

Cognitive-Processing Biases in Individuals High on Perceived Criticism

Sara R. Masland¹, Jill M. Hooley¹, Laura M. Tully¹,
Karen Dearing², and Ian H. Gotlib³

¹Harvard University; ²Morrissey-Compton Educational Center, Palo Alto, California;
and ³Stanford University

Clinical Psychological Science
2015, Vol. 3(1) 3–14
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DOI: 10.1177/2167702614529935
cpx.sagepub.com


Abstract

A considerable literature now shows that perceived criticism (PC) predicts clinical outcomes transdiagnostically. Recent work has begun to identify potential mechanisms underlying PC's connection to clinical outcomes. For example, anomalies have been found in neural processing when individuals who rate their key relatives as highly critical listen to criticism. To explore whether high-PC individuals are also characterized by other processing abnormalities, we examined cognitive processing in a sample of community participants ($N = 76$) high or low on PC. We measured the executive control of attention when these two groups of individuals processed emotional information and interpreted acoustically presented ambiguous words. High-PC individuals showed impaired executive control of negative emotional information relative to low-PC individuals. They also made more negative interpretations of ambiguous words. These findings indicate that PC is associated with underlying vulnerabilities that may predispose individuals to develop psychopathology.

Keywords

cognitive processes, attention, psychopathology, emotional processing biases, depression

Received 9/5/13; Revision accepted 3/11/14

When uttered in a particular tone or spoken in a specific context, seemingly simple statements of fact (e.g., “You’re a really great procrastinator.”) or straightforward questions (e.g., “Why’d you do it *that way*?”) can be perceived as critical, regardless of how they might be intended. We encounter criticism in our daily lives from friends, family, partners, colleagues, and even strangers. The expression or presence of criticism in close relationships is one facet of expressed emotion (EE) and has long been linked to poor clinical outcomes in psychiatric populations. Criticism has been identified as the most important factor of EE for predicting outcomes across a range of psychopathology, and patients who live in family environments that are characterized by high levels of criticism are at elevated risk of relapse relative to patients whose family members are less critical of them (see Hooley, 2007).

Despite a long history of research linking EE to clinical outcomes, the measure is time and resource intensive (see Hooley & Parker, 2006) and, thus, not practically very useful. Fortunately, perceived criticism (PC) is also a reliable

predictor of clinical outcome and holds great promise for clinical use. PC differs from EE in that it does not include objective or independent ratings of a relative’s criticism but, rather, indicates a patient’s belief about how critical a key relative is. PC is also unlike EE in that it is exceedingly easy to measure, which makes it a potential candidate for clinical use. The original measure of PC, a single item developed by Hooley and Teasdale (1989), is typically used. The measure asks respondents to rate how critical their spouse is of them; responses are made on a scale from 1 (*not at all*) to 10 (*very critical*). In Hooley and Teasdale’s study of depressed patients, not only was PC more strongly associated with relapse than was EE but use of a cut point of 6 also provided perfect specificity in predicting relapse: Every participant who gave his or her

Corresponding Author:

Sara R. Masland, Department of Psychology, Harvard University,
William James Hall, 33 Kirkland St., Cambridge, MA 02138
E-mail: smasland@gmail.com

spouse a PC rating of 6 or higher relapsed within the 9 months after discharge from the hospital. Additional work has since replicated these findings (e.g., Kwon, Lee, Lee, & Bifulco, 2006). Research has also demonstrated that PC is associated with poorer outcomes in the context of substance abuse (Fals-Stewart, O'Farrell, & Hooley, 2001), obsessive-compulsive disorder and agoraphobia (Chambless & Steketee, 1999), bipolar disorder (Scott, Colom, Pope, Reinares, & Vieta, 2012), and schizophrenia (Guada, Hoe, Floyd, Barbour, & Brekke, 2011; Tompson et al., 1995).

Given PC's ability to predict such a wide range of clinical outcomes, understanding how it does so is of paramount importance. It is possible that PC predicts transdiagnostic outcomes because it provides an easy way to identify people likely to relapse or to have poor outcomes for other reasons. However, research thus far has shown that PC is not simply a proxy for other potential predictors of poor prognosis, including personality, psychopathology, or demographics. PC is not significantly related to depression, overall symptomatology, age, or sex (see Renshaw 2008). The measure also has high 3-month test-retest reliability, which indicates that it captures more than general mood state or current psychiatric status (Hooley & Teasdale, 1989). Moreover, although PC is negatively correlated with good marital adjustment, it nevertheless has incremental predictive validity beyond marital satisfaction (Chambless & Blake, 2009; Hooley & Teasdale, 1989; Smith & Peterson, 2008).

Evidence has further suggested that PC reflects destructive rather than constructive criticism (Peterson & Smith, 2010) and converges with spouses' own ratings of how critical they view themselves (Chambless & Blake, 2009; Chambless & Steketee, 1999) as well as with ratings of general criticism made by untrained coders during interactions between partners (Chambless & Blake, 2009; Smith & Peterson, 2008). Thus, PC may be best understood not as a proxy for an underlying third variable but as a measure of how much criticism gets through to a patient. This means that for some patients, more or less criticism than is actually present may be getting through, and there remains an element of subjectivity inherent in the measurement. *Criticality bias* refers to the overperception of criticism in close relationships (Smith & Peterson, 2008) and is positively correlated with patients' negative attributions about their relatives' behavior (Peterson, Smith, & Windle, 2009). Negative attributions about partners' behavior predict PC for patients with anxiety disorders better than does observer-rated criticism (Chambless, Blake, & Simmons, 2010).

The tendency of high-PC individuals to overperceive or misattribute the causes of criticism may be due in part to a tendency to negatively misinterpret ambiguous information. The experience of actual criticism in a close

interpersonal context may "train" the individual to be more sensitive to negative emotional cues, which could play a role in the development of interpretation bias. Alternatively, some people may feel criticized even in the absence of high levels of criticism, which may ultimately produce criticality bias. By examining whether high-PC individuals, compared with their low-PC counterparts, make more negative interpretations of ambiguous information, we can gain a more comprehensive understanding of how PC affects the processing of emotional information. This can elucidate how PC may moderate the risk for relapse in emotional disorders and further our understanding of its transdiagnostic significance.

In a preliminary effort to explore the relation between PC and neural processing, Hooley, Siegle, and Gruber (2012) found that when exposed to audio recordings of maternal criticism, women who rated their mothers as high on PC showed more activation in the amygdala relative to women who rated their mothers as low on PC. Women who scored high on PC also showed lower activation and less sustained activation in the dorsolateral prefrontal cortex (DLPFC), a region known to be involved in the downregulation of emotional information (Oschner & Gross, 2005). This effect occurred regardless of depression history and appeared to be criticism specific. No differences were observed when participants listened to recordings of maternal praise.

If PC is picking up on important individual differences in how people process negative information at a neural level, we might expect to see similar effects at other processing levels. For example, individuals high on PC might show differences in cognitive processing consistent with neural-processing differences. The DLPFC has been shown to be associated with executive control and emotion regulation (e.g., Davidson, 2000). Individuals recruit the DLPFC when they voluntarily allocate attention to target stimuli in the presence of conflicting stimuli (Kane & Engle, 2002). Thus, it is possible that high-PC individuals have difficulty resolving attentional conflict in the presence of negative emotional stimuli. This would lead them to become "stuck" on this information and could contribute to aberrant processing of that material in a way that increases perception of criticism—if negative emotional information is more difficult to inhibit, then it may be more salient when individuals reflect on the behavior of their close relationship partners.

Similarly, the finding that high-PC individuals show elevated amygdala activation in response to maternal criticism (Hooley et al., 2012) suggests that these individuals, relative to low-PC control individuals, might show differences in cognitive functions served by the amygdala. The amygdala has been implicated in attentional orienting, and activation in this brain region has been linked to heightened attention and faster orienting

to threatening stimuli in individuals diagnosed with post-traumatic stress disorder (El Khoury-Malhame et al., 2011). Individuals with social anxiety disorder also show greater amygdala activation than do healthy control individuals when anticipating the presentation of a negative or ambiguous stimulus, which potentially indicates greater preparation for attentional deployment to threatening stimuli (Bruhl et al., 2011). Furthermore, healthy individuals activate the amygdala more strongly in response to faces with emotional than with neutral expressions (Breiter et al., 1996). Individuals who rate their close others as highly critical might therefore be expected to be faster to orient to negative emotional information.

Aberrant attention processing would follow from the manner in which neural processing differs in high-PC versus low-PC participants. It may also help us better understand why PC is problematic transdiagnostically, given that PC may well be a marker for difficulty disengaging from negative emotional information as well as orienting more quickly to this information. Coupled with the potential to interpret ambiguous information more negatively, this aberrant attention processing may lead to a cycle in which high-PC individuals interpret ambiguous information more negatively, attend to this information more quickly, and become stuck on it.

We examined the performance of low-PC and high-PC individuals on two different information-processing tasks. The first task involved a measure of two phases of attention processing—executive control (the attentional process of inhibiting irrelevant information and facilitating the relevant) and orienting (the process of allocating attentional resources toward a relevant target; Posner & Petersen, 1990). We hypothesized that compared with their low-PC peers, individuals who scored high on PC would show impaired executive control of negative emotional information and would orient to negative emotional information more quickly. The second task required participants to listen to and interpret ambiguous words. We predicted that high-PC individuals would make more negative, but not more positive, interpretations of ambiguous words. To ensure that observed effects were best explained by PC rather than other constructs known to be related to the cognitive processes of interest, we also measured depressive symptoms, social anxiety, and neuroticism.

Method

Participants

We screened 81 adult community residents via phone or e-mail to confirm that they had no history of traumatic brain injury and had normal or corrected-to-normal

vision and hearing. They were then invited for a laboratory visit during which they completed a series of tasks and measures for which they received \$30 ($n = 80$) or undergraduate course credit ($n = 1$). Five participants were ultimately excluded from analyses, which yielded a final sample of 76 participants (39 male, 37 female) between the ages of 18 and 54 (mean age = 30.73 years, $SD = 10.58$). One participant was not able to finish the study due to fatigue, and another reported vision problems that interfered with performance halfway through the session. An additional 3 individuals did not reach minimum accuracy (85%) on the Attention Network Task–Emotion (ANT-E; described in the Measures section). The final sample of 76 participants was predominantly Caucasian ($n = 48$). Other races and ethnicities represented included African American ($n = 9$), Asian ($n = 8$), Hispanic ($n = 6$), biracial ($n = 4$), and Native American ($n = 1$).

Procedure

During the laboratory visit, participants completed the Beck Depression Inventory–II (BDI-II; Beck, Steer, & Brown, 1996), the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), the NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992), and the Perceived Criticism Scale (Hooley & Teasdale, 1989). They then completed two behavioral tasks designed to measure aspects of cognitive processing: the ANT-E (Tully, Lincoln, & Hooker, 2012) and the ambiguous words task (AWT; Dearing & Gotlib, 2009).

Measures

BDI-II. Depression is often associated with interpretive biases and other anomalies in cognitive processing (e.g., Butler & Mathews, 1983; Dearing & Gotlib, 2009; Mogg, Bradbury, & Bradley, 2006). Accordingly, we assessed depressive symptoms to eliminate the possibility that differences in depression across high-PC and low-PC individuals might be responsible for any effects found. The BDI-II is a 21-item multiple-choice self-report scale that assesses severity of depression symptoms. The scale has strong internal consistency ($\alpha = .91$) and high test-retest reliability ($r = .93$) over a 1-week period (Beck, Steer, Ball, & Ranieri, 1996).

LSAS. Like depression, social anxiety is associated with attention bias toward socially threatening material, including words and faces (e.g., Amir, Bower, Briks, & Freshman, 2003; Mogg, Philippot, & Bradley, 2004), as well as interpretive biases (e.g., Amir, Prouvost, & Kuckertz, 2012). Because we sought to test hypotheses regarding attention and interpretation of ambiguous

information that could be socially threatening, we used the LSAS (Liebowitz, 1987) to measure social anxiety and control for its potential contribution to our results. The LSAS is a 24-item scale that assesses fear and avoidance of social situations, including eating in public places, meeting strangers, and telephoning in public. The scale was originally designed to be administered by clinicians but has satisfactory psychometric properties when administered via self-report, with strong internal consistency ($\alpha = .95$) and high test-retest reliability ($r = .83$; Baker, Heinrichs, Kim, & Hofmann, 2002).

NEO-FFI. Measurement of symptoms of depression and social anxiety allowed us to ensure that any significant effects are related to PC rather than to either of these two clinical constructs. Our use of an unselected community sample, however, could limit the utility of these clinical measures. Therefore, we also measured neuroticism using the NEO-FFI (Costa & McCrae, 1992). The NEO-FFI is a 60-item self-report measure that assesses five personality dimensions (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) in accordance with the five-factor model of personality. Costa and McCrae (1992) reported test-retest reliability (r_s) for each of the scales ranging from .75 to .83, and Murray, Rawlings, Allen, and Trinder (2003) reported internal consistencies (α_s) ranging from .75 to .87 in a community sample. Neuroticism has been shown to be related to constructs similar to our dependent variables, including difficulty disengaging attention (Bredemeier, Berenbaum, Most, & Simons, 2011) and negative interpretation bias in the context of close relationships (Finn, Mitte, & Meyer, 2013).

Perceived Criticism Scale. PC was assessed using the Perceived Criticism Scale, which consists of a single question: "How critical do you think [name of key relative] is of you?" Participants were asked to rate the relative or person who was currently the most emotionally important to them—the person with whom they shared the closest relationship. Ratings were made on a scale from 1 (*not at all critical*) to 10 (*very critical*). The scale has strong test-retest reliability, $r(18) = .75, p < .001$, and has strong convergent and divergent validity (see Renshaw, 2008, for a review).

ANT-E. The ANT-E is a variant of the ANT (Fan, McCandliss, Sommer, Raz, & Posner, 2002) designed to assess orienting and executive control of attention in relation to emotional information (Tully et al., 2012). We used an updated version of the ANT-E that has more trials per condition and a variable intertrial interval to increase task reliability. In all trials, participants are required to identify the direction of a central target

arrow. In the orienting-to-emotional-information condition, either angry (emotional) or neutral faces appear as spatial (locator) cues for the upcoming target, which alert participants to the location of the upcoming arrow. In this condition, the target arrow is always flanked by neutral, noncompeting information in the form of horizontal lines. In the executive-control-of-emotional-information condition, participants are oriented to the location of the upcoming target by a neutral spatial cue (an asterisk), and the target arrow then appears, flanked on either side by neutral or angry faces—the faces are placed on either side of the target arrow when it appears, thereby presenting information additional to the target that competes for attentional resources. In both orienting and executive-control trials, spatial cues are always congruent with the upcoming target—they provide correct information about where it will appear.

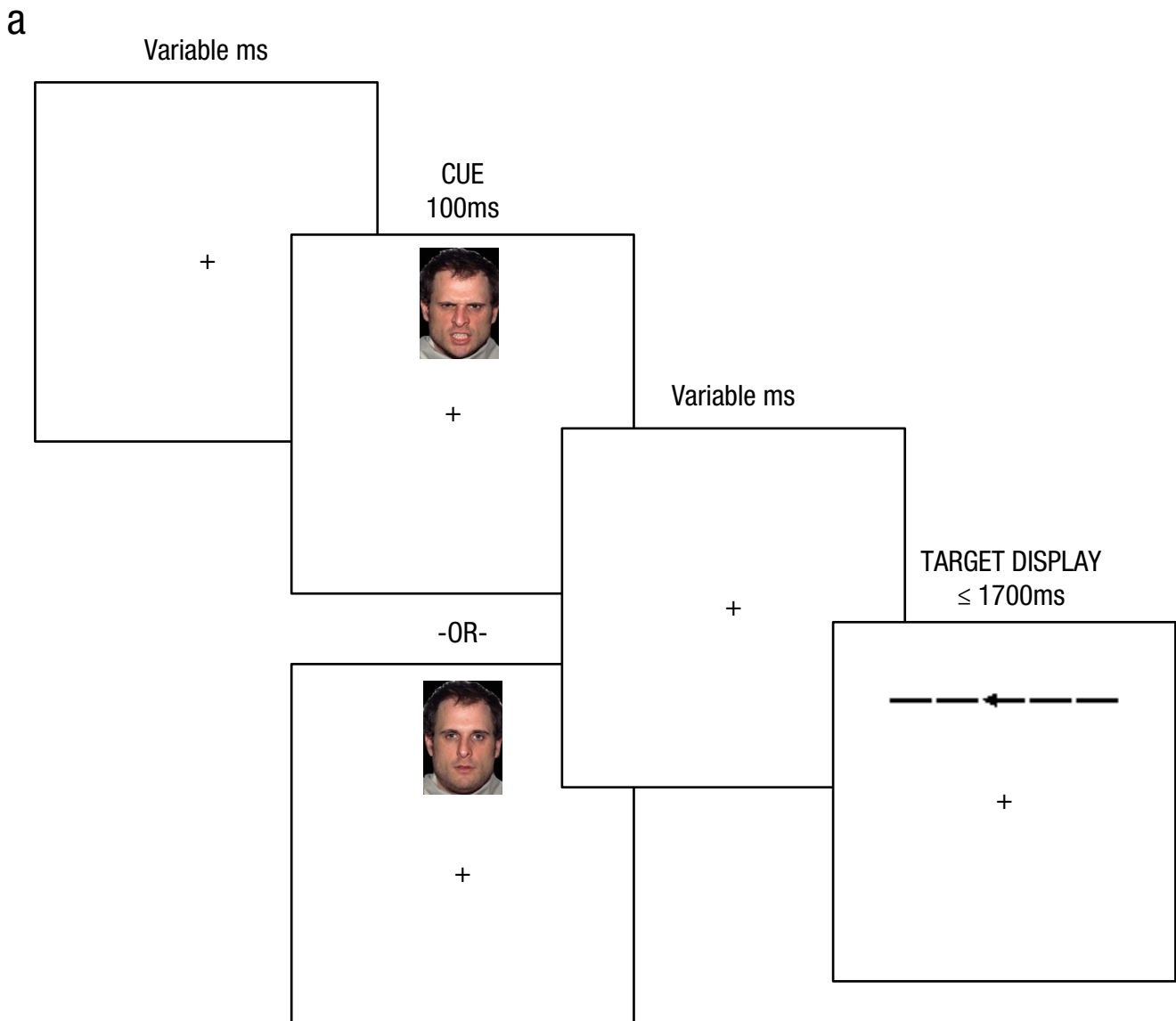
Attention network scores are obtained through simple subtractions of reaction times between conditions. Scores indexing executive control of emotional information are calculated by subtracting reaction times in the neutral-face-flanker condition from reaction times in the angry-face-flanker condition. Higher scores indicate that participants take longer to respond to an arrow flanked by angry faces than to an arrow flanked by neutral faces. Scores that indicate orienting to emotional information are calculated by subtracting reaction times in the neutral-face-spatial-cue condition from reaction times in the angry-face-spatial-cue condition. Lower scores indicate that participants are faster to respond to arrows preceded by an angry-face cue than to arrows preceded by a neutral-face cue. Orienting to emotional information was included in the task to dissociate the attentional capture of emotional information from the executive control of emotional information. If, as predicted, high-PC participants attend to negative emotional information more quickly than do their low-PC counterparts, we would expect faster orienting to emotional information. Similarly, if, as predicted, high-PC participants have difficulty inhibiting negative emotional information, we would expect them to exhibit slower executive control of emotional information.

Stimuli were 16 (8 female, 8 male) colored photographs of unfamiliar faces taken from the NIMSTIM face set (Tottenham et al., 2009); percentages of racial-ethnic groups were 50% Caucasian, 25% Asian/other, and 25% African American. All negative facial expressions were open-mouth angry stimuli. These are more reliably identified as angry than are closed-mouth angry stimuli and more reliably identified correctly compared with fear faces (Tottenham et al., 2009). Face photographs were made uniform by centering the face in a 1.68 in. \times 2.42 in. box with a black background. Each face was shown in both an angry and a neutral expression, thereby resulting in a total of 32 face stimuli.

The ANT-E has two conditions (orienting, executive control) and four trial types: two orienting (neutral-face cue, angry-face cue) and two executive control (neutral-face flanker, angry-face flanker). There are 288 trials: 144 in each of the two conditions, and 72 in each of the four trial types. Each trial begins with a fixation cross for a variable intertrial interval (400–1,600 ms), followed by one of the three cue types (asterisk, neutral face, angry face) presented for 100 ms, followed by an interval of 400 ms; finally, one of the three target stimuli (neutral-line flanker, neutral-face flanker, angry-face flanker) is presented for 1,700 ms or until the participant responds. Response accuracy is measured to ensure that participants are actively engaged in the task; participants are excluded from analyses if they do not meet an 85% accuracy

threshold. Figure 1 provides an illustration of task stimuli and timing. The task was presented on an Acer desktop computer using E-Prime professional version 2.0.

AWT. The AWT (Dearing & Gotlib, 2009) was originally designed for a study of risk factors in depression. During the task, participants listened to a series of “blended words” comprising sets of acoustically combined word pairs. Each blended word consisted of two component words: one neutral word and one word with an unambiguous valence. Each pair of component words differed by only one phoneme (e.g., sad-sand, joy-boy). Dearing and Gotlib developed the stimulus set using sound-editing software to combine the members of each word pair by averaging the distinct waveforms of each



(Figure 1. continued)

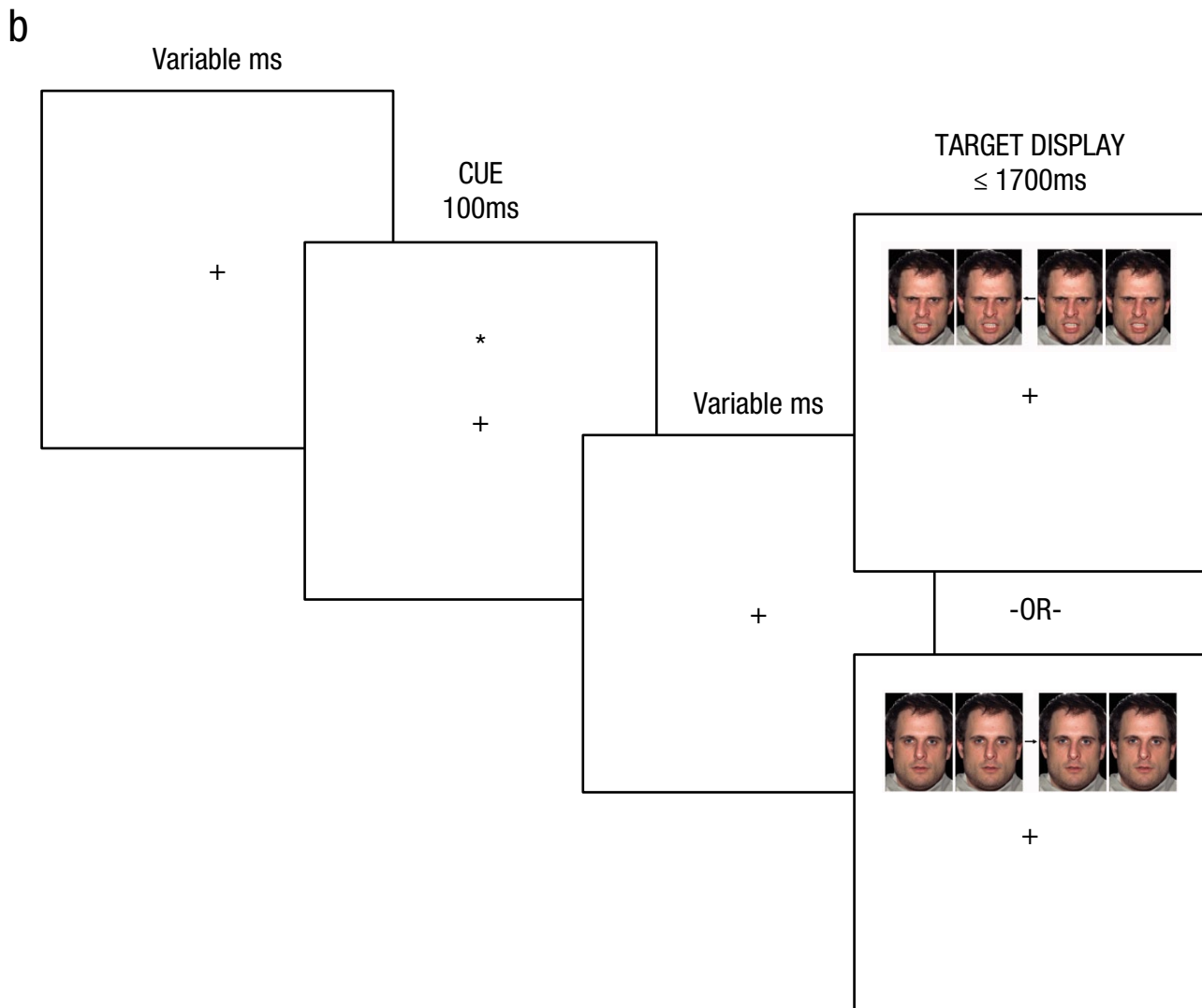


Fig. 1. Example of an orienting trial (a) and an executive-control trial (b) on the Attention Network Task–Emotion. In the orienting trial, a neutral-face or angry-face cue is followed by a target arrow flanked with neutral lines. In the executive-control trial, an asterisk cue is followed by a target arrow flanked by neutral or angry faces. Reprinted from *Psychiatry Research*, 197(1-2), L. M. Tully, S. H. Lincoln, and C. I. Hooker, “Impaired Executive Control of Emotional Information in Social Anhedonia,” pp. 29–35, Copyright 2012, with permission from Elsevier.

component word and combining the resulting waveforms into a single audio output to yield an ambiguous stimulus. The total test stimulus set contains 20 negative-neutral blends and 20 positive-neutral blends. The negative-neutral blends include both “depressotypic-neutral” blends (e.g., sad-sand) and blends involving social threat (e.g., hated-heated). In addition, three sets of control stimuli were included: nonblended neutral words (e.g., along), nonblended negative words (e.g., grief), and nonblended positive words (e.g., good). Control stimuli were included to ensure that participants responded accurately, and without a response bias, to unambiguous information. The resultant stimulus set contains 80 items.

All stimuli were presented via noise-cancelling headphones. Following Dearing and Gotlib (2009), the order of item presentation was randomized, and each item was presented once (for a total of 80 trials for each participant). Prior to the presentation of each auditory stimulus, the trial began with the presentation of a fixation cross at center screen (500 ms). After the offset of the auditory stimulus, participants were presented with two words on the screen; the participants’ task was to indicate which word they thought they had heard. The words remained on the screen until participants made a response. The placement of the words on the screen (right vs. left) was counterbalanced according to word valence. For valenced/neutral word blends, the valenced and neutral

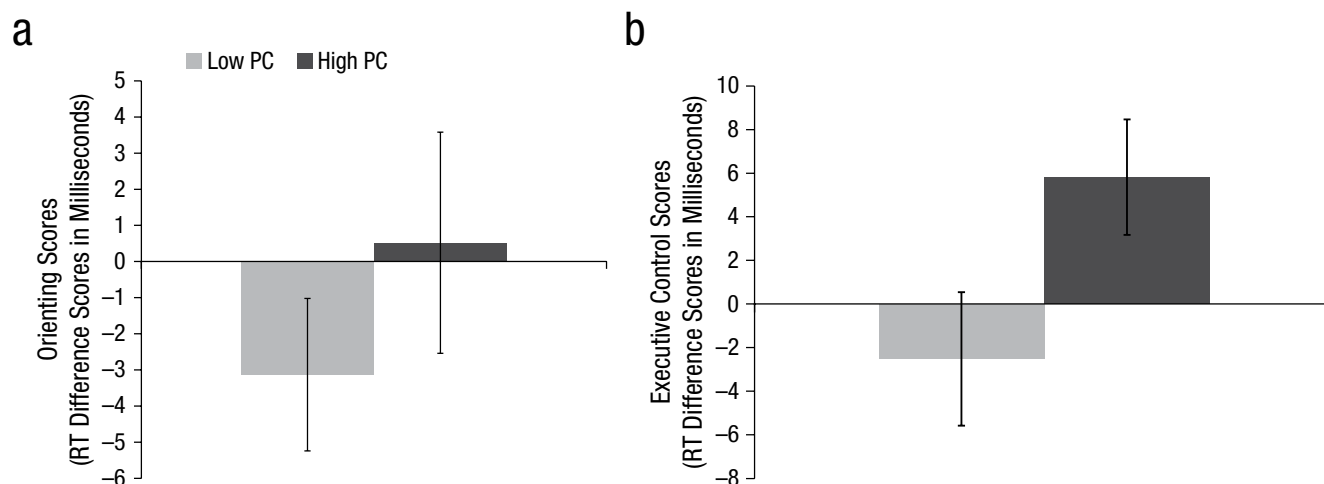


Fig. 2. Results: reaction time difference scores by group on the orienting trial (a) and the executive-control trial (b) on the Attention Network Task–Emotion. Error bars represent standard errors. PC = perceived criticism; RT = reaction time.

words that composed the blend were presented. For control trials, the valenced control words were paired with neutral words (e.g., along-alone), and the neutral control words were paired with either positive or negative words (e.g., could-good). Pairing for control trials occurred only in terms of possible responses displayed on the screen; control words themselves were not blended amalgams.

When the word pairs appeared on the screen, participants indicated which word they believed they had heard by pressing a button on the keyboard. The “M” key indicated the word on the right, whereas the “C” key indicated the word on the left. The respective keys were marked with blue stickers reading “R” and “L” to simplify response procedures. For the test items, both choices were “correct” in the sense that both choices indicated words contained in the blend. However, for control items, one response was correct and one incorrect, given that the control item itself contained only one word.

Results

High-PC and low-PC groups

High-PC and low-PC groups were derived using a median split. High-PC individuals ($n = 41$) rated their close relationship partners as 6 or higher on the 10-point scale, whereas low-PC individuals ($n = 35$) rated their relationship partners as 5 or lower. This cut point not only represents the median in the current sample but also parallels Hooley and Teasdale’s (1989) findings. In their study of relapse of depression, they found that every individual who rated his or her spouse as 6 or higher on the Perceived Criticism Scale relapsed. Thus, using 6 as a cut point, given the distribution of scores in the current study, is empirically supported. Furthermore,

the use of cut points and categorical distinctions is commonly used in clinical practice and may be most helpful to clinicians as the field moves toward closing PC’s research-practice gap.

High-PC and low-PC groups did not differ on age, $t(73) = 0.68, p = .50, d = 0.16$, or gender distribution, $\chi^2(1, N = 76) < .01, p = .99$, Cramer’s $V < .01$. In addition, there were no group differences in BDI-II scores, $t(74) = 1.66, p = .10, d = 0.38$, LSAS scores, $t(72) = -1.19, p = .24, d = 0.28$, or neuroticism scores, $t(74) = -1.16, p = .25, d = 0.27$. These findings are consistent with past work that has shown that PC is not simply a proxy for psychopathology or personality.

Orienting and executive control of attention

Univariate analysis of variance (ANOVA) was used to assess group differences on the ANT-E. Analyses showed no group differences in overall accuracy, $F(1, 74) = 0.06, p = .80, \eta^2 < .01$, or mean reaction time, $F(1, 74) = 0.34, p = .56, \eta^2 = .01$. Contrary to prediction, the high-PC and low-PC groups showed no difference in orienting to emotional information, $F(1, 74) = 1.01, p = .32, \eta^2 = .01$; that is, high-PC and low-PC individuals did not differ in the speed with which they oriented to negative information (see Fig. 2a for orienting results). However, as hypothesized, high-PC and low-PC groups did differ with respect to executive control of negative emotional information: Compared with low-PC participants, high-PC participants had significantly more difficulty inhibiting negative emotional information relative to neutral information when identifying the direction of the target arrow, $F(1, 74) = 4.12, p < .05, \eta^2 = .05$ (see Fig. 2b for executive-control results).

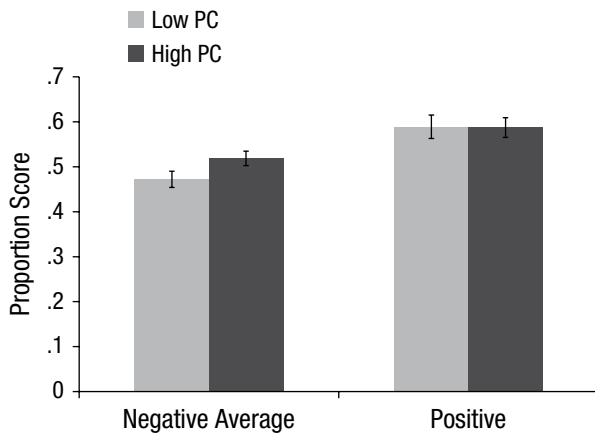


Fig. 3. Results: group proportion scores on the ambiguous words task. Error bars represent standard errors of the mean. PC = perceived criticism.

We also evaluated orienting and executive-control scores for each group against a 0 value, which represents an absence of difference in reaction time across negative and neutral conditions. The low-PC group did not differ from 0 on orienting, $t(40) = -1.48, p = .15, d = 0.46$, which indicated that they were no faster to respond to targets after negative versus neutral cues. The high-PC group showed the same pattern, $t(35) = 0.17, p = .87, d = 0.06$. In terms of executive control, the low-PC group did not differ from 0 in their ability to inhibit negative information, $t(40) = -0.83, p = .41, d = 0.26$; that is, they inhibited negative and neutral information with equal efficiency. In contrast, the high-PC group did differ from 0, $t(35) = 2.20, p = .04, d = 0.74$, which indicated that they had greater difficulty inhibiting negative faces than neutral faces.

Interpretation of ambiguous words

Before analyzing group differences for the test conditions, we compared accuracy across the control conditions, in which one nonblended word was presented and then paired on the screen with a foil. To examine group and condition effects on accuracy scores, we conducted a repeated measures ANOVA with control condition as the within-subjects factor and PC group as the between-subjects factor. As expected, the analysis yielded no significant main effect for condition, $F(3, 74) = 1.59, p = .19, \eta^2 = .02$, or group, $F(3, 74) = 1.91, p = .17, \eta^2 = .03$. Furthermore, the interaction of group and condition was not significant, $F(3, 74) = 0.81, p = .49, \eta^2 = .01$. Thus, the high-PC group was not more prone to make emotional choices when presented with clearly unambiguous words, and they performed at a similar level of accuracy to the low-PC group.

Next, we examined whether the high-PC participants, compared with the low-PC participants, made more

emotional interpretations in the ambiguous conditions. Following Dearing and Gotlib (2009), responses to each of the stimuli in the blended/ambiguous-word conditions were coded as 1 if participants chose the emotional word and as 0 if they chose the neutral word. These coded responses were summed for each of the conditions (depressotypic, social-threat, or positive blends), and scores representing the proportion of the time individuals chose the emotional word were calculated. Given the transdiagnostic relevance of PC, we expected high-PC participants to make more negative interpretations overall. Thus, we first analyzed these proportion scores across the two negative-blend conditions (depressotypic and social threat) by averaging the two conditions and conducting a two-way repeated measures ANOVA, with PC group as the between-subjects factor and condition (average negative interpretations vs. positive interpretations) as the within-subjects factor. This analysis revealed a main effect of condition, $F(1, 74) = 63.49, p < .01, \eta^2 = .46$; overall, participants made more emotional interpretations in the positive condition relative to the average negative condition. There was no main effect of PC group, $F(1, 74) = 1.25, p = .27, \eta^2 = .02$. However, consistent with our expectation that groups would differ in negative but not in positive interpretations, results showed a significant interaction between group and condition, $F(1, 74) = 4.33, p = .04, \eta^2 = .06$. An independent-samples t test on proportion scores for average negative interpretations showed that the high-PC group made more negative interpretations than did the low-PC group, $t(74) = 2.16, p = .03, d = 0.50$. As expected, the groups did not differ with respect to their tendency to make positive interpretations of ambiguous words, $t(74) = 0.08, p = .94, d = 0.02$.

We were then interested, post hoc, in exploring whether interpretation bias differed across depressotypic and social-threat conditions. Follow-up analyses showed that the high-PC group made more depressotypic interpretations than did the low-PC group, $t(74) = 2.21, p = .03, d = 0.51$, but the groups did not differ significantly in their tendency to make social-threat interpretations, $t(74) = 0.50, p = .62, d = 0.11$. Results are presented in Figure 3.

Last, we examined whether the rate at which each group chose emotional interpretations of ambiguous words differed from chance (.50). Thus, we conducted six one-sample t tests. In the positive condition, both PC groups chose emotional interpretations more often than chance—low-PC group: $t(40) = 4.87, p < .01, d = 1.54$; high-PC group: $t(34) = 5.52, p < .01, d = 1.89$. Thus, both groups showed some evidence of positive inferential bias. In the social-threat condition, the low-PC group chose emotional interpretations less often than chance, $t(40) = -3.60, p < .01, d = 1.14$, and low-PC participants did not differ from chance in the depressotypic condition, $t(40) = 0.86, p = .40, d = 0.27$. In

contrast, the high-PC group made marginally fewer social-threat interpretations than would be expected by chance, $t(34) = -2.01$, $p = .05$, $d = 0.69$, but significantly more depressotypic interpretations than chance, $t(34) = 4.52$, $p < .01$, $d = 1.55$. These results indicate, again, that whereas the low-PC and high-PC groups process ambiguously positive information similarly, high-PC individuals are more prone to make depressotypic interpretations of ambiguous information.

Discussion

People who perceive higher versus lower levels of criticism from their close partners show impaired executive control when challenged by negative emotional stimuli. As predicted, compared with low-PC individuals, people who scored high on PC took longer to identify the direction in which an arrow was pointing when it was flanked by angry versus neutral faces. Thus, they experienced greater difficulty exerting attentional control in the context of negative emotional information. However, contrary to expectation, individuals low and high on PC did not differ in the efficiency with which they oriented to negative relative to neutral emotional information. Therefore, we found no evidence to support the idea that high-PC individuals are quicker overall to detect negative information. In a second task in which participants were asked to make interpretations of ambiguous acoustic information, high-PC individuals reported hearing more negative words (e.g., sad rather than sand) in word blends than did low-PC individuals, which indicates that PC is associated with a negative interpretation bias. High-PC and low-PC participants did not differ in their interpretation of ambiguous positive information (e.g., boy vs. joy), which indicates that this interpretation bias is specific to the processing of negative material.

Although our failure to find differences in orienting between high-PC and low-PC individuals was unexpected, it is consistent with the Hooley et al. (2012) suggestion that increased amygdala activity and decreased DLPFC activation may act independently to produce additive vulnerabilities in high-PC individuals. Our finding that high-PC individuals did not differ from low-PC individuals in orienting attention, which is influenced in part by the amygdala (e.g., El Khoury-Malhame et al., 2011), but did show impairments in executive control, a largely DLPFC-mediated process, provides further support for the dissociability of these two vulnerabilities. In the present study, results showed impaired executive control of emotional information in high-PC participants on a behavioral task, consistent with the finding that high-PC individuals show less DLPFC activation than do low-PC persons when exposed to negative information in the form of criticism.

Individuals who perceive high levels of criticism in close relationships may have more difficulty exerting control over attentional resources in the face of challenging interpersonal or emotional material. This material is “stickier” for them—it grabs their attention. In an argument or other challenging interpersonal situation, a high-PC individual could attend to negative information to the detriment of processing positive or neutral information that could have de-escalated the situation, thus perpetuating interpersonal conflict. This may also help explain why some individuals show a criticality bias and perceive more criticism in interactions with loved ones than is actually present (Smith & Peterson, 2008). Given that executive control of attention is also essential to working memory (Kane & Engle, 2002), high-PC individuals may have more difficulty holding positive representations of their partners in working memory when distracted by negative emotional information. This may help explain why criticality bias, or the overperception of criticism, is associated with greater reciprocal criticism (Peterson et al., 2009). It is also consistent with findings from the EE literature that high-EE dyads have more negative contributions from both partners during conflict than do low-EE dyads (Hahlweg et al., 1989). A high-PC individual may focus more on a partner’s criticism or critical cues and respond more negatively.

Outside of the laboratory, dysfunction in other lateral prefrontal brain areas has been linked to greater interpersonal distress. In healthy adult couples, low ventral lateral prefrontal cortex (VLPFC) activation to images of a partner’s face predicts poorer emotion regulation after interpersonal conflict with that partner (Hooker, Gyurak, Verosky, Miyakawa, & Ayduk, 2010). This suggests that low VLPFC activation after an interpersonal stressor is a vulnerability factor for forms of psychopathology that are characterized by poor emotion regulation. Previous investigators had found similar neural effects using less ecologically valid affective challenges in the laboratory (e.g., Ochsner, Bunge, Gross, & Gabrieli, 2002). Thus, evidence is converging that low lateral prefrontal activation, both dorsal (e.g., Hooley et al., 2012) and ventral, is associated with aberrant processing of negative, interpersonally relevant information.

In addition to becoming stuck on negative emotional information, high-PC individuals in this study made more negative interpretations of ambiguous word blends than did low-PC individuals. Thus, in situations with ambiguous information, individuals with high levels of PC make more negative inferences than neutral inferences. This may make them more vulnerable to interpersonal difficulty and may predispose them to more readily perceive criticism or other negative content in ambiguous interactions. Resolving ambiguity is required of most social interactions. A systematic bias to resolve ambiguity with

negative inferences is thus problematic and may contribute to criticality bias or to negative attributions about a partner's behavior.

The interpretation bias that we found in high-PC individuals was specific to depressotypic interpretations. This is an interesting finding when considered in the context of prior research. Adolescent girls at risk for depression also made more depressotypic interpretations on the same AWT used here (Dearing & Gotlib, 2009). Thus, PC seems to be related to an interpretation bias that may be a risk factor for psychopathology, particularly depression. This seems all the more plausible when one considers how consistently PC predicts depression relapse. Furthermore, the ability of PC to predict negative outcomes in schizophrenia may be explained by the interpretation bias found here. Schizophrenia is marked by significant impairments in theory of mind—the ability to infer the mental states of others (Sprong, Schothorst, Vos, Hox, & Van Engeland, 2007). Individuals who have more difficulty inferring the mental states of others necessarily encounter more ambiguity about what others are thinking. A tendency to make negative inferences in such situations may make individuals with schizophrenia and high PC especially vulnerable to negative outcomes.

Follow-up analyses indicated that the high-PC and low-PC groups did not differ in social-threat interpretations. This was surprising, given that criticism can be construed as a type of social threat. In addition, PC has been shown to predict treatment outcome in anxiety disorders, which are often comorbid with depression. Furthermore, the lack of social-threat interpretation bias in high-PC individuals is seemingly inconsistent with our finding that the high-PC group had more difficulty inhibiting socially threatening information. It is possible, however, that the negative interpretation bias found here predisposes individuals to develop social anxiety disorder and other anxiety disorders. For example, social anxiety disorder is associated with negative interpretation of various kinds of information (Yoon & Zinbarg, 2008), not only information that is easily conceptualized as socially threatening, like the word blends in the social-threat condition we used here. It will be important in future research to measure response latencies and eye gaze. It is possible that the high-PC participants were initially drawn to social-threat words but then actively avoided them, in which case we might expect that they would take longer to respond because they took extra time attempting to disengage from the socially threatening information.

Further work is needed to investigate whether the differences between low-PC and high-PC individuals in attention and interpretation biases found here translate to interpersonal interactions outside of the laboratory and to then determine the temporal relation between PC and difficulties in cognitive processing. Despite these remaining

questions, the current study has important clinical implications. Recently, cognitive-bias modification has garnered a great deal of research support (for a review, see Hertel & Mathews, 2011). Training individuals to correct cognitive biases or impairments in information processing, such as the executive-control difference documented here, has been shown to have positive clinical effects. For example, in attentional-bias modification, patients are trained to attend selectively to neutral or positive information rather than to negative information. Attentional-bias modification is easily administered via computer and has been shown to reduce symptoms of social anxiety disorder (Hirsch & Mathews, 2000) and risk for depression (Browning, Holmes, Charles, Cowen, & Harmer, 2012). Assessing PC may be an efficient means of identifying individuals who are likely to benefit from these kinds of interventions, either in addition to more traditional treatments or as stand-alone preventative measures. In future work, researchers should evaluate whether the difference between low-PC and high-PC individuals in executive control observed here is amenable to change and the consequences such interventions have.

Several limitations of the study warrant mention. First, in its current form, the ANT-E does not include a positive condition. Consequently, findings from this task alone cannot rule out the possibility that high-PC individuals process all emotional information, regardless of valence, differently than do low-PC individuals. It is important, however, that findings from the AWT showed that high-PC and low-PC scorers did not differ in how they processed positive emotional information. Taken together, therefore, our findings support the formulation that higher levels of PC are associated with specific difficulties processing negative information.

A second limitation is the use of an interpretive-bias task that requires self-report of interpretation. Some researchers have argued that this format cannot fully distinguish between response bias and interpretive bias (MacLeod & Mathews, 1991). Thus, the results for our interpretation-bias task may be better explained by a tendency for high-PC individuals to respond negatively, rather than that they make negative interpretations. However, the high-PC group in the current study did not respond more negatively when asked to respond to unambiguous stimuli. This suggests that they are no more likely to respond emotionally in the absence of ambiguity. Furthermore, if our results are better interpreted as the product of response bias in high-PC versus low-PC individuals, this has interesting and clinically rich implications for the use of PC as a clinical tool, as well as for future research on the construct. Future work might benefit from use of signal detection theory or implicit measures of interpretation bias to better characterize the nature of the association between PC and interpretation bias.

Finally, given that the current study was cross-sectional in nature, we cannot make claims about the origins of the relation between PC and impaired cognitive processing. It is possible that over time, exposure to high levels of criticism influences the brain in such a way that it becomes more sensitive to negative emotional stimuli. Thus, high-PC judgments may reflect both a measure of the environment and anomalies in cognitive processing. PC is inherently susceptible to subjectivity and bias. In the present research, we have shown that individuals who feel highly criticized by close relationship partners have more difficulty inhibiting negative emotional information and interpret ambiguous information more negatively. Individuals who perceive a small suggestion of criticism may have difficulty flexibly disengaging from that information, thus perceiving more criticism than is objectively present. It is also possible that some individuals rate their relatives as highly critical because their relatives are indeed objectively critical. In either case, training high-PC individuals to disengage from negative information and to interpret ambiguous information less negatively in their social environments may make them less vulnerable to psychopathology or may mitigate the common association between PC and relapse.

Despite these limitations, taken as a whole, our findings indicate that PC may moderate how people process negative emotional stimuli. Because PC is so easy to assess, it may allow researchers and clinicians to identify individuals at risk for developing psychopathology as well as those likely to have poorer clinical outcomes. It may also help to identify individuals who would benefit from additional treatment targeted at cognitive-processing biases.

Author Contributions

S. R. Masland and J. M. Hooley developed the study concept and the overall study design. K. Dearing and I. H. Gotlib designed the ambiguous words task, and L. M. Tully designed the Attention Network Task–Emotion. S. R. Masland collected the data under the supervision of J. M. Hooley. S. R. Masland conducted the primary analyses and drafted the initial version of the manuscript, which was revised first by J. M. Hooley and then all other authors. All authors approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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