Empirical Paper

JOURNAL OF EXPERIMENTAL PSYCHOPATHOLOGY

Journal of Experimental Psychopathology
January-March 2024: 1–17

DOI: 10.1177/20438087241226642
journals.sagepub.com/home/jepp
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Association between interpretation flexibility and emotional health in an anxious sample: The challenge of measuring flexible adoption of multiple perspectives

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Abstract

Interpreting ambiguous situations in a rigidly negative manner contributes to emotional disorders. Although negative interpretation biases have been well studied in relation to anxiety and depression, the relationship between interpretation flexibility (vs. rigidity) and emotional health remains understudied. The present study is a secondary analysis to test the hypothesis that higher interpretation flexibility is associated with better emotional health, as indicated by lower anxiety and depression levels, and higher quality of life. Here, interpretation flexibility focuses specifically on the ability to recognize multiple possible interpretations within and across ambiguous situations. Using baseline data from $N = 939$ high trait-anxious community participants who enrolled in an online anxiety intervention, multiple ways of computing interpretation flexibility were applied to help the field learn how different operationalizations can lead to varied conclusions about the connection between interpretation flexibility and emotional health. Using two measures of interpretation style, four approaches (some pre-registered, some exploratory) to computing interpretation flexibility were tested using an internal replication analytic approach. Results varied across type of approach, but in general, contrary to hypotheses, results indicated that higher interpretation flexibility was either unrelated to, or associated with higher, anxiety, and depression, and lower quality of life.

Keywords

Interpretation bias, flexibility, anxiety, depression, quality of life

Date received: 5 September 2023; accepted: 27 December 2023

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Introduction

The tendency to rigidly interpret ambiguous situations in a negative manner is theorized to causally contribute to anxiety and depression (Mathews & Mackintosh, 1998; Mathews & MacLeod, 2005; Ouimet et al., 2009). Such theoretical accounts have received support from empirical studies that show the tendency to preferentially assign negative (vs. non-negative) meanings to ambiguous information is associated with elevated anxiety and depression (Lawson & MacLeod, 1999; MacLeod et al., 1993; Mogg et al., 2006); for reviews see Everaert et al. (2017) and Hirsch et al. (2016). Consistent with theorized causal links, experimental inductions of a negative interpretation style leads to greater negative emotion reactivity to a stressor as compared to the induction of a benign interpretation style (Mathews & Mackintosh, 2000; Mathews & MacLeod, 2002; Wilson et al., 2006). Analogously, cognitive bias modification of interpretation style (CBM-I) interventions, which are designed to reduce negative interpretation style through repeated practice adopting benign/positive interpretations reduce worry and rumination (Hirsch et al., 2020), as well as anxiety and depressed mood (Fodor et al., 2020; Krebs et al., 2018).

The primary mechanism through which CBM-I interventions reduces emotional psychopathology is theorized to be the induction of positively biased interpretation style in place of negatively biased interpretation style (Hertel & Mathews, 2011; Hoppitt et al., 2010; Menne-Lothmann et al., 2014). However, another plausible mechanism of CBM-I is that, by engaging in repeated practice of interpreting ambiguous situations in a benign or positive manner, individuals learn to interpret ambiguous situations more flexibly, finding it easier to consider an ambiguous situation from multiple perspectives (Steinman et al., 2021). This proposed mechanism makes the assumption that making flexible interpretations is adaptive and beneficial to emotional wellbeing, such that having a rigidly negative interpretation style or a rigidly positive interpretation style, are both suboptimal. This assumption is plausible based on research pointing to the positive links between emotional wellbeing and psychological flexibility more generally (Bonanno & Burton, 2013; Kashdan & Rottenberg, 2010; Stange et al., 2017). While interpretation bias flexibility is conceivably a sub-component of psychological flexibility, the relationship between interpretation flexibility and emotional wellbeing remains unclear, in part due to the lack of a common approach to conceptualizing and assessing interpretation flexibility.

As reflected in the wider literature on psychological flexibility, flexibility is a multifaceted construct that spans the deployment and regulatory control of a diverse range of responses at cognitive, emotional, and behavioral levels in a context sensitive manner (Bonanno & Burton, 2013; Cherry et al., 2021; Stange et al., 2017). As such, flexibility in adopting multiple interpretations of the meaning, causes, and implications of ambiguous situations can be construed as a component of cognitive flexibility; namely, the ability to adopt multiple perspectives (Dennis & Vander Wal, 2010; Fresco et al., 2007). In the present context, adopting multiple perspectives refers to seeing a given ambiguous situation as having multiple potential causes and possible outcomes and recognizing that different situations play out in different ways; a particular form of perspective taking. Interpreting ambiguous situations in multiple ways may thus be related to other constructs such as hypothetical thinking (Evans et al., 2003) and social perspective taking (Gehlbach & Mu, 2023). We note that the present focus is related to, but distinct from, other important facets of interpretation flexibility, such as the updating of initially negative interpretations within an unfolding situation in response to new information (e.g., as assessed by the emotional Bias Against Disconfirmatory Evidence task (Everaert et al., 2018), or the specific ability to shift from negative to positive causal inferences for negative events (Perlman & Mor, 2022).

The present focus on interpretation flexibility as the adoption of multiple perspectives was selected because it arises routinely in daily life, and deficits in this ability are likely to have many downstream negative consequences for individuals prone to emotional vulnerability. Specifically, in addition to its impact on negative emotion and negative repetitive thinking (rumination and worry (Hirsch et al., 2020), rigidly interpreting ambiguous or uncertain situations in a negative manner may contribute to avoidance and withdrawal behaviors that maintain anxiety and depression (Barlow, 2004; Ottenbreit & Dobson, 2004). For example, if you assume a friend canceled on plans with you because they dislike you and you don't consider other possible explanations, you will likely avoid reaching out to that friend again. Comparably, rigidly interpreting ambiguous or uncertain situations in a positive manner may also lead to maladaptive behaviors, such as not going to see a doctor about persistent symptoms because you interpret the symptoms as benign. While it is plausible that greater interpretation flexibility would be associated with greater emotional wellbeing, there has been little empirical investigation into these links.

The present paper uses our data from Ji et al. (2021) to test the relationships between four different operationalizations of interpretation flexibility and indicators of emotional health, assessed via measures of anxiety and depression symptoms and quality of life. We conducted a pre-registered internal replication using baseline data from a large, online clinical trial with high trait anxious adults (NCT02382003), followed by secondary exploratory analyses. The four operationalizations of flexible interpretation style were applied to data from two widely used measures of interpretation bias: the Recognition Rating task (adapted from Mathews & Mackintosh, 2000) and the Brief Bodily Sensations Interpretation Questionnaire (BBSIQ; Clark

et al., 1997). While these measures were designed to assess interpretation valence bias (the tendency to adopt negative rather than benign/positive interpretations) rather than interpretation flexibility, both measures present a range of ambiguous everyday situations that have negative as well as non-negative interpretations, and participants are asked to rate how much they endorse each type of interpretation. Thus, we attempted to use these responses as indicators of flexible adoption of multiple perspectives within and across situations.

Approach 1: Flexibility as lower valence bias (pre-registered)

The first approach to operationalizing flexible interpretations is simply a re-conceptualization of the common approach to computing interpretation valence bias. That is, research on the role of negatively biased interpretation style has traditionally computed valence bias scores such that a higher negative bias score indicates greater endorsement of negative interpretations relative to benign/positive interpretations. By the same token, the absence of valence bias in either a negative or benign/positive direction indicates comparable preferences for negative and positive interpretations, and as such could reflect the adoption of multiple perspectives. While this standard measure of valence bias is not typically considered an index of flexibility, we include it here because it affords an interesting opportunity to consider the degree of difference between negative and positive interpretations as an index of an individuals' tendency to assign multiple meanings to an ambiguous situation[1]. Also, as an established measure, it provides a useful comparison point for the novel measures of interpretation flexibility that follow. Interestingly, the standard valence bias hypothesis (positive interpretation style is beneficial to emotional wellbeing) and the flexibility hypothesis (low valence bias in interpretation style is beneficial to emotional wellbeing) differ regarding the expected relationships between the interpretation measure's (negative minus positive interpretation) difference score(s) and the emotional health scores. The standard valence bias hypothesis would predict that less negative/more positive bias will be associated with better emotional health, while the flexibility hypothesis would predict that *low* valence bias (operationalized here as comparable endorsement of both a positive and negative possible interpretation) will be associated with better emotional health.

Approach 2: Flexibility as lower consistency across contexts (pre-registered)

The second approach conceptualized interpretation flexibility as the degree to which individuals inconsistently adopt negative interpretations and inconsistently adopt positive interpretations across ambiguous situations, suggesting they do not assume all situations play out in the same way. Approach 2 does not focus on level of positivity or negativity, but on the consistency of responding *across* situations. This approach is based on the hypothesis that having a highly consistent interpretation style across situations is maladaptive, irrespective of whether that style is predominantly negative or positive, as it indicates rigidity and low context sensitive flexibility. Thus, we expect that individuals with higher flexibility, when operationalized as being less consistent in interpretation endorsements across contexts (separately for negative items, positive items, and negative plus positive items combined), will report lower anxiety and depression, and higher quality of life.

Approach 3: Flexibility as higher dispersion across contexts (not pre-registered)

The third approach conceptualized interpretation flexibility as the amount of variation or dispersion of interpretation responses across situations (examined by looking at the standard deviation, akin to the approach used to capture explanatory flexibility; Fresco et al., 2006, 2007), with greater spread indicating greater variation in interpretations across situations. Dispersion was examined tied to the endorsement of negative interpretations, the endorsement of positive interpretations, and the endorsement of total (combined negative and positive) interpretations. It is hypothesized that individuals with higher flexibility (when operationalized as greater variation or dispersion of interpretations across situations, indicating greater context sensitivity) will report lower anxiety and depression, and higher quality of life.

Approach 4: Flexibility as higher valence diversity (not Pre-registered)

The final approach conceptualized flexibility as the diversity of interpretations within and across situations. The diversity approach is based on the Shannon–Wiener index (Shannon, 1948), which is used in ecology as a measure of both the abundance and evenness in the distribution of species in a given area. This approach has been used to assess the diversity of emotional experiences (Quoidbach et al., 2014) and emotion regulation strategy use (Daniel et al., 2023; Wen et al., 2021). The diversity approach is sensitive to both the degree to which different interpretation styles are used, as well as the even-handedness of style use. High diversity indicates frequently and evenly using both negative and positive interpretation styles. Because the diversity approach is sensitive to both frequency *and* even-handedness, an individual who *very* frequently uses one style exclusively would have a lower diversity score than someone who

moderately frequently uses multiple styles. It was hypothesized that individuals with greater flexibility (when operationalized as endorsing both negative and positive interpretations of ambiguous situations as likely and in an even-handed manner) will report lower anxiety and depression, and higher quality of life.

The present study

The present study used baseline data from an online CBM-I trial (see Ji et al., 2021, and https://osf.io/3b67v for study details) to test the four operationalizations of interpretation flexibility in a large community sample. Two measures of interpretation style were used, the Recognition Rating task (Mathews & Mackintosh, 2000) and the Brief Bodily Sensations Interpretation Questionnaire (BBSIQ; Clark et al., 1997). Anxiety and depression symptom severity, and quality of life were assessed as outcome variables. While the four approaches outlined in the introduction represent different ways of operationalizing interpretation flexibility, all approaches stem from the recognition that there are multiple plausible interpretations that can be adopted when assigning meaning within and across ambiguous situations.

The general hypothesis is that greater interpretation flexibility is beneficial to emotional wellbeing, so individuals who score higher on indices of interpretation flexibility will score lower on measures of anxiety and depression, and higher on measures of quality of life (though we noted a different hypothesis for Approach 1). A large dataset from a high trait anxious sample was used for these analyses as it was likely that such a sample would comprise individuals who tend to make varying degrees of relatively negative interpretations, thus ensuring a good representation of negative interpretation responses in the sample. The first two of the four approaches were pre-registered as part of the initial research plan. Two further exploratory approaches were subsequently added as the results of the first two approaches were inconsistent and we wanted to capture additional ways of evaluating interpretation flexibility to help understand the inconsistencies. Given the theoretical importance of interpretation flexibility across numerous models of psychopathology, coupled with its limited empirical evaluation, the intent of this paper is to share our exploration of different ways of conceptualizing interpretation flexibility and their ties to emotional wellbeing. We hope to spur further research that can advance conceptual and measurement clarity about flexible adoption of multiple perspectives.

Method

Participants

Baseline assessment data came from a sample of N = 939 participants with elevated anxiety from the community who were recruited to the online anxiety intervention MindTrails (https://mindtrails.virginia.edu/). Of these participants, nine did not complete any measure of interpretation bias and were thus excluded from analysis, resulting in a sample of N = 930 participants for analysis. Demographics and baseline characteristics for N = 16 participants were lost due to server error, and age information was missing from a further 3 participants due to errors in birth year input. Summary participant characteristics are provided below, with full details reported in Supplementary Table 2. Average age of the sample was 33.80 years, with 71.80% identifying as female. The majority of participants were White (71.20%) and resided in the United States, and more than half (58.8%) had either completed or partially completed an undergraduate degree. Just over half (52.2%) of participants were working, and just over half (58.7%) were not married (single or in a relationship). For income, about a third (37.80%) of participants reported an income of less than $50,000/year, and a third (32.90%) reported an income of between $50,000 and $150,000/year.

Measures

Interpretation style assessment measures.

1. **Recognition rating task.** The Recognition Rating (RR) task was adapted from the task developed by Mathews and Mackintosh (2000). The RR task involved reading and imagining nine scenarios about social situations that remained ambiguous even when the word fragment was completed. After scenario presentation, participants were presented with four disambiguated interpretations of each scenario and asked to rate how similar each disambiguated interpretation was to what they interpreted the meaning of the original scenario to be, on a scale of 0 ("*very different*") to 3 ("*very similar*"). Endorsements of threat-relevant negative interpretations (*true negative* items) are distinguished from threat-irrelevant negative interpretations (*foil negative* items), and likewise for positive interpretations (true positive vs. foil positive items). Higher scores on negative and positive items indicate greater perceived similarity of negative and positive interpretations, respectively, to one's original interpretation. See Appendix Table 1 for an example of the scenarios and rating scales used. A total of N = 901 participants completed all ratings of the RR task, providing the data used for analyses. Internal consistency (interpreting alpha in the traditional way where higher number indicate greater reliability) was good for baseline RR true negative items: Cronbach's α = .800, excellent for RR foil negative items, Cronbach's α = .855, acceptable for RR true positive items: Cronbach's α = .730, and excellent for RR foil positive items, Cronbach's α = .834.
2. **Brief bodily sensation interpretation questionnaire** (BBSIQ; Clark et al., 1997). In the BBSIQ, participants are

presented with fourteen ambiguous scenarios relating to potential physical threat (e.g., feeling lightheaded) or external threat (e.g., smelling smoke, social situations) concerns. The scenarios are presented alongside three possible explanations, one that is relevant to the ambiguous potential threats and is emotionally negative, and two that are not directly relevant to the ambiguous potential threat and can be negative or positive/benign. Participants rated the extent to which they agreed with each explanation of why the ambiguous event occurred, on a Likert scale from 0 ("*not at all likely*") to 4 ("*extremely likely*"). See Appendix Table 1 for an example of the scenarios and rating scales used. Typically, the BBSIQ is administered on an eight-point Likert scale, but a 0–4 scale was used to align with other rating scales in the study. Higher scores on threat and non-threat items indicate greater perceived likelihood of threat and non-threat related interpretations, respectively. A total of $N = 899$ participants completed all items of the BBSIQ. Internal consistency in this sample was excellent: Cronbach's alpha for threat items = .898, and for Non-threat items = .856.

Emotional health measures

1. ***Anxiety subscale of the Depression, Anxiety, and Stress Scale - 21-items (DASS-21)*** (Lovibond & Lovibond, 1996): the DASS-21 Anxiety Subscale (AS) was used to assess anxiety symptoms. This subscale has seven items assessing the frequency of anxiety symptoms over the past week, on a scale of 0 ("*did not apply to me at all*") to 3 ("*applied to me very much, or most of the time"*). The DASS-21 has strong psychometric properties (Henry & Crawford, 2005). DASS-21 AS scores ranged from 0 to 21, with higher scores indicating greater anxiety symptoms. Due to server error, DASS-21 AS scores from 128 participants were lost, leaving data from $N = 802$ participants for analyses. Internal consistency for the DASS-21 Anxiety subscale in the current sample was acceptable, Cronbach's alpha = .678.
2. ***Overall Anxiety Severity and Impairment Scale*** (OASIS; Norman et al., 2006): The five-item OASIS assesses anxiety frequency, severity, and associated avoidance, work and social interference. All items are rated on a scale of 0 (lowest impairment/severity) to 4 (highest impairment/severity), with higher scores indicating greater anxiety severity and impairment. The OASIS was selected due to its brevity and strong psychometric properties. In the present sample, $N = 902$ participants completed the OASIS at baseline. Internal consistency for the OASIS in the current sample was good, Cronbach's alpha = .811.
3. ***Depression subscale of the Depression, Anxiety, and Stress Scale - 21-items (DASS-21)***(Lovibond & Lovibond, 1996): The DASS-21 Depression Subscale (DS) was used to assess depression symptom severity. This subscale has seven items assessing the frequency of depression symptoms in the past week, each rated on a four-point Likert scale (0 = Did not apply to me at all to 3 = Applied to me very much or most of the time). DASS-21 DS scores ranged from 0 to 21, with higher scores indicating greater depression symptoms. Due to server error, DASS-21 DS scores from 102 participants were lost, leaving data from $N = 828$ participants for analysis. Internal reliability for the depression subscale in the present sample was excellent, Cronbach's $\alpha = .890$.
4. ***Quality-of-Life Scale*** (QOLS; Flanagan, 1978): The QOLS was used to assess five domains of quality of life: well-being, social activities, relationships, recreation, and personal fulfillment and development. Comprising 16-items rated on a seven-point scale where higher scores indicate higher quality of life, the scale has strong psychometric properties (Burckhardt & Anderson, 2003). In the present sample, a total of $N = 921$ participants completed the QOLS at baseline. Internal reliability of the QOLS was excellent in the current sample, Cronbach's alpha = .854.

Procedure

All participants were told that the study was designed to help people change the way they interpret certain life situations and reduce anxiety. After being presented with relevant information about the CBM-I intervention they were enrolling into in the parent study, participants then completed the DASS-21 AS as an anxiety screener, and those who were eligible were invited to create an account and enroll in the study. After providing consent, participants completed a battery of baseline measurements, including demographic information, mental health history, and treatment history. In addition, participants completed the RR and BBSIQ interpretation bias measures and the OASIS anxiety symptom measure in a fixed order. The MindTrails study was approved by the University of Virginia Institutional Review Board for the Social and Behavioral Sciences (Protocol Number: 2703). Informed consent was obtained from all individual participants included in the study.

Analysis plan

The dataset was randomly split into two halves for internal replication purposes. Informed consent was obtained from all individual participants included in the study. Different formulas were used to compute interpretation flexibility indices within each of the four approaches. Across all approaches, the interpretation flexibility index was correlated with the four outcome variables (assessed via

Pearson's correlation coefficient) to examine their cross-sectional relationship.

Approach 1: Flexibility as Lower Valence Bias (pre-registered at https://doi.org/10.17605/OSF.IO/QV4MG)**.** For the Recognition Rating task, valence bias was computed as the difference between negative and positive interpretations for: a) an Emotion ambiguity-*specific* valence bias; and b) an Emotion ambiguity-*general* valence bias. To calculate emotion ambiguity-*specific* valence bias, positive interpretation residual scores were subtracted from negative interpretation residual scores, where residual scores were computed as the residuals from true items (emotion ambiguity-relevant items) regressed onto foil items (emotion ambiguity-irrelevant items). A non-residual difference-score method was also conducted, where positive interpretation scores (calculated as true positive score—foil positive score) were subtracted from negative interpretation scores (calculated as true negative score—foil negative score). To calculate emotion ambiguity-*general* valence bias, positive interpretation scores (calculated as the average of the true positive and foil positive scores) were subtracted from negative interpretation scores (calculated as the average of true negative and foil negative scores).

Only the Recognition Rating measure was used because the BBSIQ measure does not include clearly positive interpretations, given the non-threat items include a mix of positive, benign, and negative items. See Table 2 for details of formulas and score interpretations.

Approach 2: Flexibility as Lower Consistency Across Contexts (pre-registered at https://doi.org/10.17605/OSF.IO/QV4MG). Greater flexibility was operationalized as less consistency in the tendency to adopt negative or positive interpretations across scenarios, reflecting different contexts. Given each scenario on the Recognition Rating measure has two "true" items that are relevant to the situation's emotional ambiguity (one negative and one positive), interpretation style consistency was computed as the inter-item internal reliability (Cronbach's alpha) across scenarios. Separate context consistency indices were computed for negative items, positive items, as well as total items,(pooling responses across both negative and positive items without differentiating them). Lower consistency as indicated by lower scores on any index score indicates greater interpretation flexibility. For the BBSIQ task, only threat item consistency and total item consistency were computed (non-threat items were not analyzed as these items were inconsistent in valence). See Table 3 for details of formulas and score interpretations.

Approach 3: Flexibility as Higher Dispersion across contexts (not pre-registered). Greater flexibility for Approach 3 is operationalized as higher variation/dispersion in interpretation scores, applied to the set of negative items, the set of positive items, and items in total (pooling responses across both negative and positive items without differentiating them). Following Fresco et al. (2007), intraindividual standard deviations (SD) of emotion ambiguity-specific negative and positive items (true items) were analyzed for the Recognition Rating Task, and the intraindividual SD of threat and combined (threat plus non-threat items) interpretations were analyzed for the BBSIQ (non-threat items were not analyzed as these items were inconsistent in valence). Like Approach 2, Approach 3 is agnostic to the degree to which negative or positive interpretations were endorsed as likely or unlikely, focusing instead on the degree of response dispersion. In contrast to Approach 2, Approach 3 is computed at the individual participant level, and measures the degree of variability centered around each participants' average response score, rather than the degree of inter-item correlation across participants at each score level of the outcome measure (as is the case in Approach 2). See Table 4 for details of formulas and score interpretations.

Approach 4: Flexibility as Higher Valence Diversity Across Contexts (not pre-registered). Diversity is defined as the degree to which an individual tends to adopt negative and positive interpretations, and the degree to which they do so in an even-handed manner. Diversity indices are computed as the proportion of scenarios on which the participant endorsed the negative and benign/positive interpretations as likely (rating at or above the sample median for that scenario) as a function of the maximum number of interpretations possible. Given the Recognition Rating task has nine scenarios, and each scenario has four interpretation response items, the maximum possible diversity score is 36. For the BBSIQ, as there are 14 scenarios and each scenario has three response items, the maximum possible diversity score is 42. Diversity indices were computed for emotion ambiguity-specific items (true negative and positive items) on the Recognition Rating Task, and threat and non-threat items on the BBSIQ (non-threat items were included in Approach 4 as threat item responses were not compared against non-threat items, rather all responses were considered as a part of the response repertoire). See Table 5 for details of formulas and score interpretations.[2]

Results

Summary statistics

Data from the full sample were randomly split into two halves for internal replication purposes. Mean scores did not differ across the two halves for anxiety (OASIS; DASS-21 AS), depression (DASS-21 DS), quality of life (QOLS), or Recognition Rating task interpretation scores. However, non-threat interpretation scores (but not threat interpretation scores) on the BBSIQ differed across the two halves of data, See descriptive statistics and group comparison statistics in Table 1.

Table 1. Summary statistics for outcome variables across the two halves of the sample.

	Sample A				Sample B				
Variable	Mean	SD	Min	Max	Mean	SD	Min	Max	Group comparison
OASIS	10.80	3.48	0.00	20.00	10.90	3.40	0.00	20.00	F = 0.154
DASS-21 AS	23.30	7.77	12.00	42.00	22.70	7.86	12.00	42.00	F = 1.152
DASS-21 DS	21.50	11.29	0.00	42.00	21.70	11.13	0.00	42.00	F = 0.103
QOLS	49.40	10.98	19.00	76.00	49.20	10.42	16.00	74.00	F = 0.041
RR Negative true	1.70	0.60	0.00	3.00	1.70	0.58	0.00	3.00	F = 0.204
RR Negative foil	0.60	0.55	0.00	2.67	0.60	0.56	0.00	2.89	F = 0.023
RR Positive true	1.20	0.50	0.00	2.67	1.20	0.53	0.00	2.67	F = 0.138
RR Positive foil	0.60	0.52	0.00	2.67	0.60	0.54	0.00	2.78	F = 0.223
BBSIQ threat	1.40	0.76	0.00	3.64	1.40	0.81	0.00	3.64	F = 0.154
BBSIQ Non-threat	2.10	0.47	0.82	3.68	2.00	0.49	0.00	3.57	F = 6.335**

Statistical significance markers: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.
Note. OASIS = Overall Anxiety Severity and Impairment Scale. DASS-21 AS = DASS-21 Anxiety Subscale. DASS-21 DS = DASS-21 Depression Subscale. QOLS = Quality of Life Scale. RR = Recognition Rating task. BBSIQ = Brief Bodily Sensation Interpretation Questionnaire.

Approach 1—Interpretation flexibility as lower valence bias

For the Recognition Rating measure, as can be seen in Table 2 and the associated Figures, consistent with the valence bias hypothesis (rather than the flexibility hypothesis), across the three analysis methods used to examine valence bias, higher valence bias was consistently associated with higher anxiety (OASIS; DASS-21 AS) and depression, and lower quality of life. This pattern of findings was internally replicated across the two halves of the data.

Approach 2—Interpretation flexibility as lower consistency across contexts

For the Recognition Rating measure, as can be seen in Table 3 and the associated Figures, contrary to predictions, greater consistency of negative or positive interpretations were not associated with anxiety (DASS-21 AS) or depression, and this pattern of findings was internally replicated across the two halves of the data. As for total interpretation consistency (negative plus positive interpretations combined), consistent with predictions, higher total interpretation consistency was associated with higher anxiety (DASS-21 AS) in one half of the data, but this finding did not internally replicate, and no relationship was found with depression.

For the BBSIQ measure, as can be seen in Table 3, contrary to predictions, the consistency of threat interpretations were not associated with anxiety (DASS-21 AS) or depression, and this pattern of findings was internally replicated across the two halves of the data. As for total interpretation consistency (threat and non-threat interprepttations combined), consistent with predictions, higher total interpretation consistency was associated with higher anxiety (DASS-21 AS) in one half of the data, but this result did not internally replicate. There was no relationship between total interpretation consistency and depression.

Across all interpretation flexibility measures, anxiety (OASIS) and quality of life were not able to be analyzed for consistency due to the limited range of scores on the OASIS and QOLS, which resulted in too few levels in the outcome measures to compute Cronbach's alpha.

Approach 3—Interpretation flexibility as higher variety/dispersion across contexts

For the Recognition Rating measure, as can be seen in Table 4 and the associated Figures, contrary to predictions, there were no associations between the variety/dispersion of negative or positive interpretations and anxiety (OASIS; DASS-21 AS), depression or quality of life, and this pattern of findings was internally replicated across the two halves of the data. As for the consistency of total interpretations (negative and positive interpretations combined), contrary to predictions, greater total interpretation variety/dispersion was associated with higher anxiety (OASIS; DASS-21 AS) in one half of the data, although this result did not internally replicate. Similarly, greater total interpretation variety/dispersion was associated with higher depression in one half of the data, but this result did not internally replicate. No relationship was found between total interpretation variety/dispersion and quality of life.

For the BBSIQ measure, as can be seen in Table 4 and the associated Figures, contrary to predictions, higher

Table 2. Interpretation flexibility analysis Approach 1.

Approach 1: Interpretation Flexibility as Lower Valence Bias (pre-registered)								
		Recognition Rating Measure						
Operationalization	Analysis	Formula	Interpretation	DV	Sample A	Figure	Sample B	Figure
Extent to which individuals tend to adopt negative versus positive interpretations of ambiguous situations **a) Emotion ambiguity-*specific* valence bias:**	1. Residual method	**Valence bias score** = *Negative Residual score*—*Positive Residual score* *Negative Residual score* = residuals from linear regression with foil Negative item score predicting true Negative item score *Positive Residual score* = residuals from linear regression with foil positive item score predicting true positive item score	Valence bias scores closer to 0 indicate greater congruence between ambiguous threat-specific positive and negative response options, with scores above 0 indicating greater negative interpretation relative to positive interpretation, and vice versa for scores below 0	OASIS DASS-21 anxiety DASS-21 depression QOLS	Positive relationship Positive relationship Positive relationship Negative relationship	Figure 1.1(1)	Replicated Replicated Replicated Replicated	Figure 1.1(2)
	2. Difference of difference score method	**Valence bias score:** *Negative interpretation score* - *Positive interpretation score* *Negative interpretation score* **=** True Negative score—foil Negative Score *Positive interpretation score* = True positive score—foil positive score		OASIS DASS-21 anxiety DASS-21 depression QOLS	Positive relationship Positive relationship Positive relationship Negative relationship	Figure 1.2(1)	Replicated Replicated Replicated Replicated	Figure 1.2(2)
		BBSIQ measure Not analyzed as BBSIQ non-threat items can be benign or negative in valence						
b) Emotional ambiguity-*general* valence bias:	3. Averaged difference score method	**Valence bias score:** *Negative interpretation score* - *Positive interpretation score* *Negative interpretation score* = (True Negative score+foil Negative Score)/2 *Positive interpretation score* = (True positive score+foil positive Score)/2	Valence bias scores closer to 0 indicate greater congruence between positive and negative response options (regardless of ambiguous threat specificity), with scores above 0 indicating greater negative interpretation relative to positive interpretation, and vice versa for scores below 0	OASIS DASS-21 anxiety DASS-21 depression QOLS	Positive relationship Positive relationship Positive relationship Negative relationship	Figure 1.3(1)	Replicated Replicated Replicated Replicated	Figure 1.3(2)
		BBSIQ measure Not analyzed as BBSIQ non-threat items can be benign or negative in valence						

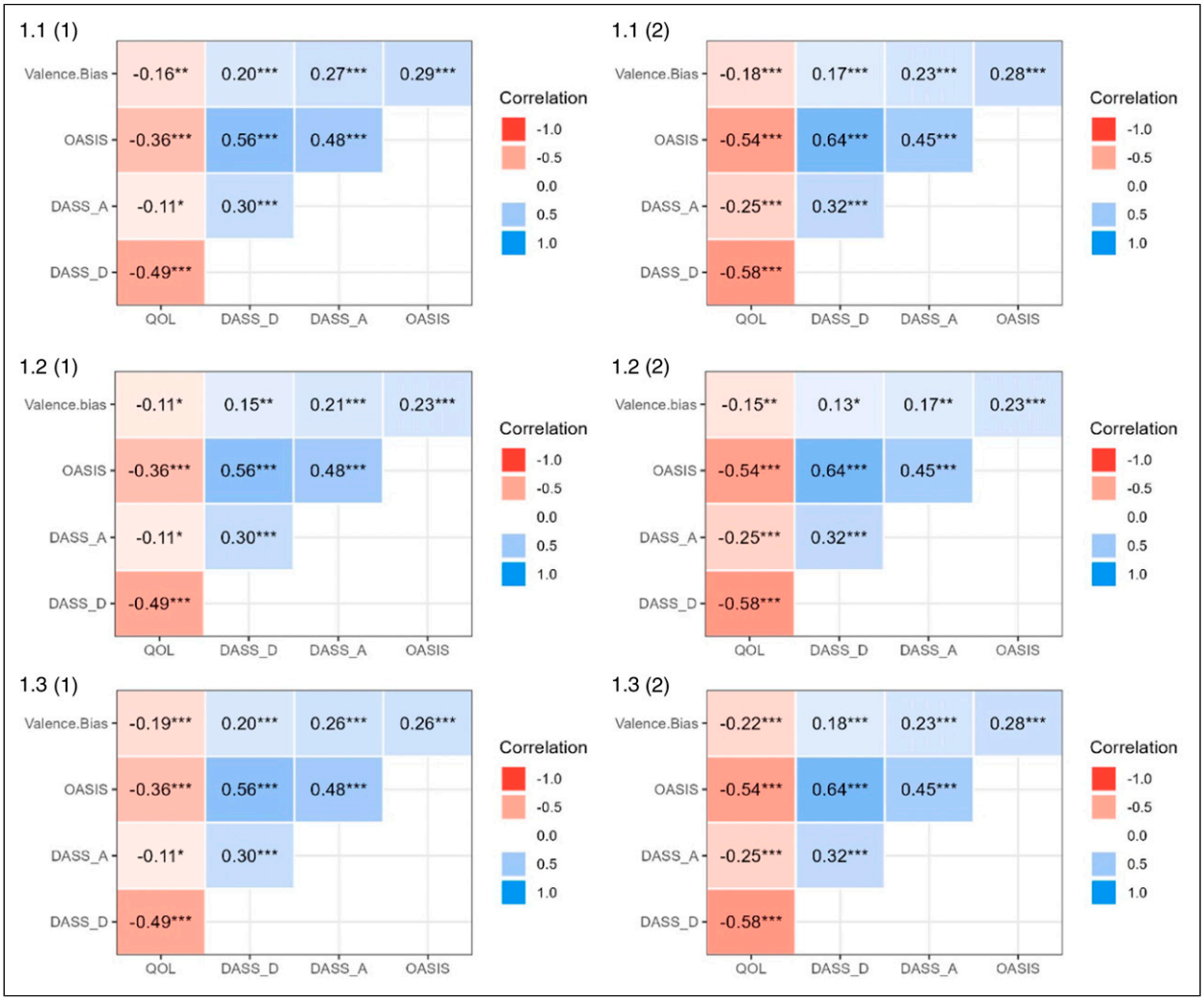

Figure 1. 1.1. Approach 1 analysis 1 using the RR measure. 1.2. Approach 1 analysis 2 using the RR measure. 1.3. Approach 1 analysis using 3 the RR measure. (Note: OASIS = Overall Anxiety Severity and Impairment Scale; DASS_A = DASS Anxiety; DASS_D = DASS Depression; QOL; Quality of Life). The (1) and (2) for each Figure denotes results from two halves of the data for the internal replication purposes.

interpretation variety was associated with higher anxiety (OASIS and DASS-21 AS) and depression, and lower quality of life. This pattern of findings was internally replicated across the two halves of the data.

Approach 4—Interpretation flexibility as Higher Valence Diversity Across Contexts

For the Recognition Rating measure, as can be seen in Table 5 and the associated Figures, contrary to predictions, positive associations were found between interpretation valence diversity scores and anxiety (OASIS & DASS-21 AS), and depression in one half of the data, although these findings did not internally replicate. There was no association between interpretation valence diversity and QOL score in either half of the data.

For the BBSIQ measure, as can be seen in Table 5 and the associated Figures, contrary to predictions, higher valence diversity was consistently associated with higher anxiety (OASIS; DASS-21 AS) and depression, and lower quality of life, and this pattern of results was also internally replicated across the two halves of the data.

Discussion

The present brief report outlines a series of analyses conducted to examine the relationship between a key component of interpretation flexibility (the ability to recognize multiple possible interpretations across and within ambiguous

Table 3. Interpretation flexibility analysis Approach 2.

Approach 2: Interpretation Flexibility as Lower Consistency Across Contexts (pre-registered)

	Recognition Rating (RR) Measure						
Operationalization	Formula	Interpretation	DV	Sample A	Figure	Sample B	Figure
Consistency in the degree to which negative, positive, and total (combined) interpretations are adopted across scenarios *Note:* "N/C" = too few levels in the DV measure to compute Cronbach's alpha	**Negative interpretation consistency score =** Cronbach's alpha score for true Negative item responses across scenarios, computed at each score level of a DV	Higher scores indicate lower negative interpretation flexibility, that is, higher negative interpretation consistency	OASIS	*N/C*	__	*N/C*	__
			DASS-21 anxiety	No relationship	Figure 2.1(1)	Replicated	Figure 2.1(2)
			DASS-21 depression	No relationship	Figure 2.2(1)	Replicated	Figure 2.2(2)
			QOLS	*N/C*	__	*N/C*	__
	Positive interpretation consistency score = Cronbach's alpha score for true positive item responses across scenarios, computed at each score level of a DV	Higher scores indicate lower positive interpretation flexibility, that is, higher positive interpretation consistency	OASIS	*N/C*	__	*N/C*	__
			DASS-21 anxiety	No relationship	Figure 2.1(1)	Replicated	Figure 2.1(2)
			DASS-21 depression	No relationship	Figure 2.2(1)	Replicated	Figure 2.2(2)
			QOLS	*N/C*	__	*N/C*	__
	Total consistency score = Cronbach's alpha score for both true Negative and true positive item responses across scenarios, computed at each score level of a DV	Higher scores indicate lower total flexibility, that is, higher overall interpretation consistency	OASIS	*N/C*		*N/C*	
			DASS-21 anxiety	No relationship	Figure 2.1(1)	Positive relationship	Figure 2.1(2)
			DASS-21 depression	No relationship	Figure 2.2(1)	Replicated	Figure 2.2(2)
			QOLS	*N/C*	__	*N/C*	__
	Brief Bodily sensations interpretation questionnaire (BBSIQ) measure						
	Formula	**Interpretation**	**DV**	**Sample A**	**Figure**	**Sample B**	**Figure**
	Threat consistency score = Cronbach's alpha of ambiguous threat-specific responses across scenarios, computed at each score level of a DV	Higher scores indicate lower threat interpretation flexibility, that is, higher threat interpretation consistency	OASIS	*Not computable*		*Not computable*	
			DASS-21 anxiety	No relationship	Figure 2.3(1)	Replicated	Figure 2.3(2)
			DASS-21 depression	No relationship	Figure 2.4(1)	Replicated	Figure 2.4(2)
			QOLS	*Not computable*	----	*Not computable*	----
	Non-threat consistency score	Not analyzed as BBSIQ non-threat items can be benign or negative in valence					
	Total consistency score = Cronbach's alpha of all responses across scenarios, computed at each score level of a DV.	Higher scores indicate lower total flexibility, that is, higher threat interpretation consistency	OASIS	*Not computable*	----	*Not computable*	----
			DASS-21 anxiety	Positive relationship	Figure 2.3(1)	No relationship	Figure 2.3(2)
			DASS-21 depression	No relationship	Figure 2.4(1)	Replicated	Figure 2.4(2)
			QOLS	*Not computable*	----	*Not computable*	----

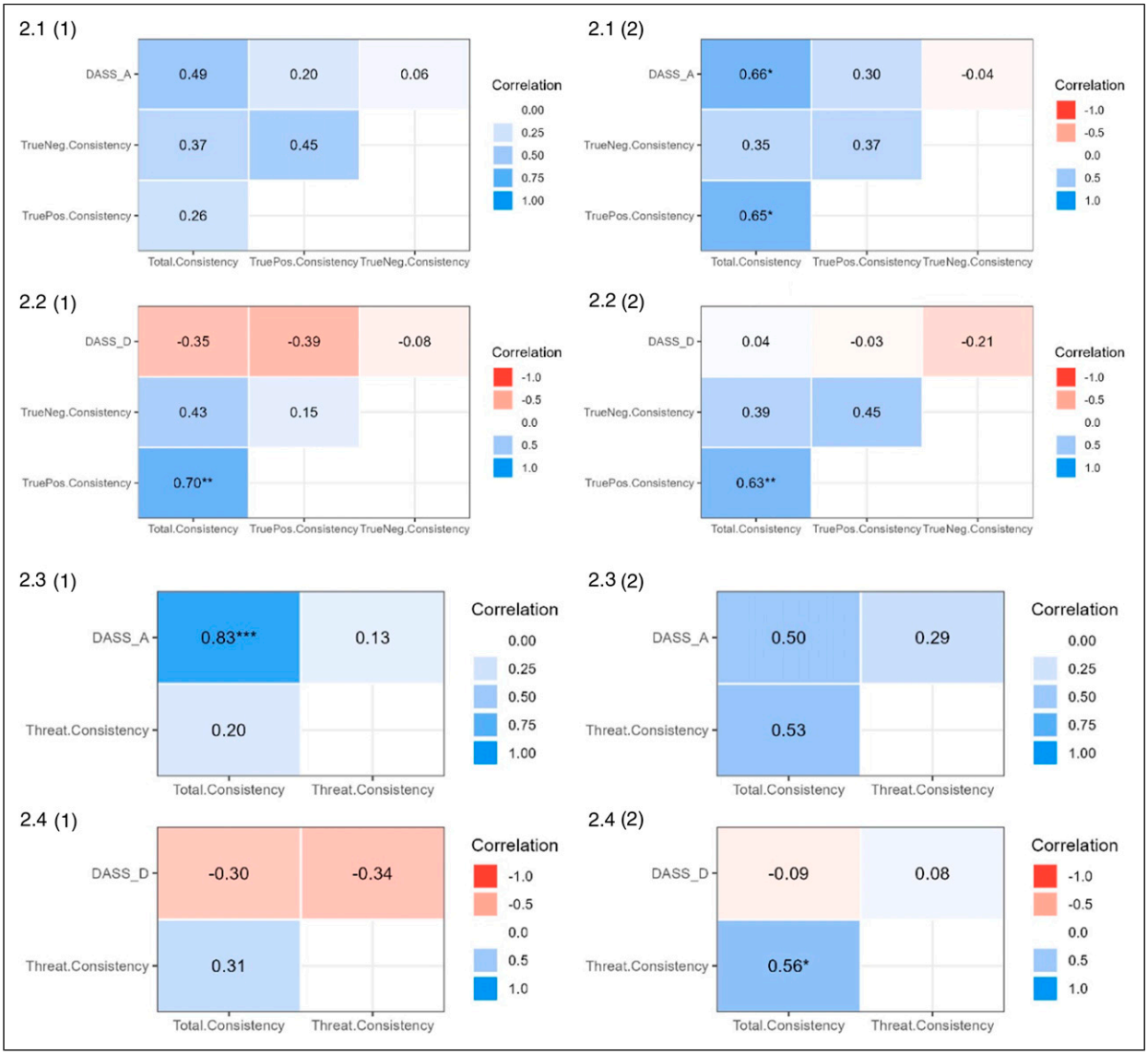

Figure 2. 2.1-2.2. Approach 2 analyses using the RR measure. 2.3-2.4 Approach 2 analyses using the BBSIQ measure. (Note: DASS_A = DASS Anxiety; DASS_D = DASS Depression). The (1) and (2) for each Figure denotes results from two halves of the data for the internal replication purposes.

situations) and emotional health. Findings across four different conceptualizations of interpretation flexibility using two different measures of interpretation style found no replicable evidence consistent with the hypothesis that greater interpretation flexibility is beneficial to emotional wellbeing, as assessed via anxiety, depression, and quality of life questionnaires. For example, while there was some evidence from approach 3 (interpretation flexibility as lower consistency across contexts) indicating that higher interpretation consistency was associated with higher anxiety on both the Recognition Rating and BBSIQ measures, this finding did not internally replicate for the Recognition Rating measure. In contrast, findings overall indicated that greater interpretation flexibility was either unrelated to, or associated with higher, anxiety and depression, and lower quality of life. The pattern of results was mostly internally replicated across two halves of the data within each interpretation bias measure, but not always across the two types of interpretation bias measures, with the BBSIQ revealing more consistent findings of the negative relationship between interpretation flexibility and emotional health.

The pattern of results was unexpected, so explanations for the findings are necessarily *post hoc*, but one speculation

Table 4. Interpretation flexibility analysis Approach 3.

Approach 3: Interpretation Flexibility as Higher Variety/Dispersion Across Contexts (not pre-registered)							
	Recognition Rating Measure						
Operationalization	Formula	Interpretation	DV	Sample A	Figure	Sample B	Figure
Degree to which individuals' negative, positive, and total (combined) interpretation scores varied/are dispersed across scenarios at the participant level	**Negative interpretation variety score =** standard deviation (SD) of true Negative item responses	Higher scores indicate greater flexibility (variation/dispersion) of negative interpretations across scenarios	OASIS	No relationship	Figure 3.1(1)	Replicated	Figure 3.1(2)
			DASS-21 anxiety	No relationship		Replicated	
			DASS-21 depression	No relationship		Replicated	
			QOLS	No relationship		Replicated	
	Positive interpretation variety score = standard deviation (SD) of true positive item responses	Higher scores indicate greater flexibility (variation/dispersion) of positive interpretations across scenarios	OASIS	No relationship		Replicated	
			DASS-21 anxiety	No relationship		Replicated	
			DASS-21 depression	No relationship		Replicated	
			QOLS	No relationship		Replicated	
	Total variety score = standard deviation (SD) of true Negative item responses + SD of true positive item responses	Higher scores indicate greater flexibility (variation/dispersion) across scenarios, regardless of valence of response options	OASIS	Positive relationship		No relationship	
			DASS-21 anxiety	Positive relationship		No relationship	
			DASS-21 depression	No relationship		Positive relationship	
			QOLS	No relationship		Replicated	
	BBSIQ measure						
	Formula	**Interpretation**	**DV**	**Sample A**	**Figure**	**Sample B**	**Figure**
	Threat interpretation variety score = standard deviation (SD) of threat item responses	Higher scores indicate greater flexibility (variation/dispersion) of threat interpretations across scenarios	OASIS	Positive relationship	Figure 3.2(1)	Replicated	Figure 3.2(2)
			DASS-21 anxiety	Positive relationship		Replicated	
			DASS-21 depression	Positive relationship		Replicated	
			QOLS	Negative relationship		Replicated	
	Non-threat interpretation variety score	Not analyzed as BBSIQ non-threat items can be benign or negative in valence					
	Total variety score = standard deviation (SD) of threat item responses + SD of Non-threat item responses	Higher scores indicate greater flexibility (variation/dispersion) of interpretations across scenarios, regardless of valence of response options	OASIS	Positive relationship		Replicated	
			DASS-21 anxiety	Positive relationship		Replicated	
			DASS-21 depression	Positive relationship		Replicated	
			QOLS	Negative relationship		Replicated	

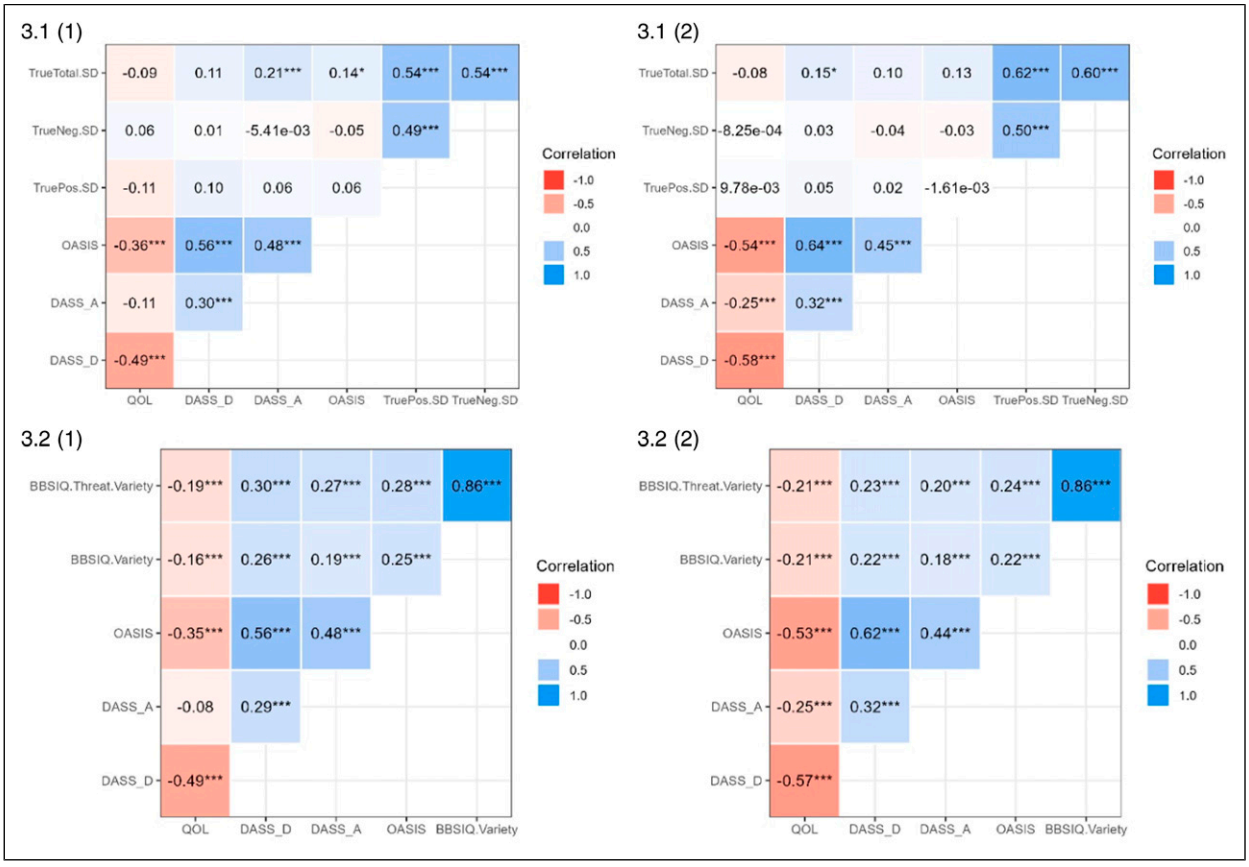

Figure 3. 3.1. Approach 3 analyses using the RR measure. 3.2. Approach 3 analyses using the BBSIQ measure. (Note: OASIS = Overall Anxiety Severity and Impairment Scale; DASS_A = DASS Anxiety; DASS_D = DASS Depression; QOL; Quality of Life). The (1) and (2) for each Figure denotes results from two halves of the data for the internal replication purposes.

is that seeing both negative and positive interpretations as comparably plausible and having many diverse interpretations reflects (or is activating) a sense of uncertainty or paralyzing indecision, which would likely be associated with worse emotional health. Intolerance of uncertainty is known to be a transdiagnostic factor contributing to emotional disorders (Carleton et al., 2012; Mahoney & McEvoy, 2012), thus greater perceived uncertainty about the world and how events will turn out would likely exacerbate emotional difficulties. However, prior research has also found that, while elevated psychopathology was associated with greater negative interpretations of ambiguous situations in general, it was not associated with greater negative interpretations *when the situation was uncertain* (i.e., when a good vs. bad outcome was equally likely to occur; Chen & Lovibond, 2016). It is clear that more work is needed to understand the link between uncertainty and interpretation flexibility.

Methodological limitations due to using existing measures of interpretation style to compute flexibility indices also constrain interpretations of the present findings. The psychometric properties of the Recognition Rating and BBSIQ measures have not been established other than for limited indicators of internal consistency. Relatedly, the present analyses were conducted using measures designed to assess interpretation valence bias rather than interpretation flexibility. Along these lines, comparing participants' ratings of the similarity and likelihood of different interpretation response items may not necessarily reflect the flexible adoption of multiple perspectives within and across situations. In addition, the Recognition Rating and BBSIQ scenarios might not be well suited to examine flexibility across contexts (i.e., context sensitivity) given that the base-rate likelihood of negative and positive interpretations in each scenario is not known. For example, the threat interpretation in one scenario may be more likely to occur in the real world than that of another scenario (e.g., dinner guests not having a good time versus a burglary), or more likely to occur for some participants than other participants (e.g., heart attacks). Tasks that are sensitive to differences in the base rates of the different outcomes

Table 5. Interpretation flexibility analysis Approach 5.

Approach 4: Flexibility as Higher Valence Diversity (not pre-registered)

	Recognition Rating Measure						
Operationalization	Formula	Interpretation	DV	Sample A	Figure	Sample B	Figure
The degree to which individuals adopt both negative and positive interpretations and do so in an even-handed manner, computed as a proportion against the maximum number of interpretations possible Since the RR task has nine scenarios, and each scenario has four interpretation response items, the maximum possible diversity score is 36. For the BBSIQ, as there are 14 scenarios and each scenario has three response items, the maximum possible diversity score is 42	**Diversity score** = (((TrueNeg score/36)* ln(TrueNeg score/36) + ((TruePos score/36)* ln(TruePos score/36))) * −1 *TrueNeg Score* = each participant's number of scenarios where the true Negative item was rated as likely. *TruePos Score* = each participant's number of scenarios where the true positive item was rated as likely. Likely = if a response item is rated above the sample median for that scenario	Higher diversity scores indicate greater flexibility: Higher tendency to adopt negative and positive interpretations in an even-handed manner (i.e., likelihood ratings are high and fairly comparable across negative and positive items)	OASIS DASS-21 anxiety DASS-21 depression QOLS	Positive relationship Positive relationship Positive relationship No relationship	Figure 4.1(1)	No relationship No relationship No relationship Replicated	Figure 4.1(2)
	BBSIQ measure						
	Formula	**Interpretation**	**DV**	**Sample A**	**Figure**	**Sample B**	**Figure**
	Diversity score = (((threat score/42)* ln(Threat score/42) + ((Non-threat score/42)* ln(Non-threat score/42))) * −1 *Threat Score* = the number of scenarios where the threat item was rated as likely *Non-Threat Score* = the number of scenarios where *either* one of the two Non-threat items was rated as likely Likely = if a response item is rated above the sample median for that scenario *Note:* Non-threat items were included in approach 4 as threat item responses were not compared against non-threat items, rather all responses were considered as a part of the response repertoire)	Higher diversity scores indicate greater flexibility: Higher tendency to adopt threatening and non-threatening interpretations in an even-handed manner (i.e., likelihood ratings are high and fairly comparable across threat and non-threat items)	OASIS DASS-21 anxiety DASS-21 depression QOLS	Positive relationship Positive relationship Positive relationship Negative relationship	Figure 4.2(1)	Replicated Replicated Replicated Replicated	Figure 4.2(2)

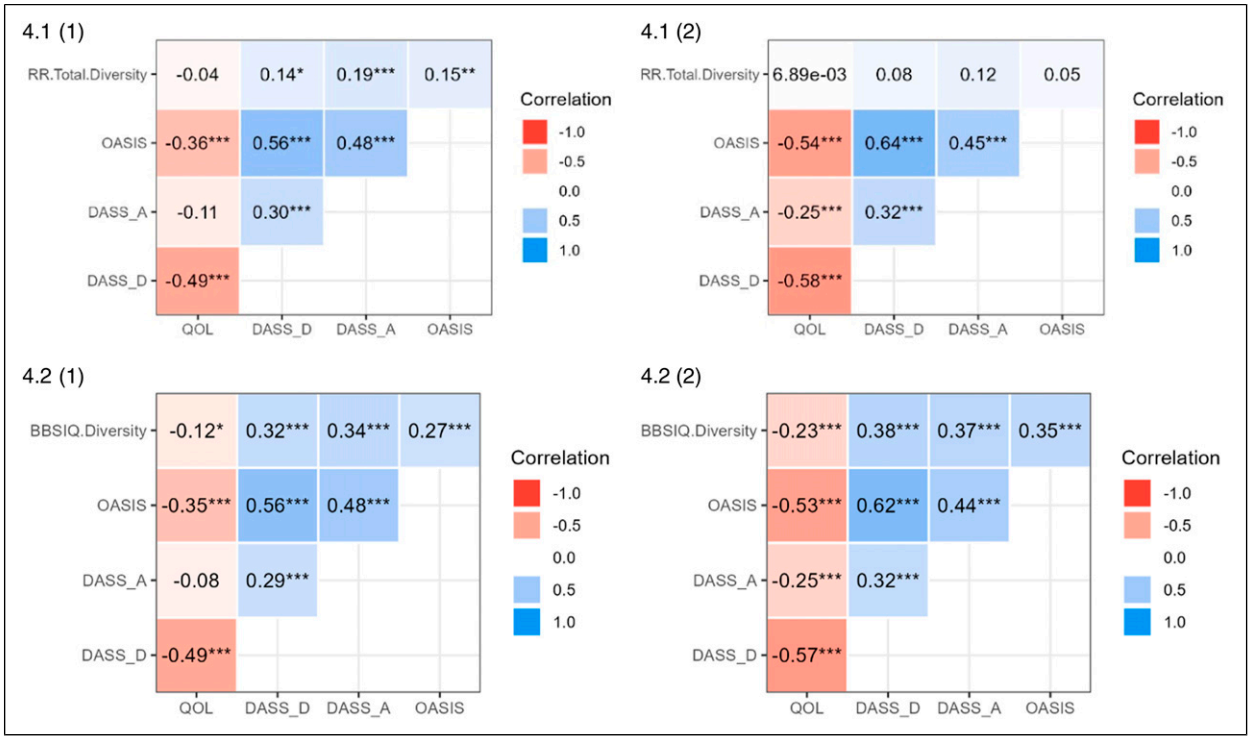

Figure 4. 4.1. Approach 4 analyses using the RR measure. 4.2. Approach 4 analyses using the BBSIQ measure. (Note: OASIS = Overall Anxiety Severity and Impairment Scale; DASS_A = DASS Anxiety; DASS_D = DASS Depression; QOL; Quality of Life). The (1) and (2) for each Figure denotes results from two halves of the data for the internal replication purposes.

proposed across threat interpretations would help more directly assess the adaptiveness of variable interpretation styles across contexts. Further, tasks that do not present a limited set of possible interpretations to choose from, but instead evaluate what interpretations people generate independently, would likely provide much-needed insight into more naturalistic interpretation flexibility. As such, understanding the relationship between interpretation flexibility and emotional health requires the development of tasks that are better able to assess the degree to which multiple perspectives are adopted when interpreting ambiguous situations in controlled laboratory and real-life contexts.

In addition to examining novel measures of interpretation flexibility in future work, it will also be helpful to consider additional analytic approaches. For example, it is possible that the relationship between interpretation flexibility and emotional health is non-linear, which our approaches would have missed. Further, examining interpretation flexibility in a range of diverse samples will also be helpful as we do not know to what extent the particular scenarios used in this study matched the cultural context and specific anxiety triggers for this population. More work is needed to better understand how and when different forms of interpretation flexibility promote versus inhibit emotional health.

Acknowledgments

The authors thank Katharine E. Daniels and the PACT lab at the University of Virginia for helpful discussions, and the MindTrails team for their work developing the MindTrails platform.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This work was supported in part by NIMH grants (R34MH106770 and R01MH113752) awarded to Bethany A. Teachman. The authors thank Katharine E. Daniels and the PACT lab for helpful discussions and the MindTrails team for their work developing the MindTrails platform.

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Supplemental Material

Supplemental material for this article is available online.

Notes

1. We acknowledge that this analysis approach is limited as it assumes that flexibility involves *equal* adoption of negative and positive interpretations, without recognizing that the positive and negative interpretations might not be equally probable events in terms of their base rates. We also recognize that it is possible to have a low valence bias because you think both the positive and negative interpretation options are not plausible, which would not indicate a clear endorsement of multiple perspectives.
2. Prior to Approach 4, we also conducted a simpler (but less precise) version of it where interpretation flexibility was computed as valence even-handedness, or the tendency to adopt both negative and positive interpretations within the same situation. See Supplementary Materials Appendix 2.

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