
Martin-Romero, Sanchez-Lopez, & Vazquez, (in prep), Study 2*	Depressed, remitted, never depressed (409)	Negativity score	-

Miller, Rude, & Haner, (2015)	Unselected students (137)	Training congruent vs. incongruent sentences	Post CBM: Big picture vs. evaluative CBM: $g = .48$
Moon & Lord, (2006), Study 1	Unselected students (91)	Negativity score	Instructions to only create positive sentences were given
Moon & Lord, (2006), Study 3	Unselected students (100)	Negativity score	Instructions to only create positive sentences were given
Murphy et al., (2015)	Healthy older adults (77)	Negativity score	Pre-post CBM (4 weeks): Imagery: $g = .00$ Control: $g = .06$ Pre-follow up CBM (8 weeks): Imagery: $g = -.06$ Control: $g = -.11$
Novović, Mihić, Biro, & Tovilović, (2014)	Unselected students (1071)	Negativity score	-
O'Connor, Everaert, & Fitzgerald, (2021)	Unselected students (82)		

Penton-Voak et al., (2020) Study 2	Depressed individuals (190)	Negativity score	Post CBM: CBM vs. control group: Adjusted mean difference: $\Delta = .30$
Phillips, Hine, & Bhullar, (2012)	Unselected students (306)	Negativity score	-
Phillips & Hine, (2013)	Unselected students (355)	Negativity score	-
<i>Rohrbacher, (2016) dissertation*</i>	Students with varying levels of depressive symptoms (70)	Negativity score	-
Romero, Sanchez, & Vazquez, (2014)	Remitted and never depressed students (70)	Negativity score	-
<i>Rude, Durham- Fowler, Baum, Rooney, & Maestas, (2010); cited in Maestas et al., (2008)*</i>	Male partners of women from the same study (73)	Positivity score	-
Rude, Mazzetti, Pal, & Stauble, (2011)	Students with a recent rejection experience (196)	Negativity score	Post coping manipulation: Evaluative vs. control: $g = .07$ Contextual vs. control: $g = -.20$ Experiential vs. control: $g = -.22$

Rude, Wenzlaff, Gibbs, Vane, & Whitney, (2002); Rude, Valdez, Odom, & Ebrahimi, (2003)	Unselected Students (339), Subsample of the first sample tested again (84)	Negativity score	-
Sanchez, Everaert, De Putter, Mueller, & Koster, (2015)	Students with varying levels of depressive symptoms (52)	Positivity score	-
Sanchez, Everaert, & Koster, (2016)	Students with varying levels of depressive symptoms (36)	Positivity score	<i>Instruction to form attend positive sentences as the intervention</i>
Sanchez-Lopez, De Raedt, van Put, & Koster, (2019)	Unselected students (41)	-	-
Sanchez-Lopez, Everaert, Van Put, De Raedt, & (Koster, 2019)	Unselected students (66)		
<i>Seeds, (2012) Dissertation*</i>	Unselected female students (180)	Negativity score	-
Viviani et al., (2010)	Unselected students (60)	Negativity score	-
Viviani, Dommès, Bosch, Stingl, & Beschoner, (2018) Behavioral study	Unselected students (43)	Positivity score	-

Wells, Vanderlind, Selby, & Beevers, (2014)	Non-depressed students (155)	Negativity score	-
Wenzlaff & Bates, (1998)	Non-depressed, at-risk and depressed students (90)	Negativity score	-

Note. Author names in italics and marked with an asterisk indicate unpublished data, preprints before peer-review or doctoral dissertations. a = positivity and negativity scores were presented with differing values, only one index was extracted in this table. b, c = Samples were partly drawn from larger studies; thus some participants are included in both studies. Studies with the same subscript are derived from the same larger study. larger study. Negative effect sizes represent a decrease in the respective bias score from pre to post in pre-post designs (or follow-up) and vice versa for positive effect sizes. In cross-sectional comparisons a negative effect size represents a higher bias score in the first mentioned condition compared to the second and vice versa for positive effect sizes. a) In this study, two different scoring methods were used, only scores for the adaptive bias are presented in the results. Susceptibility to change was mostly computed from descriptive statistics. As information about correlation between different assessment time points or a disparity measure of the change scores was not always available, no p-values were computed.