Neuroticism predicts increased sensitivity in identifying negative facial affect in young adults

Julia R. Hopkins, Chelsea Lang, Dana E. Glenn, & Kalina J. Michalska

Department of Psychology, University of California, Riverside

Abstract

Our personalities color how we interpret others' emotions. Some people have an increased tendency to identify others' facial affect as negative or threatening, which may lead to the misinterpretation of social cues, poor responses in social settings, and could exacerbate feelings of stress or anxiety in social situations. Yet, studies linking personality traits on the Big Five Inventory (BFI), specifically neuroticism, to emotion recognition are mixed (Cunningham, 1977; Matsumoto et al., 2000). This study investigated the effect of neuroticism on people's discriminability and speed when identifying others' facial emotions. Participants (n = 37) judged the emotion of faces that were morphed along two emotion spectra: happiness to fear and happiness to anger. Responses determined participants' negativity threshold, or the point on the spectrum where their judgment switched from happy to angry or fearful. We tested the hypothesis that people who scored high on the neuroticism scale of the BFI would detect negative emotions more readily than people scoring low on neuroticism. We also measured the influence of personality traits on response time. As expected, we observed that high neurotic people were more sensitive to negative facial affect than low neurotic people. This extends on the research finding that individuals high in neuroticism have high emotional reactivity to negative stimuli to include ambiguous facial expressions. However, contrary to our hypothesis, response time was not associated with neuroticism level. Together, our findings suggest that people high in neuroticism have an increased sensitivity to detect negative facial emotions. Future studies should test whether the misinterpretation of social cues leads to impoverished social connections.

KEYWORDS: Big Five Inventory, neuroticism, emotion recognition

Introduction

Personality is multifaceted and has wide-ranging consequences for a person's life, wellbeing, and social connections (Lucas & Diener, 2009; Côté, & Moskowitz, 1998). For example, neuroticism is a personality disposition to experience negative affect that has been reliably shown to relate to mood and anxiety symptoms (Brandes & Tackett, 2019; Kotov et al., 2010). Even though accumulating evidence supports the characterization of neuroticism as a risk factor for psychopathology and impaired social connections (Hengartner et al., 2016; Kotov et al., 2010; Roberts & Kendler, 1999), the psychological mechanisms by which neuroticism may confer risk are not well characterized. Here we ask whether people who are high on neuroticism perceive the social world around them differently than those low on neuroticism, which may, in turn, lead to impoverished social interactions and psychopathology. Specifically, we examined the impact of the Big Five Inventory (BFI) personality trait neuroticism on participants' discriminability and speed of identifying others' displays of facial emotions.

Accurate identification of other people's emotional expressions provides us with cues to important features of the emotional state of our interaction partners. For example, when someone frowns or glares at us during a conversation, we might adjust our tone so as to appease them. However, some people display aberrations in their emotion recognition abilities, like the increased tendency to mistakenly view others' ambiguous facial emotions as negative or threatening. This decrease in "negativity threshold" is often associated with psychopathology like anxiety and depression (Dalili et al., 2015; Maoz et al., 2016; Reeb-Sutherland et al., 2015). Identifying the source of changes in negativity threshold is important because a skewed

perception of social interactions might lead a person to misinterpret social cues, respond poorly in social situations, and potentially exacerbate underlying psychopathology due to negative feedback loops. Given that personality influences social relationships and wellbeing (Lucas & Diener, 2009; Côté, & Moskowitz, 1998), certain personality traits may also influence how people interpret emotional expressions. Neuroticism, which measures emotional instability and the tendency toward negative emotions like anxiety, depression, and self-doubt (John et al., 1991), is one personality factor that has been linked with biases in interpreting socioemotional stimuli. Individuals scoring high on neuroticism display elevated emotional reactivity to negative events (Canli, 2008; Lommen et al., 2010), experience increased negative emotions (John et al., 1991), and are more likely to develop disorders such as depression (Spijker et al., 2007) and anxiety (Lahey, 2009). Neuroticism has also been associated with an increased tendency to interpret stimuli or situations as negative (Byrne & Eysenck, 1993; Salemink & van den Hout, 2010; Vinograd et al., 2020). Only a few studies have examined how neuroticism specifically influences facial emotion recognition with mixed results (Andric et al., 2014; Cremers et al., 2010; Lommen et al., 2010; Saylik, 2018) and none to our knowledge have tested the impact of neuroticism on emotion gradients. This study addresses this gap in the literature and aids in a broader understanding of how high neurotic individuals interpret facial cues which may influence their subsequent socio-behavioral understanding. Finding that neuroticism is associated with biases in the recognition of facial affect might open up new avenues for treatment and inform interventions for children or adults with high levels of negative emotionality.

We examined negativity thresholds in emotion recognition by testing how people identified photographs of ambiguous facial expressions because it provides a realistic representation of real-world emotion recognition (Pollak, & Kistler, 2002). In daily life, we often

encounter people whose facial emotions we must decode and interpret to enable effective communication. Only seldom do people express extremely negative emotions. More often, negative facial expressions are ambiguous, and people only display hints of annoyance, frustration, or disappointment, which they might try to cover up. Therefore, rather than testing how accurately people identify obvious facial expressions, it is more ecologically valid to ask people to categorize ambiguous emotions, for instance, faces that are a blend of two different emotional expressions.

The present study examined how the BFI personality trait neuroticism influences young adults' emotion recognition. We utilized an emotion identification task and administered the BFI to test the effect of neuroticism and negativity biases in emotion identification. Because neurotic individuals have a tendency to interpret ambiguous stimuli and experiences as negative (Byrne & Eysenck, 1993; Salemink & van den Hout, 2010; Vinograd et al., 2020), we hypothesized individuals high in neuroticism would display greater sensitivity in detecting negative facial emotions (fear and anger) than those low in neuroticism. We also hypothesized that this may result in a reduced response time when identifying emotions. In addition, as neuroticism peaks in the period between late adolescence and early adulthood (Lahey, 2009), testing the influence of neuroticism on emotion identification in young adults may provide insights into the effects of negative emotionality in a population that may be most vulnerable. If neuroticism is a meaningful source of negativity bias during emotion recognition, the current study may elucidate potential prevention targets for anxiety and depression and inform a nascent evidence base.

Method

Participants

Undergraduate students were recruited from the University of California, Riverside (UCR) psychology subject pool (see Table 1 for demographic information) to participate in a two-part study. In part one, participants completed a series of online questionnaires, collected via Qualtrics. Within 10 weeks of finishing part one, interested participants completed a computer-based emotion identification task conducted through the online platform Inquisit. Consent was collected at the start of both online visits. Participants received course credit for participation in each part of the study. Participants were excluded from analysis if they did not complete the task (see Methods) resulting in a total of 37 participants. This study was approved by the UCR Institutional Review Board.

Big-Five Inventory Trait: Neuroticism

Participants' self-reported personality traits were assessed via the Big Five Inventory (John et al., 1991; John, Naumann, & Soto, 2008). The BFI is a 44-item self-report questionnaire that measures openness, conscientiousness, agreeableness, extraversion, and neuroticism on a Likert scale from 1 (disagree a lot) to 5 (agree a lot). We studied the influence of neuroticism on emotion identification because neuroticism predicts anxiety and depression (Brandes & Tackett, 2019; Kotov et al., 2010) both of which are associated with biases in emotion identification (Spijker et al., 2007; Maoz et al., 2016). The 8-item neuroticism subscale measures emotion instability and tendency to experience negative emotions (e.g., worries a lot). Participants with scores above ($\geq$ 50th percentile) or below ($<$ 50th percentile) the median personality factor score were categorized as high or low neuroticism, respectively.

Emotion Identification Task

Face stimuli were black and white pictures of four ethnically diverse people expressing happy, angry, and fearful facial expressions (Tottenham, 2009). Each face identity was morphed along two emotion spectra: a happiness to fear spectrum and a happiness to anger spectrum. The stimuli were morphed in steps of ~7% using FantaMorph software v5.0 (Abrosoft), totaling 15 morphs per face identity and emotion spectrum (Figure 1). To control the percentage of each emotion present, we identified key anatomical locations which shift incrementally from happiness to anger or fear (Pollak, & Kistler, 2002).

Each participant completed a 20-minute, computer-based emotion identification task (Maoz et al., 2016; Pollak & Kistler, 2002; Stoddard et al., 2016) in which they judged the emotion of faces morphed along each emotion spectra. In each trial, participants were shown a fixation cross (1000ms), followed by a stimulus (200ms), a visual noise mask consisting of a scrambled face stimulus (200ms), and a response screen (2000ms) (Figure 2). Stimuli were randomized and each stimulus was presented three times for a total of 360 trials. Participants used a keyboard to select whether the face displayed happiness, sadness, fear, or anger. Of note, none of the stimuli displayed sadness and the sadness response option was included as a quality check to help identify participants who selected answers at random. Participants' data were excluded if they did not correctly identify the facial expressions that were 100% happy (0% fearful/angry) with at least 60% accuracy (n = 0).

Data Analysis

Participants' emotion judgments were used to determine their sensitivity to negative facial emotions via their fear and anger "thresholds". Each participant's fear and anger thresholds (i.e., the point at which the participant's judgment switches from one emotion [happy] to the

other [fearful/angry]), were calculated as the point of subjective equality (PSE) via psychometric functions fit to their emotion judgments (Figure 3). A psychometric function models the relationship between a feature of a stimulus (emotion intensity) and the probability that someone detects the stimulus (emotion). We implemented a Weibull cumulative density function, a standard psychometric function for force-choice decisions, using the Palamedes Toolbox in Matlab (Prins & Kingdom, 2018) with a fixed guess rate of $\gamma = .05$ and lapse rate of $\lambda = .05$. A smaller PSE value (lower fear/anger threshold) indicates greater sensitivity to detect fear or anger. To test whether neuroticism was related to biases in emotion identification, we conducted a mixed-design analysis of variance (MD-ANOVA) with emotion threshold (fear, anger) as a within-subject factor, neuroticism (high, low) as a between-subject factor, and participants' emotion threshold as the dependent variable. To whether neuroticism influences response times, we ran a separate MD-ANOVA for neuroticism with emotion as a within-subjects effect, neuroticism as a between-subjects effect, and response time as the dependent variable.

Results

Fear and Anger Thresholds

In line with our hypothesis, an MD-ANOVA revealed an effect between neuroticism and increased sensitivity to negative facial affect. Specifically, there was a significant main effect of neuroticism on emotion identification, $F(1, 32) = 7.98$, $p = .029$, such that high neurotic individuals (scores $\geq$50th percentile) had smaller negativity thresholds than participants who were low in neuroticism (scores <50th percentile), $t(32) = 2.29$, $p = .029$. In other words, high neurotic people were more likely to identify ambiguous facial images as fearful or angry than individuals low in neuroticism (Figure 3). On average, the high neurotic group began to identify

faces as angry when they were 55.0% angry/45.0% happy whereas people with low neuroticism identified faces as angry when they were 60.1% angry/39.9% happy. Similarly, people high in neuroticism began to identify fear in faces with an average of 60.9% fearful/39.1% happy expressions and people low in neuroticism began detecting fear when faces averaged 66.1% fearful/34.9% happy expressions (see figure 1 for facial image percentages). In other words, high neurotic people detected anger and fear when there were fewer traces of negative emotion presented in the face. This tendency to see negative information with fewer cues present could result in misinterpretations of social cues in everyday life leading to impoverished social connections.

Response Time

Next, we evaluated how participants' neuroticism influenced their response time when identifying facial emotion. We conducted an MD-ANOVA on neuroticism to test if neuroticism scores impacted how fast they could identify the emotion present in the faces. We included emotion (fear, anger) as a within-subject factor and neuroticism (high, low) as a between-subject factor. Response time was not significantly influenced by neuroticism, $F(1, 32) = .768$, $p = .382$, indicating neuroticism level did not impact the speed the participants identified emotions.

However, an MD-ANOVA did reveal a main effect of emotion on response time across all participants, regardless of neuroticism level, $F(2, 64) = 102.02$, $p < .001$. Follow-up paired-samples *t*-tests revealed that participants were significantly faster to respond to happy faces (M = 517.57ms, SD = 111.62ms) compared to angry (M = 643.58ms, SD = 131.56ms; $p < .001$) and fearful faces (M = 787.70ms, SD = 161.94ms; $p < .001$). Participants were also significantly faster to respond to fearful faces (M = 787.70ms, SD = 161.94ms) than angry faces (M =

643.58ms, *SD* = 131.56ms; *p* = .001). These results imply that, while neuroticism does not influence the speed of emotion identification, certain emotions took longer to identify for all participants, regardless of neuroticism level.

Discussion

The present study examined how young adults' neuroticism was associated with their performance on an emotion recognition task. Three main findings emerged. First, we observed that individuals high in neuroticism were more sensitive to recognizing negative emotions than people low in neuroticism. Second, we found that neuroticism levels did not influence the time it took for participants to identify facial affect. Third, we observed a main effect of emotion on response time, such that participants identified happy faces faster than both fearful and angry faces. Our study provides promising preliminary evidence that neuroticism level is associated not only with high-level social behaviors, emotions, and moods, but also lower-level psychological processes like facial emotion perception and identification.

Our primary goal was to examine how neuroticism influenced young adults' emotion recognition abilities. In line with our hypotheses, we observed that elevated neuroticism predicted increased sensitivity in detecting negative emotions upon viewing ambiguous facial affect. Previous research finds that neuroticism is associated with negativity thresholds that increase sensitivity to negative social cues (Byrne & Eysenck, 1993; Salemink & van den Hout, 2010; Vinograd et al., 2020). However, many of these studies examined people's responses to obvious or extreme emotional cues, which occur less frequently in daily life. Expanding on this prior literature, we found that high neurotic young adults were more likely to detect subtle traces of negative affect when faces show conflicting emotional expressions, compared to those with

low neuroticism. Future research should investigate whether increased sensitivity to negative facial affect is also associated with social impairments for neurotic individuals.

Our second aim was to test whether response times differed based on neuroticism level. We hypothesized that neurotic people would be faster to identify negative affect because of their increased levels of emotional reactivity and negative emotionality. However, we found no evidence that neuroticism influenced participants' response times. It may be that, although neurotic people have an increased tendency to interpret emotions more negatively, each participant may need a similar amount of time to process each image before interpreting the emotion. Furthermore, this study was conducted online, thus, external distractions may have influenced participants' response times on certain trials more so than would have occurred in a controlled laboratory environment. Future research should investigate if response time in identifying ambiguous facial expressions is influenced by other personality traits.

Lastly, we observed a main effect of emotion type on emotion recognition. Both anger and fear took longer to identify than happy emotions. This is in line with research finding that adults and children are faster to detect happy facial expressions than angry or fearful expressions (De Sonneville et al., 2010), possibly because people encounter happy facial expressions more often in daily life. Additionally, fear is one of the more difficult emotions to categorize as it is often confused with neutral and surprised faces (Tarnowski et al., 2017). The increased response times for fear and anger may also have been due to the options of two negative emotions to choose from in comparison to only one positive emotion.

In an ethnically diverse sample of young adults, we examined the relationship between neuroticism and biases in emotion recognition. The present study has several important strengths.

We implemented a precise psychophysical paradigm with carefully controlled stimuli to ensure that no aspect of the design or stimulus features interfered with participants' perceptions. We also recruited diverse ethnic populations that are often understudied and employed ethnically diverse emotional stimuli. Despite these strengths, the present study is limited by recruitment within the university setting. Future in-person studies will explore physiological and neural responses to emotional stimuli in participants on a wider range of personality traits and other psychopathology.

In conclusion, our findings that high neurotic individuals have an increased sensitivity in detecting negative affect extends findings from prior research to include the interpretation of ambiguous facial expressions. Our research also helps better understand how neurotic individuals interpret emotions in more realistic situations which may help identify the negative consequences of holding such personality characteristics.

Figures and tables

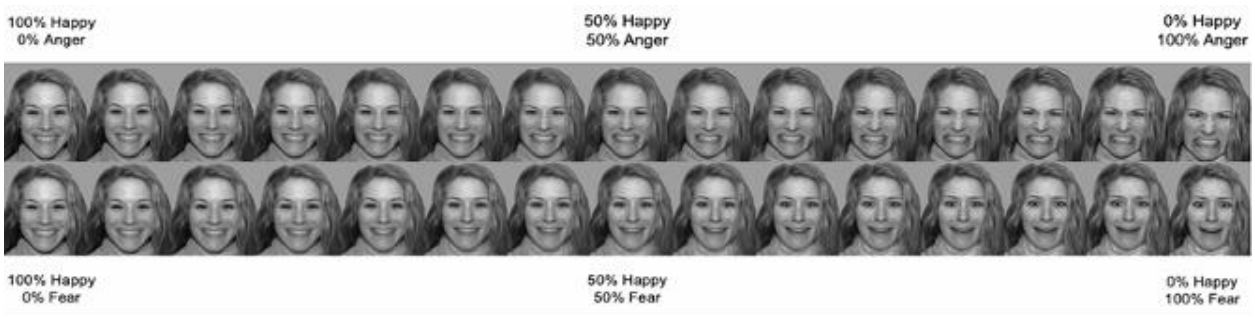
Table 1.

Participant Demographics

Neuroticism Split			Ethnicity			
High Neuroticism (M, SD)	Low Neuroticism (M, SD)	Female (%)	Hispanic	Asian	Native Hawaiian / Pacific Islander	Black
45.38, 6.32	32.33, 5.92	40.5	35.1%	35.1%	8.1%	5.4%

Figure 1.

Happiness to Anger Spectrum and Happiness to Fear Spectrum



Faces were morphed from happy to anger or fear in steps of ~7%, resulting in 15 stimuli equally spaced along the continua. The seventh face is the midpoint between the 100% happy facial expression and the 100% fearful/angry facial expression.

Figure 2.

Emotion Identification Methodology

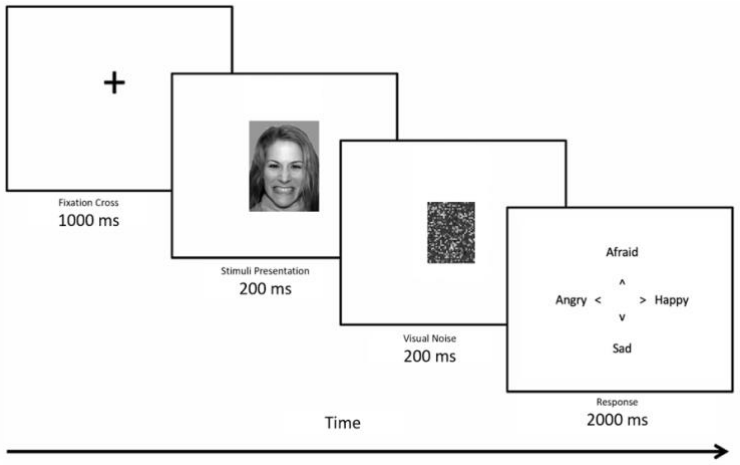
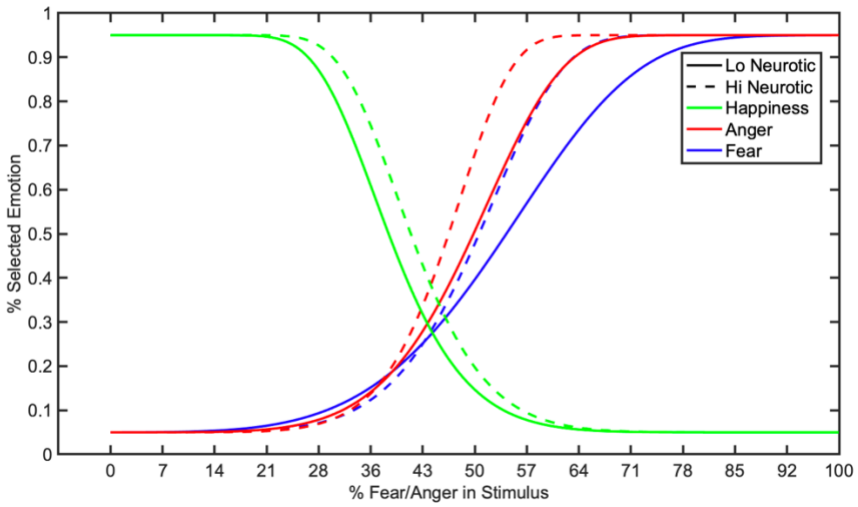


Figure 3.

Negativity Threshold by High versus Low Neuroticism



The average proportion of trials that participants selected anger or fear is plotted against the morph level for participants with high versus low neuroticism. Participants with scores above (>50th percentile) or

below (< 50th percentile) the median neuroticism score were categorized as high or low, respectively, in neuroticism.

References

Andric, S., Maric, N. P., Knezevic, G., Mihaljevic, M., Mirjanic, T., Velthorst, E., & van Os, J. (2016). Neuroticism and facial emotion recognition in healthy adults. *Early Intervention in Psychiatry*, *10*(2), 160-164.

Brandes, C. M., & Tackett, J. L. (2019). Contextualizing neuroticism in the Hierarchical Taxonomy of Psychopathology. *Journal of Research in Personality*, *81*, 238-245.

Byrne, A., Eysenck, M. W. (1993). Individual differences in positive and negative interpretive biases. *Personality and Individual Differences*, 14, 849–851.

Côté, S., & Moskowitz, D. S. (1998). On the dynamic covariation between interpersonal behavior and affect: Prediction from neuroticism, extraversion, and agreeableness. *Journal of Personality and Social Psychology*, *75*(4), 1032–1046.

Cremers, H. R., Demenescu, L. R., Aleman, A., Renken, R., van Tol, M. J., van der Wee, N. J. & Roelofs, K. (2010). Neuroticism modulates amygdala—prefrontal connectivity in response to negative emotional facial expressions. *NeuroImage*, *49*(1), 963-970.

Cunningham, R. M. (1977). Personality and the structure of the nonverbal communication of emotion. J. Person. 45, 564–584.

Dalili, M. N., Penton-Voak, I. S., Harmer, C. J., & Munafò, M. R. (2015). Meta-analysis of emotion recognition deficits in major depressive disorder. *Psychological Medicine*, *45*(6), 1135-1144.

De Sonneville, L. M. J., Verschoor, C. A., Njiokiktjien, C., Op het Veld, V., Toorenaar, N., & Vranken, M. (2002). Facial identity and facial emotions: speed, accuracy, and processing strategies in children and adults. *Journal of clinical and experimental neuropsychology*, *24*(2), 200-213.

Hengartner, M. P., Kawohl, W., Haker, H., Rössler, W., & Ajdacic-Gross, V. (2016). Big Five personality traits may inform public health policy and preventive medicine: Evidence from a cross-sectional and a prospective longitudinal epidemiologic study in a Swiss community. *Journal of Psychosomatic Research*, *84*, 44-51.

John, O. P., Donahue, E. M., & Kentle, R. L. (1991). The big five inventory: Versions 4a and 54 [Technical Report]. *Berkeley: University of California, Institute of Personality and Social Research*.

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative big five trait taxonomy. *Handbook of Personality: Theory and Research*, *3*(2), 114–158.

Kotov, R., Gamez, W., Schmidt, F., & Watson, D. (2010). Linking "big" personality traits to anxiety, depressive, and substance use disorders: a meta-analysis. *Psychological bulletin*, *136*(5), 768.

Lahey, B. B. (2009). Public health significance of neuroticism. *American Psychologist*, *64*(4), 241.

Lommen, M. J., Engelhard, I. M., & van den Hout, M. A. (2010). Neuroticism and avoidance of ambiguous stimuli: Better safe than sorry?. *Personality and Individual Differences*, 49(8), 1001-1006.

Lucas, R. E., & Diener, E. (2009). *Personality and subjective well-being.* In E. Diener (Ed.), *Social indicators research series: Vol. 37. The science of well-being: The collected works of Ed Diener* (p. 75–102). Springer Science + Business Media.

Matsumoto, D., LeRoux, J., Wilson-Cohn, C., Raroque, J., Kooken, K., Ekman, P., ... & Amo, L. (2000). A new test to measure emotion recognition ability: Matsumoto and Ekman's Japanese and Caucasian Brief Affect Recognition Test (JACBART). *Journal of Nonverbal Behavior*, *24*(3), 179-209.

Maoz, K., Eldar, S., Stoddard, J., Pine, D. S., Leibenluft, E., & Bar-Haim, Y. (2016). Angry-happy interpretations of ambiguous faces in social anxiety disorder. Psychiatry Research, 241, 122-127.

Pollak, S. D., & Kistler, D. J. (2002). Early experience is associated with the development of categorical representations for facial expressions of emotion. Proceedings of the National Academy of Sciences of the United States of America, 99(13), 9072–9076.

Prins, N & Kingdom, F. A. A. (2018) Applying the Model-Comparison Approach to Test Specific Research Hypotheses in Psychophysical Research Using the Palamedes Toolbox. Frontiers in Psychology, 9:1250.

Roberts, S. B., & Kendler, K. S. (1999). Neuroticism and self-esteem as indices of the vulnerability to major depression in women. *Psychological medicine*, *29*(5), 1101-1109.

Salemink, E., van den Hout, M. (2010). Validation of the "recognition task" used in the training of interpretation biases. *Journal of Behavior Therapy and Experimental Psychiatry*, 41, 140–144.

Saylik, R. (2018). Neuroticism related attentional biases on an emotion recognition task. *Anadolu Psikiyatri Dergisi*, *19*(1), 1-6.

Spijker, J., de Graaf, R., Oldehinkel, A. J., Nolen, W. A., & Ormel, J. (2007). Are the vulnerability effects of personality and psychosocial functioning on depression accounted for by subthreshold symptoms?. *Depression and Anxiety*, *24*(7), 472-478.

Stoddard, J., Sharif-Askary, B., Harkins, E. A., Frank, H. R., Brotman, M. A., Penton-Voak, I. S., ... & Leibenluft, E. (2016). An open pilot study of training hostile interpretation bias to treat disruptive mood dysregulation disorder. Journal of child and adolescent psychopharmacology, 26(1), 49-57.

Tarnowski, P., Kołodziej, M., Majkowski, A., & Rak, R. J. (2017). Emotion recognition using facial expressions. *Procedia Computer Science*, *108*, 1175-1184.

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., Marcus, D. J., Westerlund, A., Casey, B. J., & Nelson, C. (2009). The NimStim set of facial expressions: judgments from untrained research participants. *Psychiatry Research*, *168, (3) 242-249*

Vinograd, M., Williams, A., Sun, M., Bobova, L., Wolitzky-Taylor, K. B., Vrshek-Schallhorn, S., ... & Craske, M. G. (2020). Neuroticism and interpretive bias as risk factors for anxiety and depression. *Clinical Psychological Science*, *8*(4), 641-656.