

### **Highlights**

- Diminished positive interpretation bias in individuals with social anxiety compared to healthy controls
- Positive interpretation bias predicted enhanced cognitive reappraisal
- This effect was especially robust when state positive affect was low
- Positive interpretation bias predicted better self-perceptions of speech performance
- Potential benefits of enhancing positive interpretations of social information

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POSITIVE INTERPRETATION BIAS AND COGNITIVE REAPPRAISAL

**The effects of positive interpretation bias on cognitive reappraisal and social performance:**

**Implications for social anxiety disorder**

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## **Abstract**

People with social anxiety disorder (SAD) lack non-socially anxious individuals' tendency to interpret ambiguous social information in a positively biased manner. To gain a better understanding of the specific in-vivo social consequences of positive interpretation bias, we recruited 38 individuals with SAD and 31 healthy controls (HC) to participate in an in-vivo social task. We tested whether a positive interpretation bias, measured using a sentence completion task, might confer benefits for the adaptive emotion regulation strategy of cognitive reappraisal, and whether such benefits depended on participants' emotional states. We also examined whether positive interpretation bias might confer additional benefits such as improved self-perceived and observer-rated social performance. In support of prior research, HC participants exhibited a positive interpretation bias on the sentence completion task, whereas participants with SAD did not. Regression analyses revealed that positive interpretation bias predicted greater cognitive reappraisal during social stress, particularly when state positive affect was low. Moreover, positive interpretation bias predicted more positive self-perception of social performance and reduced underestimations of performance relative to observer ratings. These results suggest that positive interpretations of ambiguous social information may be related to improvements in cognitive reappraisal and more positive self-perceptions of social performance.

**Keywords:** positive interpretation bias, cognitive reappraisal, emotion regulation, positive affect, social anxiety

**The effects of positive interpretation bias on cognitive reappraisal and social performance:**

**Implications for social anxiety disorder**

Individuals with social anxiety disorder (SAD) are preoccupied with the possibility of scrutiny and evaluation within social settings, demonstrating persistent fear of situations in which they may be evaluated by others (American Psychiatric Association, 2013). Alongside research on these fear-related symptoms, a growing number of studies have documented a variety of “positivity deficits” for people with higher levels of social anxiety across a range of situations and experiences (Kashdan, 2007; Kashdan, Weeks, & Savostyanova, 2011). High levels of social anxiety have been related to lower positive affect from social experiences (Kashdan & Collins, 2010), fewer positive experiences (Kashdan & Steger, 2006) and reduced capacity to savour such experiences (Eisner, Johnson, & Carver, 2009). Unlike healthy individuals, individuals with SAD tend to underestimate their social competence even in positive interactions, and lack the tendency to interpret ambiguous social situations in a positive manner (see Amir, Foa, & Coles, 1998; Huppert, Pasupuleti, Foa, & Mathews, 2007; Moscovitch, Orr, Rowa, Reimer, & Antony, 2009; Stopa & Clark 2000). These data suggest that social anxiety is associated with infrequent, low-intensity, and short-lived positive experiences, as well as distinct biases in cognitive processing that restrict quality of life (Kashdan et al., 2011).

The positivity deficits that have been demonstrated by individuals with SAD have been linked to problems with emotion regulation, which entails the ability to control or adjust thoughts, emotions, and behaviours dependent on the situational context (Kashdan & Rottenberg, 2010). Indeed, individuals with SAD often employ maladaptive self-regulatory strategies such as avoidance, use of safety behaviours, and emotional suppression (Kashdan et al., 2011; Morrison & Heimberg, 2013), and tend to report less frequent and effective use of putatively adaptive

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strategies such as cognitive reappraisal (e.g., Kivity & Huppert, 2016, 2018, 2019; Werner, Goldin, Ball, Heimberg, & Gross, 2011), which involves the ability to reassess and alter the content of a disturbing stimulus (e.g., a thought or image; Katz, Lustig, Assis, & Yovel, 2017). These findings align with recent emphasis on the role of emotional dysregulation in social anxiety, and particularly that individuals with SAD may be less effective at using cognitive reappraisal in their day to day lives (Kivity & Huppert, 2016; Morrison & Heimberg, 2013).

Thus, the work of Kashdan and colleagues as well as others suggests that emotion regulation difficulties likely interact with cognitive biases characteristic of SAD to maintain symptoms of social anxiety. Reappraising initial interpretations of social situations to more accurately depict reality may therefore be one pathway that facilitates symptom reduction (Kivity & Huppert, 2019). Although not explicitly examining the cognitive strategy of reappraisal, research suggests that correcting interpretation bias may facilitate the reduction of social anxiety symptoms (e.g., Beard & Amir, 2008; Murphy, Hirsch, Mathews, Smith, & Clark, 2007; Hirsch, Meeten, Krahe, & Reeder, 2016). In these studies, individuals with high levels of social anxiety are trained to interpret ambiguous social information in a positive or benign manner (e.g., the Interpretation Modification Program; Beard & Amir, 2008). The procedure facilitates positive or benign endorsements of ambiguous material by providing participants with positive feedback (i.e., “Correct!”) when they generate a benign endorsement of ambiguous material and refuse a threat endorsement. Research suggests that such training can afford a variety of beneficial outcomes, including reduced social anxiety symptoms and stress responses within the context of socially threatening tasks (Amir & Taylor, 2012; Liu, Li, Han, & Liu, 2017).

Although a number of studies have demonstrated that the ability to alter one’s initial interpretation of social information may be beneficial, prior research has not investigated

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whether or not a tendency towards positive interpretation of social information may relate to cognitive reappraisal of social threat. A tendency to interpret social situations positively could enhance one's ability to use cognitive reappraisal within the context of an affectively charged in-vivo social task because initial positive interpretations of potentially anxiety-provoking social situations may support a more flexible deployment of cognitive resources geared toward challenging and altering negative thinking (e.g., Kashdan & Rottenberg, 2010). Moreover, positive interpretation bias might beneficially influence self-perception of performance in social situations, particularly for those who can successfully reappraise their negative thoughts about the social task. Finally, a positive interpretation bias might also confer benefits for objective social performance given that it may allow for individuals with SAD to relax their focus on negative self-perception and engage in tasks more adaptively, without use of safety behaviours and other avoidance strategies which have been shown to impact observer ratings of performance (Rowa et al., 2015).

The current study investigated the relationship between positive interpretation biases and cognitive reappraisal in the context of social threat. Individuals with and without a clinical diagnosis of SAD completed the Sentence Completion Task (SCT; Huppert et al., 2007), a measure of positive interpretation bias, and then participated in a social stress task, which included a three-minute speech preparation period and three-minute speech performance. In anticipation of the speech performance, participants completed a measure of cognitive reappraisal, as well as measures of positive and negative affect. Following the speech, participants rated their social performance. Objective raters then watched and rated aspects of participants' performance. This study design allowed us to extend research on the benefits of positive interpretation bias by providing information about how the tendency to interpret

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ambiguous social information in a positive manner may facilitate cognitive reappraisal of socially threatening information and predict actual social performance. In assessing participant affect during the task we also aimed to shed light on whether the link between positive interpretation bias and cognitive reappraisal is moderated by participants' state affective responses to the social context.

We aimed, first, to show that relative to healthy control (HC) participants, individuals with SAD would demonstrate fewer positive interpretations of ambiguous social situations on the SCT. Second, we used regression analyses to test the hypothesis that, collapsed across groups, the tendency to interpret ambiguous social situations in a positive manner would predict greater use of cognitive reappraisal during the social stress task. Relatedly, we tested the prediction that the relationship between positive interpretation bias and reappraisal would be strengthened in the presence of high state negative affect and/or low state positive affect in anticipation of the social task. We reasoned that the presence of high negative affect and/or low positive affect within the social situation would reflect an emotional context in which reappraisal would be most needed and, potentially, most beneficial; in other words, that participants within such contexts would be particularly motivated to draw on positive interpretations of social stimuli in order to facilitate reappraisal as a form of adaptive coping (see Blanchette & Richards, 2010 for discussion of the influence of affective context on interpretation). We expected that either high negative affect or low positive affect could serve as a robust contextual moderator in this manner, and refrained from advancing specific predictions about the potential for one to outweigh the effects of the other. Finally, we tested hypotheses about the relationship between positive interpretation bias and positive aspects of social performance, rated both subjectively and objectively. For this final set of analyses, we expected that the tendency to interpret ambiguous social situations in a

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positive manner would predict more positive self- and observer-ratings of performance and a smaller discrepancy between self and observer ratings. We also expected this relationship to be moderated by cognitive reappraisal. Specifically, we expected that the relationship between positive interpretation bias and positive perceptions of speech performance would be strengthened by higher levels of cognitive reappraisal. A graphical depiction of our planned regression analyses is represented in Figure 1.

### **Method**

#### *Participants*

The sample for this study ( $N = 69$ ) consisted of 38 individuals who met DSM-5 criteria for a current clinical diagnoses of SAD and 31 HC participants who were matched on demographic characteristics with the clinical sample but had no history of significant mental health concerns (see Table 1 for clinical and demographic characteristics of participants). Participants from both groups were recruited from the community via online and paper advertisements as part of a collaborative anxiety disorders research group at a Canadian university. These advertisements invited individuals with and without anxiety symptoms to contact us by phone or email about joining a research participant pool. Individuals who contacted the research group were then screened for symptoms of social anxiety and exclusion criteria using an online questionnaire and subsequent phone screen adapted from the *Mini International Neuropsychiatric Interview* (MINI; Sheehan, 2014). The MINI is a well-validated semi-structured diagnostic interview and the phone screen is capable of capturing the presence or absence of any essential symptoms that would meet DSM diagnostic criteria (American Psychiatric Association, 2013; Pinninti, Madison, Musser, & Rissmiller, 2003; Sheehan et al., 1998).



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Participants were eligible for inclusion in the HC group if they did not endorse any psychiatric symptoms on the phone screen that could reasonably have met DSM diagnostic criteria for a mental disorder, whereas individuals who endorsed symptoms consistent with a diagnosis of SAD were invited to complete the entire MINI in-person. During the in-person assessment, trained graduate students completed the MINI interview, which was appended with symptom checklists from the Anxiety Disorders Interview Schedule for DSM-5 (ADIS-5; Brown & Barlow, 2014) in order to achieve a more thorough assessment. Each case was reviewed by two licensed clinical psychologists. Anyone who met DSM-5 criteria for a diagnosis of SAD and for whom the SAD diagnosis was deemed the most clinically interfering and/or distressing was invited to participate (i.e., cases who received a principal SAD diagnosis with a clinician severity rating of at least 4 or above on a 0-8 scale). Exclusion criteria for SAD participants included endorsement of active and clinically significant suicidality, mania, psychosis, or substance abuse or dependence.

### *Measures*

***Symptoms.*** To assess symptoms of social anxiety, participants completed the *Social Phobia Inventory* (SPIN; Connor et al., 2000), on which they rated the extent to which each of the 17 items bothered them over the past week on a 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*). The SPIN can reliably distinguish individuals with versus those without clinical levels of SAD (Antony, Coons, McCabe, Ashbaugh, & Swinson, 2006). Cronbach's alpha in the current study was .96.

***Interpretation bias.*** To assess interpretation bias, we used the Sentence Completion Task (SCT; Huppert et al., 2007), 10-item version (as in Naim, Kivity, Bar-Haim, & Huppert, 2018). During the SCT, participants are required to listen to audio recordings of incomplete sentences

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describing social situations. Each sentence is left unfinished so that the valence of the social situation is ambiguous and participants are required to finish the sentence with a one-word ending. For example, “*After your first date with someone, they think you are...*”. In the current study, participants were first provided with a practice item to ensure that they understood the task. They then listened once to the audio recording of each of the 10 items in turn. After each was presented, they were instructed to generate as many one-word endings as came to mind. Following the procedure of Naim et al. (2018), once all 10 items were completed, participants were presented with all of their generated one-word responses for each sentence and were instructed to indicate whether they believed each to be negative, positive, or other (with “other” responses generally reflecting a neutral or ambiguous word). Several scores that reflect either positive or negative interpretation bias may be obtained from the SCT. Here, we examined the percentage of positive words generated as a measure of positive interpretation bias. Scores were obtained by summing the total number of positive words and dividing by the total number of words generated for each of the 10 sentences, to create a score for positive interpretation bias.

***Social stress task.*** Following prior studies (Rapee & Lim, 1992; Vidovic, Romano, & Moscovitch, 2019), participants engaged in an impromptu speech task in order to elicit social stress. For this task, the research assistant provided participants with three controversial topics (abortion, freedom of speech, population control) and informed them that they would soon be expected to deliver a 3-minute speech in which they were required to give their opinion on any or all of the topics (as they wished). They were told that they would present their speech to a video-camera in the lab room, with no other spectators present but that expert raters would later rate the quality of their speech and various other aspects of their performance. Although this procedure did not require the presence of confederates to rate social performance during the task,

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we have found in prior studies that the presence of a video camera alone similarly induces the experience of social threat by priming the expectation of social evaluation (e.g., Moscovitch & Hofmann, 2007; Vidovic et al., 2019). Following this instruction, the research assistant left the room and participants were given 3-minutes to anticipate their speech. When the 3-minute period had ended, participants completed a measure of their emotional reactions as well as a measure of cognitive reappraisal associated with the upcoming speech task (described below). Following completion of these two measures, the research assistant reiterated the speech task instructions to participants and told them to stand in front of the camera while the research assistant again left the room to begin recording the participants' speech. The research assistant returned to the lab room only after the speech was finished, at which point participants were instructed to complete a measure of their speech performance. Following study completion, aspects of participants' video-recorded performance were also rated by trained raters.

***Positive and negative affect.*** To assess emotional responses in anticipation of the speech, participants rated their positive and negative affect, which consisted of 20 emotion adjectives from the *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988). The positive subscale (10 items) and negative subscale (10 items) were sum-scored separately to indicate participant ratings of positive affect ( $\alpha = .92$ ) and negative affect ( $\alpha = .90$ ), respectively.

***Cognitive reappraisal.*** To measure cognitive reappraisal in anticipation of the speech task, participants completed the reappraisal subscale of the State Emotion Regulation Inventory (SERI; Katz et al. 2017). The SERI is a brief measure of situational use of four cognitive emotion regulation strategies: distraction, reappraisal, brooding and acceptance (see Gross & Thompson, 2007). The reappraisal subscale assesses the extent to which one attempts to modify the content of cognitive material to be less negative. This subscale consists of four items (e.g., “I

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*tried to reevaluate the situation more positively*”), to which participants respond on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The factor structure of the SERI has been supported through both exploratory and confirmatory factor analyses and the reappraisal subscale has been shown to correlate positively with other measures of reappraisal, such as the reappraisal subscale of the Thought Control Questionnaire (Katz et al., 2017). In the current study, participants were instructed to respond to the reappraisal subscale with respect to any thoughts that arose during anticipation of the speech task ( $\alpha = .84$ ).

***Perceptions of speech performance.*** Self and objective observer ratings of speech performance were assessed using the Perception of Speech Performance questionnaire (PSP; Rapee & Lim, 1992). On the PSP, participants are required to rate various aspects of their performance of a scale of 0 (*not at all*) to 4 (*very much*). The original measure requires participants to respond to 17 items that incorporate both negative (e.g., “*appeared nervous*”) and positive (e.g., “*made a good impression*”) aspects of their performance; however, recent research has examined ratings for positive and negative scale items separately (Sarfan, Cody, & Clerkin, 2018). Although both participants and observers rated all 17 items of speech performance, for the purposes of the current study, we were specifically interested in analyzing participant and observer ratings of the positive aspects speech performance only, because we expected these constructs to covary with individual differences in positive interpretation bias. Cronbach’s alpha for participants’ own reports of the seven positive items was .91, and the alpha for each of the two raters separately was .86.

***Objective observer ratings.*** Two research assistants blind to study hypotheses and participant group were trained to rate each participant on the characteristics of their speech performance using the PSP. During the training period, the research assistants practiced using the

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PSP independently to rate aspects of performance in speech video recordings. Practice and training continued until an acceptable intraclass correlation (ICC) of  $>.70$  was reached for positive items based on Cicchetti's (1994) criteria, which identifies ICCs below .40 as showing poor agreement, .60 - .74 as good agreement, and .75 as excellent agreement. Following this period, each coder rated all participant speech videos. Rater reliability for the coded sample was assessed using ICCs (two-way mixed; Shrout & Fleiss, 1979), in which absolute agreement of the total score for positive items was analyzed. The raters achieved an excellent level of reliability (ICC = .85). The total score for the seven positive items given by each rater was averaged together to create a single score for each participant and this score was used in analyses.

***Self-observer discrepancy ratings.*** In order to evaluate the discrepancy between self and observer ratings of speech performance, we calculated difference scores by subtracting self-ratings from observer-ratings. Larger difference scores represent a greater self-observer discrepancy.

### *Procedure*

All study procedures were approved by the institutional ethics board. The study was advertised as an intervention study about mental images and memories in social anxiety and the recruitment letter informed participants that they would be required to complete a memory interview and social tasks, as well as questionnaires about their social experiences prior to the intervention phase of the study<sup>1</sup>. For the current study, all participants who met inclusion criteria and provided informed consent to participate in the study attended a single laboratory session. During this session, participants first completed self-report symptom measures of social anxiety

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<sup>1</sup> Details about the intervention conditions and their effects are reported elsewhere (Romano et al., 2019), as are data on pre-intervention measures of social problem solving (Romano et al., 2019).

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to confirm group membership on the day of testing. Second, participants completed the SCT task. Third, participants completed the impromptu speech task and associated measures, in which they were first provided with a 3-minute speech preparation period, then completed measures of positive affect and cognitive reappraisal, and finally completed the 3-minute video-recorded speech, after which they rated their perceptions of their speech performance. All measures, including the SCT were completed in the lab by participants at a desktop computer using an online survey platform hosted by Qualtrics™.

### *Analysis plan*

***Data screening and preparation.*** Data integrity checks included valid values and range checks. Some variables showed small departures from normality (i.e., SPIN scores, negative affect scores and observer-rated PSP scores for the control group); therefore, we replicated *t*-tests and regression analyses using a 95% bias-corrected confidence-interval bootstrapping procedure in SPSS (Efron & Tibshirani, 1985; Preacher & Hayes, 2004), which is robust to non-normally distributed data (Shrout & Bolger, 2002)<sup>2</sup>. Homogeneity of variance was violated in analyses pertaining to the SPIN; therefore, the *t*-test statistic that does not assume equal variances is reported for these analyses.

***Group comparisons.*** Following data preparation, we compared groups to assess equivalence with respect to demographic characteristics and differences with respect to clinical characteristics. To test our first hypothesis, we compared groups on positive interpretation bias.

***Regression analyses predicting cognitive reappraisal and performance variables.*** Prior to running regression analyses, zero-order correlations were computed to probe associations between the study variables. To test the hypotheses illustrated in Figure 1, we conducted each regression analysis using the process macro for SPSS (Hayes, 2013). We conducted five separate

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<sup>2</sup> The pattern of results remained unchanged when the bootstrapping procedure was performed.

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regression analyses, collapsing across the groups (i.e., using the whole sample) for each. First, we examined positive interpretation bias as a predictor of reappraisal, with either positive affect or negative affect entered as a moderator variable (models 1a and 1b). Positive and negative affect were analyzed in separate models to examine the hypothesis that the type of affective response to social stress would moderate the relationship between positive interpretation bias and reappraisal. Second, we examined positive interpretation bias as a predictor of positive self and observer perceptions of speech performance, as well as self-observer discrepancy, with reappraisal entered as a moderator variable (models 2a, 2b and 2c). All predictor variables were mean-centered prior to the regression analyses.

### Results

#### *Missing and excluded data*

One control participant was excluded from all analyses due to endorsing past treatment for psychological difficulties and exhibiting a SPIN score in the clinical range (34) on the day of testing. Five SAD participants did not complete the speech due to the experience of overwhelming anxiety in reaction to the task; therefore, we removed responses to any associated measures for these participants<sup>3</sup>. One additional SAD participant did not complete the speech task and associated measures (i.e., SERI, PANAS, PSP) due to a sudden onset of illness occurring in the latter part of the session. Of the SAD participants who completed the speech, positive affect scores were missing for two participants and reappraisal scores missing for one participant because they failed to follow instructions and completed the measures at the incorrect time during the speech task. Also, the speech video file was missing for one participant due to a

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<sup>3</sup> Participants with SAD who opted not to complete the speech task did not differ from those who completed the task with respect to both self-reported social anxiety symptoms ( $t_{(35)} = .920, p = .364$ ) and clinician severity ratings ( $t_{(35)} = .088, p = .930$ ), or the percentage of positive words generated on the SCT ( $t_{(35)} = -.999, p = .324$ ).

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recording error. All HC participants completed the speech task; however, data for the positive subscale of the PSP was missing for one participant due to a Qualtrics™ recording error. In total, after accounting for excluded participants, the sample size for analyses ranged from 30 to 38 for participants with SAD and 29 to 30 for HC participants, which according to power analyses using GPower 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009), was sufficient for the detection of medium effect sizes ( $f^2 \geq 0.15$ ) with power of 0.8 for the planned regression models (Figure 1).

### *Equivalence of groups*

There were no significant differences between SAD and HC participants in demographic characteristics, but as expected, the two groups differed on symptom measures of social anxiety, with SAD participants self-reporting higher symptom levels than HC participants (see Table 1).

### *Group comparisons*

***Positive interpretation bias.*** In support of the first hypothesis, participants with SAD generated a significantly lower percentage of positive words than HC participants in response to the ambiguous social scenarios presented in the SCT (SAD:  $M = 26.37$ ,  $SD = 13.28$ ; HC:  $M = 52.24$ ,  $SD = 13.14$ ),  $t_{(66)} = 8.01$ ,  $p < .001$ ,  $d = -1.96$  [-2.51, -1.36]. To confirm a positive bias in the control group, we conducted within group comparisons which compared the percentage of positive words generated with the percentage of negative words generated. Within their respective groups, HC participants generated a greater percentage of positive words ( $M = 52.24$ ,  $SD = 13.14$ ) than negative words ( $M = 37.43$ ,  $SD = 13.83$ ),  $t(29) = 3.25$ ,  $p = .003$ ,  $d = 0.58$  [0.06, 1.95], whereas SAD participants generated fewer positive words ( $M = 26.37$ ;  $SD = 13.28$ ) than negative words ( $M = 61.68$ ,  $SD = 14.34$ ),  $t(37) = -8.40$ ,  $p < .001$ ,  $d = -1.31$  [-1.81, -0.82].

The differences both within and between groups suggests that HC participants demonstrated a positive interpretation bias, which SAD participants lacked. Group differences



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were not accounted for by the number of neutral words generated on the SCT: SAD participants  $M = 11.95$ ,  $SD = 9.61$ ; HC participants:  $M = 10.33$ ,  $SD = 10.19$ ,  $t_{(66)} = -0.67$ ,  $p = .505$ . Moreover, group differences were not accounted for by the total number of words generated because participants in both groups generated a similar number of total words: SAD participants:  $M = 46.66$ ,  $SD = 16.42$ ; HC participants:  $M = 47.87$ ,  $SD = 21.87$ ,  $t_{(66)} = 0.26$ ,  $p = .795$ .

### *Regression analyses*

Zero-order correlations among each of the study variables are presented in Table 2.

***Model 1a and 1b: Predicting reappraisal from positive interpretation bias, with positive and negative affect as moderator variables.*** For model 1a with positive affect as the moderator, the overall model was significant:  $F_{(3, 56)} = 8.28$ ,  $p < .001$ ,  $R^2 = .31$ , and the addition of the interaction term added  $R^2 = .05$  to the model above the main effects ( $\Delta F_{(1, 56)} = 4.39$ ,  $p = .041$ ). The effect of SCT positive words was significant ( $b = .11$ ,  $t = 2.64_{(56)}$ ,  $p = .011$ ), as was the effect of positive affect ( $b = .34$ ,  $t = 3.69_{(56)}$ ,  $p = .001$ ). The interaction between positive words generated on the SCT and positive affect was also significant ( $b = -.01$ ,  $t = -2.09_{(56)}$ ,  $p = .041$ ). Simple slopes analyses demonstrated that at low levels of positive affect (1 SD below the mean), a greater proportion of SCT positive words significantly predicted higher levels of reappraisal ( $b = .21$ ,  $t = 3.14$ ,  $p = .003$ ). Similarly, at average levels of positive affect, SCT positive words significantly predicted reappraisal ( $b = .11$ ,  $t = 2.64$ ,  $p = .011$ ). However, at higher levels of positive affect (1 SD above the mean), the percentage of SCT positive words was not associated with reappraisal ( $b = .02$ ,  $t = 0.34$ ,  $p = .735$ ). A graphical depiction of the interaction is represented in Figure 2.

For model 1b with negative affect as the moderator, the overall model was significant:  $F_{(3, 56)} = 3.25$ ,  $p = .029$ ,  $R^2 = .15$ ; however, the addition of the interaction term accounted for no

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additional variance above the main effects ( $\Delta R^2 = .00$ ,  $\Delta F_{(1, 56)} = 0.30$ ,  $p = .583$ ). The percentage of positive words generated on the SCT predicted higher levels of cognitive reappraisal ( $b = .14$ ,  $t = 2.92_{(56)}$ ,  $p = .005$ ); however neither negative affect, nor the interaction between negative affect and SCT positive words significantly predicted reappraisal: negative affect ( $b = .11$ ,  $t = 0.87_{(56)}$ ,  $p = .388$ ); SCT positive words x negative affect ( $b = -.00$ ,  $t = -0.55_{(56)}$ ,  $p = .583$ ).

***Model 2a, 2b and 2c: Predicting self- and observer-rated positive speech performance from positive interpretation bias, with reappraisal as a moderator variable.*** For model 2a with self-rated positive speech performance as the outcome variable, the overall model was significant:  $F_{(3, 56)} = 11.58$ ,  $p < .001$ ,  $R^2 = .38$ , although the addition of the interaction term accounted for no additional variance above the main effects ( $\Delta R^2 = .00$ ,  $\Delta F_{(1, 56)} = 0.37$ ,  $p = .547$ ). The percentage of positive words generated on the SCT predicted higher ratings of positive self-perceptions of speech performance ( $b = .19$ ,  $t = 4.89_{(56)}$ ,  $p < .001$ ). However, neither reappraisal nor the interaction between reappraisal and SCT positive words significantly predicted positive items on the PSP: reappraisal ( $b = .14$ ,  $t = 1.40_{(56)}$ ,  $p = .166$ ); reappraisal x SCT positive words ( $b = .00$ ,  $t = 0.61_{(56)}$ ,  $p = .547$ ).

For model 2b with observer-rated positive speech performance as the outcome variable, the overall model was non-significant:  $F_{(3, 56)} = 1.77$ ,  $p = .162$ ,  $R^2 = .09$ , and the addition of the interaction term accounted for no additional variance above the main effects ( $\Delta R^2 = .01$ ,  $\Delta F_{(1, 56)} = 0.83$ ,  $p = .367$ ).

For model 2c with self-observer discrepancy as the outcome variable, the overall model was significant:  $F_{(3, 55)} = 4.66$ ,  $p = .006$ ,  $R^2 = .20$ , although the addition of the interaction term accounted for no additional variance above the main effects ( $\Delta R^2 = .00$ ,  $\Delta F_{(1, 55)} = 0.00$ ,  $p = .984$ ). The percentage of positive words generated on the SCT predicted lower self-observer

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discrepancy scores ( $b = -.12, t = -3.07_{(55)}, p = .003$ ). However, neither reappraisal nor the interaction between reappraisal and SCT positive words significantly predicted self-observer discrepancy scores: reappraisal ( $b = -.09, t = -0.91_{(55)}, p = .369$ ); reappraisal x SCT positive words ( $b = .00, t = 0.20_{(55)}, p = .984$ ).

### Discussion

The current study aimed to examine the relationship between positive interpretation bias and cognitive reappraisal during a social stress task and whether this relationship is moderated by positive and negative affect. We also examined the degree to which positive interpretation bias and cognitive reappraisal interacted to predict both self and observer ratings of speech performance.

Results supported the hypothesis that individuals with a diagnosis of SAD tend to lack the positive interpretation bias shown by HC participants on the SCT. This group difference was characterized by a large effect size, which replicates and extends the findings of Huppert and colleagues (2007), who investigated a nonclinical sample of individuals high and low in social anxiety. It is also consistent with previous studies that examined interpretation bias with varying methodologies (Amir et al., 1998; Moscovitch et al., 2009; Stopa & Clark, 2000), and further supports the notion that social anxiety may inhibit positive interpretations of ambiguous social information – an inhibition that likely contributes to their difficulties approaching social encounters in a manner that promotes experiences of pleasure and other positive outcomes (Kashdan et al., 2011).

In partial support of study hypotheses, regression analyses conducted using the entire sample revealed an interaction between SCT positive words and positive affect, which accounted for an additional 5% of the variance in predicting reappraisal (a small effect); however, the

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interaction between positive words and negative affect was not significant. Among participants who experienced diminished (low or moderate) levels of positive affect during the task, those with a greater tendency towards positive interpretations on the SCT compared to those with a weaker tendency, were more likely to use reappraisal. In contrast, among individuals who experienced high positive affect during the task, the use of reappraisal was consistently more robust, irrespective of the strength of their positive interpretation bias. According to the affect-as-information model (Clore & Storbeck, 2006; Schwarz & Clore, 2007), positive affect can function as valuable feedback about task-relevant thoughts and inclinations, which regulate styles of thinking and guide downstream decision-making and behaviour. Clore and Storebeck (2006) suggest that positive affect serves as a “green light” and negative affect a “red light” for relying on accessible cognitions and inclinations. Our findings partially support this model, as the model would predict that reliance on positive interpretation bias to inform cognitive reappraisal should be more likely in the context of positive affect as opposed to negative affect. Notably though, it was only at low to moderate levels of positive affect that positive interpretation bias appeared to facilitate the reappraisal of a stressful event. That is, when the “green light” was weak, participants’ reappraisal capacity appeared to depend more on positive interpretation bias. In contrast, levels of negative affect did not moderate the relationship between positive interpretation bias and reappraisal, suggesting that negative affect may not function as a “red light” within this context in the manner predicted by the affect-as-information model. It is possible that levels of negative affect may be particularly important for reliance on negative interpretations or for initiating escape or avoidance responses rather than moderating the use of reappraisal per se.

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These findings suggest that clinicians seeking intervention targets for improving the use of reappraisal in individuals with and without SAD might focus on both increasing positive interpretation bias and enhancing positive affective experiences that are tied to social reward, including social pleasure, contentment, connection, and the experience of pride (i.e., the elements of positive affect that are most relevant for social interaction and performance; e.g., Gilboa-Schechtman, Shachar, & Sahar, 2014). As described by Craske et al. (2019) it might be beneficial for clinicians to guide individuals explicitly to recount and savour positive aspects of their experiences even in instances when these experiences were initially judged as neutral or negative, as well as identify aspects of their own behaviour that allowed for the positive outcomes to occur. Such interventions may allow individuals to reinterpret particular situations and increase attention to positive aspects of experience that may enhance future positive affect during similar situations.

Finally, in partial support of hypotheses, regression analyses demonstrated that positive interpretation bias predicted self-ratings of positive aspects of one's speech performance, as well as the discrepancy between self and observer ratings (with these models accounting for a medium to large portion of the variance in performance ratings); however, positive interpretation bias did not predict observer ratings of speech performance, nor were any of these effects moderated by cognitive reappraisal. As discussed in more detail below, it is possible that cognitive reappraisal did not moderate the relationship between interpretation bias and social performance because, we did not specifically assess whether or not our participants were *able* to reappraise their negative thoughts about the task, but only the degree to which they tried to do so. Overall, these findings suggest that holding a positive interpretation bias may bolster self-perception of social performance such that one is less likely to underestimate one's actual

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performance. Though results of the regression analysis suggested that the impact of a more positive interpretation bias may not have been apparent to objective observers, bivariate correlations demonstrated a significant relationship between positive interpretation bias and positive appraisals of social performance for observer ratings, though this link ceased to be significant with cognitive reappraisal in the model.

Results of the present study should be interpreted in light of the study limitations, which also highlight avenues for future research. First, although use of the SERI is advantageous due to its focus on state rather than trait cognitive reappraisal capacity, the measure captures the extent to which participants endorsed attempting to use this regulation strategy as opposed to their actual effective use of the strategy per se. Thus, it remains unclear to what extent participants' attempts to reappraise would reflect their actual use of reappraisal. For example, prior studies have shown that although individuals with SAD are able to use cognitive reappraisal to regulate emotional experiences when their efforts are measured directly by researchers during lab-based tasks, such individuals tend to underestimate their reappraisal self-efficacy compared to individuals with low levels of social anxiety, such that they self-report less frequent and effective use of cognitive reappraisal (Kivity & Huppert, 2019). Given that the SERI reappraisal subscale may reflect self-efficacy of reappraisal, it would be important for future research to employ measures that assess the actual process of cognitive reappraisal such as the Emotion Regulation Task (EReg; Hajcak & Nieuwenhuis, 2006) in order to allow researchers to assess whether positive interpretation bias predicts participants' perceptions about the extent to which they use cognitive reappraisal, as well as their actual ability to reappraise stimuli when it is desirable to do so. We also only used one measure of interpretation bias and, although the measure allows for idiosyncratic interpretations, it does not differentiate between inferences made at the time the

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sentences are first encoded and those that occur later, at retrieval. Because our measure of interpretation bias only captured inferences made after reflection, responses may have been influenced by demand effects if participants responded to the task in a way they perceived to be appropriate or expected (e.g., Hirsch et al., 2016; Schoth & Lossi, 2017).

In the current study, we were specifically interested in the emotion regulation strategy of cognitive reappraisal; however, participants may have employed other emotion regulation strategies that influenced self and other perceptions of task performance. In order to extend our work to SAD more specifically, future studies could assess the link between positive interpretation bias and other forms of emotion regulation that have been implicated in recent cognitive models of SAD, such as expressive suppression which involves attempts to restrict the display of emotion within social situations (Morrison & Heimberg, 2013). Also, because individuals with SAD may tend to use one form of emotion regulation or another depending on how anxiety provoking the situation is (Werner et al., 2011), future research could assess emotional arousal in addition to the valence of the affective experience, whereas the latter was our sole focus of measurement here. Similarly, measurement of affective valence and/or emotional arousal from baseline over time during a social task may provide information about whether or not attempts at emotion regulation in fact succeeded throughout the task; moreover, studies that specifically manipulate participant emotional experiences could also shed further light on the impact of emotional context. Future work could also address specific facets of positive emotional experiences and how they might relate to positive interpretation bias and perceptions of reappraisal during social stress. Recent research has suggested that individuals with high levels of social anxiety, including those with SAD, do not just experience general hedonic deficits (i.e., lower positive affect), but that deficits in the experience of pride

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specifically account for the relationship between social anxiety and deficient positive affect (Cohen & Huppert, 2018).

Future work could also employ mediational models or analyses which allow for an examination of the interrelationships between each variable instead of conducting separate regression analyses. Such analyses require large sample sizes but would allow for more fine-grained conclusions about potential causal links between positive interpretation bias, cognitive reappraisal, and social performance. Such work could also employ experimental designs that manipulate positive interpretation bias and cognitive reappraisal in order to examine the possibility that a general positive bias may be the result of cognitive reappraisal ability, rather than vice versa (i.e., positive bias enhancing reappraisal ability).

Despite our use of a community-based demographically diverse sample of participants with and without SAD, which enhances its potential generalizability, there were some limitations associated with the sample itself. First, some participants with SAD were excluded from analyses because they refused to complete the speech task. Although the group of participants who refused to complete the speech did not differ from those who completed it on any measured baseline characteristics, we cannot say whether current results would generalize to groups of individuals with SAD who are highly avoidant. We are also unable to conclude based on the current sample that group differences on our measure of interpretation bias was due to SAD per se and not the presence of another psychiatric or emotional disorder, or to draw any firm conclusions about the potential effects of comorbid conditions on group differences. Similarly, our regression analyses were conducted across all participants and so we cannot specifically draw conclusions about the nature of these relationships in individuals with SAD specifically.



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Despite these limitations, findings highlight the potential utility of clinical intervention focused on enhancing positive interpretations of ambiguous social material as well as increasing experiences of positive affect within social contexts. Indeed, these two interacting pathways appear to work together to facilitate the putatively adaptive strategy of cognitive reappraisal, an emotion regulation strategy that has been linked both to the maintenance of SAD and to its amelioration via effective psychological therapies (Goldin & Gross, 2010).

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Table 1. *Demographic characteristics of the study sample overall and in each group separately*

	Overall sample ( <i>n</i> = 68)	SAD group ( <i>n</i> = 38)	HC group ( <i>n</i> = 30)	Test statistic <sup>a</sup>
Age in years: M (SD)	27.78 (11.00)	28.16 (9.93)	27.30 (12.38)	$t_{(66)} = -0.32, p = .752$
Gender (% female) <sup>b</sup>	57.4	60.5	53.3	$\chi^2 = 1.29, p = .700$
Ethnicity <sup>c</sup>				$\chi^2 = 3.93, p = .597$
White/European	66.2	63.2	70	
South Asian	11.8	15.8	6.7	
Asian	14.7	15.8	13.3	
Southeast Asian	1.5	2.6	0	
Black	1.5	0	3.3	
Other	4.4	2.6	6.7	
Education				$\chi^2 = 0.38, p = .979$
Attended and/or graduated high-school	7.4	7.9	6.7	
Some college/university education	41.2	39.5	43.3	
Degree from college or university	39.7	39.5	40.0	
Post-graduate degree	11.8	13.2	10.0	
Employment status				$\chi^2 = 5.40, p = .183$
Full or part-time student	39.7	44.7	33.3	
Employed full/part-time or self-employed	48.5	39.5	60.0	
Unemployed	7.4	10.5	3.3	
Temporarily unable to work	2.9	5.3	0	
Retired	1.5	0	3.3	
Marital status				$\chi^2 = 0.32, p = 1.00$
Single	64.7	65.8	63.3	
Married/common law/engaged or in committed relationship	32.4	31.6	33.3	
Divorced/separated	2.9	2.6	3.3	
Clinical characteristics				
Psychotropic medication		23.7	-	

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Comorbid anxiety disorder		44.7	-	
Comorbid mood disorder	-	23.7	-	
Comorbid other	-	26.3	-	
Number of comorbid diagnoses: M (SD)	-	1.08(1.15)	-	
SAD Clinical Severity Rating: M(SD)	-	4.97(.72)	-	
SPIN	25.00 (19.00)	39.29 (12.28)	6.90 (5.94)	$t_{(55.93)} = -14.28, p < .001$

Note. SAD = social anxiety disorder; HC = healthy control; SPIN = Social Phobia Inventory.

<sup>a</sup>Values presented for  $\chi^2$  represent Fisher's Exact Test values.

<sup>b</sup>One participant in the clinical group identified as non-binary.

<sup>c</sup>Ethnic groups are based on Canadian census categories.

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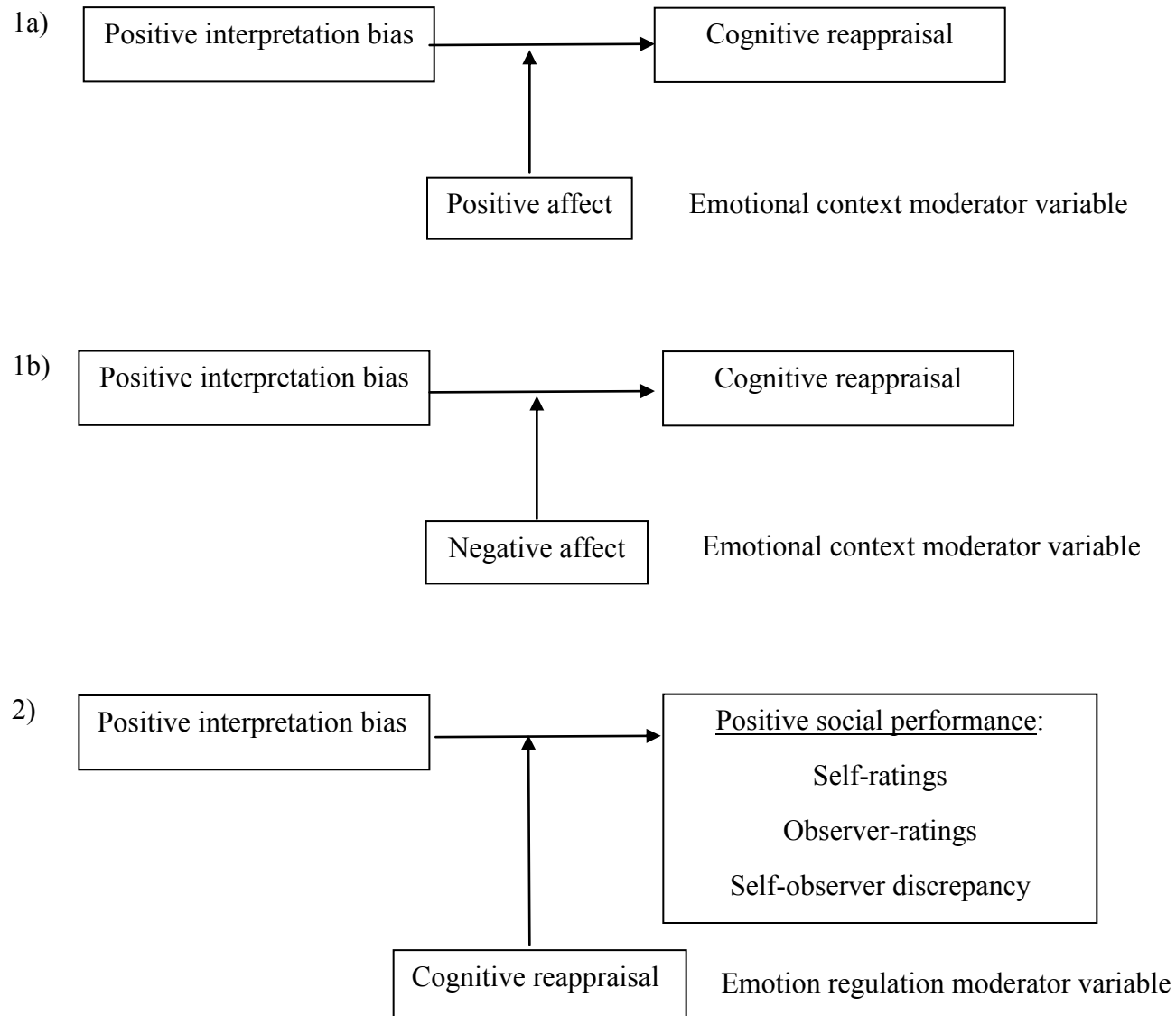
Table 2. *Correlations between study variables*

	1.	2.	3.	4.	5.	6.	7.	8.
1. SPIN	-	-.70 <sup>***</sup>	-.04	.68 <sup>***</sup>	-.27 <sup>*</sup>	-.67 <sup>***</sup>	-.35 <sup>**</sup>	.43 <sup>***</sup>
2. SCT % positive words		-	.26 <sup>*</sup>	-.44 <sup>***</sup>	.35 <sup>**</sup>	.60 <sup>***</sup>	.26 <sup>*</sup>	-.44 <sup>***</sup>
3. PANAS positive affect			-	-.13	.43 <sup>**</sup>	.40 <sup>**</sup>	.33 <sup>*</sup>	.14
4. PANAS negative affect				-	-.04	-.59 <sup>***</sup>	-.35 <sup>**</sup>	.35 <sup>**</sup>
5. SERI reappraisal					-	.36 <sup>**</sup>	.15	-.25 <sup>*</sup>
6. PSP-self positive						-	.51 <sup>***</sup>	-.68 <sup>***</sup>
7. PSP-observer positive							-	.29 <sup>*</sup>
8. PSP self-observer discrepancy								-

Note. SPIN = Social Phobia Inventory; SCT = Sentence Completion Task; PANAS = Positive and Negative Affect Scale; SERI = State Emotion Regulation Inventory; PSP = Perceptions of Speech Performance.

\*\*\* =  $p < .001$ ; \*\* =  $p < .01$ ; \* =  $p < .05$

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Figure 1. Graphical depiction of planned regression analyses to test study hypotheses.

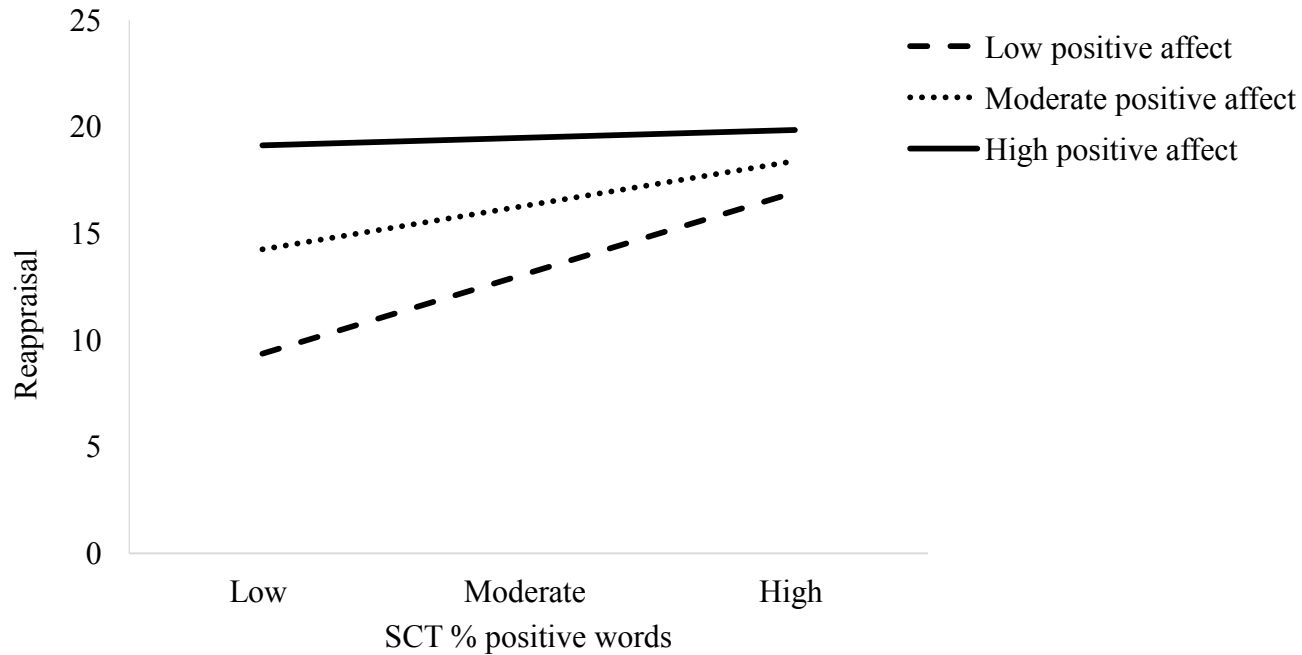


Figure 2. Graphical depiction of the significant interaction between SCT % positive words and positive affect in predicting reappraisal. At low and moderate levels of positive affect (1 SD below the mean and at the mean), SCT % positive words predicted reappraisal; however, this effect was non-significant at high levels of positive affect (1 SD above the mean).

**Declaration of interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

### **CRedit Author Statement**

**Mia Romano:** Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Data Curation, Writing – Original Draft preparation and Review/Editing, Visualization, Project Administration.

**David Moscovitch:** Conceptualization, Methodology, Resources, Writing – Original Draft preparation and Review/Editing, Supervision, Project Administration, Funding acquisition.

**Prabhjot Saini:** Methodology, Software, Investigation, Data Curation.

**Jonathan Huppert:** Software, Resources, Writing – Review and Editing