THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF PSYCHOLOGY

COMING FACE-TO-FACE WITH DEPRESSION: THE IMPACT OF SYMPTOM SEVERITY ON EMOTION PERCEPTION

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FALL 2022

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Psychology
with honors in Psychology

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ABSTRACT

Emotion perception plays a critical role in our face-to-face social interactions. Although many may not realize it, emotions provide nonverbal signals to the affective state of others, which can influence our response and behavior during interpersonal exchanges. However, many disorders, such as Major Depressive Disorder (MDD), may have a detrimental impact on the ability to perceive and interpret facial expressions accurately. Prior research suggests that individuals with a history of MDD often exhibit a negative bias while observing happy, neutral, and ambiguous facial expressions. We wanted to know if this bias extends to subclinical levels of MDD as well. Our study aimed to investigate if perceptual sensitivity to emotional expressions differed in adult participants at varying levels of depressive symptom severity. Using a perceptual staircase procedure, we determined the lowest threshold level at which participants were able to detect different expressions. We then utilized mixed linear models to measure the relationship between symptom severity and sensitivity to the expressions. The findings suggest a marginal negative effect of symptom severity on sensitivity to sad expressions and a significant positive effect on sensitivity to fearful expressions. Overall, symptom severity only seemed relevant when perceiving negative emotions. There also did not appear to be significant group differences when factoring in emotional complexity. While the results support the negative bias theory to some extent, we cannot reach a sound conclusion, given that the effects on sadness were only marginal.

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ACKNOWLEDGEMENTS

This project was made possible through funding from the Erickson Discovery Grant and the Schreyer Honors College. In addition, thank you to the Laboratory of Developmental Neuroscience for this invaluable experience. I would like to express my sincerest gratitude to Dr. Suzy Scherf (Principal Investigator) and the graduate students (Myles Arrington and Lark Caboy) for your unyielding support and mentorship over the past year. Through all the hard work, endless rough drafts, critiques, and important lessons, I know I have come out stronger and even more capable than when I first started.

Introduction

Major depression, in recent years, has been at the forefront of mental health discussions as it grows to be the leading cause of disability worldwide (*Depression*, 2021). The year 2020 has accelerated our current mental health crisis. Undoubtedly, this can be attributed largely to the effects of the COVID-19 pandemic, which has abruptly altered the lives of millions around the globe. Since the onset of the pandemic and social distancing regulations, depressive symptoms at every level of severity have increased 3-fold across the United States (Ettman et al., 2020). Although the appearance of symptoms does not necessarily indicate a disorder, they often signify mental or physical disturbances that could affect a person's daily life. For example, even at subclinical levels, depressive symptoms can manifest as physical and behavioral changes (e.g., motor slowness, disinterest in hobbies, low mood) or cognitive impairments (e.g., poor concentration and memory; American Psychiatric Association, 2013).

At a diagnosable level, the psychiatric condition, also known as **Major Depressive Disorder (MDD),** is characterized by persistent feelings of sadness or depressed mood for at least two weeks. It may also include anhedonia, changes in appetite or sleeping behavior, increased fatigue, low self-esteem, feelings of hopelessness, and suicidal thoughts. Although these are the more commonly understood features of depression, there are lesser-known information-processing deficits as well. (*American Psychiatric Association*, 2013; *Depression*, 2021). For instance, individuals diagnosed with MDD exhibit altered perceptions of facial emotional expressions (Bourke et al., 2010; Krause et al., 2021).

Here, in my research, I examined whether variations in the severity of depressive symptoms, from subtle to more extreme, on the order of an MDD diagnosis, impact the ability to perceive various emotional expressions. By addressing this critical issue, we can begin to understand the implications of the rise in depressive symptoms, particularly in terms of our face-to-face social interactions, which have been greatly restricted by strategies to reduce COVID-19 exposure. In doing so, experts can identify and implement effective measures to improve public health.

Major Depression and Emotion Perception

Emotions play a fundamental role in human social connection. Therefore, the ability to perceive emotional expressions is critical for establishing healthy relationships. **Emotion perception** involves the identification and interpretation of emotion in others, which is communicated through facial expressions, verbal cues, and body language. Facial expressions are especially important when navigating social interactions. This is because they provide nonverbal signals regarding the affective state of others, which can influence one's behavior toward social partners. For example, if a person raises their voice at a friend who, consequently, expresses sadness on their face (i.e., inner brows raised, corners of lips droop, heavy eyelids, and down casted eyes), the person may respond by changing their tone (Reed & DeScioli, 2017). Thus, emotion perception helps inform our decisions and select our responses appropriately in interpersonal relationships (Bourke et al., 2010).

Over the past decade, numerous studies have been conducted on individuals diagnosed with MDD to evaluate their ability to perceive and interpret emotions. In a literature review by Bourke et al. (2010), it was discovered that MDD is associated with deficits in recognition accuracy, response bias, and attentional bias when processing facial emotional expressions. After a thorough analysis, it was concluded that depressed participants, in general, have a negative bias when viewing happy, neutral, and ambiguous faces – in other words, they tend to perceive these expressions as being more negative and sadder (Gur et al., 1992; Surguladze et al., 2004; Phillips et al., 2003; Krause et al., 2021; Eguchi et al., 2017; Roiser et al., 2011). Additionally, other cognitive processes that may be dysregulated include learning and memory, in which depressed groups tend to recall negative memories more readily than healthy controls (Eguchi et al., 2017; Roiser et al., 2011). These findings are supported by cognitive theories suggesting that individuals with depression often judge uncertain or ambiguous events as negative experiences. Thus, the ambiguity in facial expressions is interpreted in a more negative or threatening way. It is reasonable to say that this behavior can be detrimental to one's social interactions and lead to misinterpretations that ultimately exacerbate symptom severity. It is also worth mentioning that depressed groups are slower at responding to happy or positive expressions. This bias is especially true when researchers factor in stimulus duration. Generally, stimuli presented for longer durations (at least 1000 milliseconds) result in a higher risk for negative attentional bias. As stated by Krause et al. (2021), "results regarding longer stimulus duration could be explained in terms of the diagnostic criteria for MDD, which indicates motor slowness and indecision as symptoms of the disorder."

Finally, some researchers have brought forth the idea that impaired information processing of facial expressions may play a causal role in MDD rather than being a product of the disorder (Roiser et al., 2011; Bourke et al., 2010). For example, cognitive neuropsychological models suggest that abnormal emotion perception can be used to predict the outcomes of patients who are at risk or have mild depressive symptoms. As these individuals exhibit negative bias, they "create a stable dysfunctional and self-reinforcing" view of the world. This self-reinforcement is due to bottom-up processing (i.e., perceptual bias), which forms the negative bias, combined with top-down processing (i.e., attentional bias), which maintains their pessimistic outlook. In other words, distorted emotion perception might contribute to adverse reactions in social situations. However, the human mind perpetuates this depressive cycle by focusing attention on negative stimuli more and more, which may eventually develop into a disorder (Roiser et al., 2012; Eguchi et al., 2017). Therefore, emotion perception could potentially be used by researchers to assess the trajectory of patients vulnerable to MDD and create preventative measures to treat these individuals.

Limitations in the Literature

Research on the relationship between MDD and emotion perception has greatly expanded over time. However, it should be cautioned that existing research on this topic has produced mixed results. For example, some studies report an overall decrease in sensitivity to emotional expressions that is not specific to happiness or sadness. Others believe the impairments are only related to sadness or are nonexistent (Persad & Polivy, 1993; Krause et al., 2021). Furthermore, a sizable number of studies support the negative bias theory for response, recognition, and attention, but some argue that there is reduced positive bias as well (Phillips et al., 2003). This can be explained, in part, by differences in paradigm tasks or other method variations. For instance, discrimination and identification tasks are the two most common paradigms for recognition accuracy. Both tasks present photographs or schematic representations of faces, and participants can have a fixed or unlimited amount of time to view the stimuli. Identification tasks frequently involve labeling emotions, while discrimination tasks require participants to detect differences in expressions or gauge the intensity of emotions. Nonetheless, investigators have utilized other types of paradigms such as Implicit Processing tasks for recognition accuracy/response bias, or Dot-Probe, Face in the Crowd, Stroop tasks, and Affective go/no-go tasks for attentional bias (Bourke et al., 2010; Roiser et al., 2012). All-in-all, there is no standardized way to measure the effect of MDD on emotional facial processing.

Another limitation of our understanding of the link between MDD and emotion perception is that current literature focuses almost exclusively on the processing of 'basic' emotions. Basic emotions provide social signals about a specific set of universal expressions, such as happiness, sadness, anger, disgust, fear, and surprise (Ekman & Friesen, 1971). However, adult social interactions often hinge on 'complex' expressions, which provide signals about emotions related to more nuanced social behavior and inner thoughts (Golan et al., 2007). For example, during the adolescent years, the ability to perceive complex expressions improves significantly due to increased exposure to a wider spectrum of social information. Adolescents quickly learn subtle gestures, such as a flirtatious glance, as an indicator of romantic feelings, or a coy, mischievous smile as playfulness. These are signs of sexual maturity that emerging young adults need to develop to have a healthy foundation for future relationships (Motta-Mena &

Scherf, 2017). Critically, there is only one positively valenced basic expression (happiness). However, there are many positively valenced complex expressions (e.g., flirtatious, adoring). Therefore, studying negative bias in response to complex expressions may reveal even more severe consequences of MDD on emotion recognition. These outcomes may be particularly devastating with the rise in mild, moderate, and severe depressive symptoms due to COVID-19.

Study Objective

My study aimed to investigate the relationship between the severity of depressive symptoms and the ability to perceive positive and negative emotional expressions at different levels of complexity (i.e., basic vs complex). Although prior studies have found a negative bias in affective facial processing with increased sensitivity toward sadness, the overall findings have been mixed (Bourke et al., 2010; Rosier et al., 2011). Therefore, I wanted to measure the perceptual threshold sensitivity to detect emotional expressions in adult participants with varying levels of depressive symptoms. I predicted that higher levels of depression would be associated with impairments in the ability to detect positively valenced expressions (e.g., happiness, sexual interest). This is especially true for complex positive expressions. In contrast, higher levels of depression would be associated with greater sensitivity to negatively valenced expressions (e.g., sadness, contempt). In this case, the negative bias would be consistent across both basic and complex expressions. Both patterns of findings would reflect a negative bias in the processing of emotions. However, they would help address whether and to what extent this bias extends to the perception of complex expressions. Also, extending the prior literature by asking about the full range of symptoms – not just full-blown MDD.

In addition, many of the procedures and analyses for this study were inspired by Motta-Mena & Scherf (2017). Therefore, I would also like to see how the results compare to previous findings if I use similar methods. In doing so, I seek to replicate existing data to preserve the reliability of current research and expand our knowledge on the subject even further.

Methodology

Participants

The final sample consisted of 123 emerging adults between the ages of 18 to 25 years old. The participants were recruited through Cloud Research (web page) and Amazon Mechanical Turk (web page), participant-sourcing platforms that are designed for online research and data collection (Litman et al., 2017). We obtained consent using procedures approved by the Internal Review Board of the Pennsylvania State University. First, individuals were screened for the inclusion and exclusion criteria. Participants had to be medically healthy with no history of neurological diseases (i.e., Parkinson's disease or Huntington's disease), psychiatric disorders (i.e., Autism, Bipolar disorder, Schizophrenia), developmental disorders, or developmental delays (i.e., low birth weight). Neither a history of major depressive disorder nor an anxiety disorder was an exclusion criterion. Next, eligible participants were invited to continue to the full study. The subjects were compensated $0.25 for filling out the screener and an additional $3.25 for completing the experiment.

Behavioral Measures

Demographic Information. Participants provided general demographic information, including age, race/ethnicity, sex, and depression scores from the *Patient Health Questionnaire Depression Scale* (PHQ-8; see **Results** for demographics table). The **PHQ-8** is an eight-item diagnostic and severity measure for depressive disorders and has been utilized in a vast number of clinical studies (Kroenke et al., 2008). Each item allows participants to rate how often they have experienced various depressive symptoms over the past two weeks (e.g., "little interest or pleasure in doing things," "feeling tired or having little energy"). The scores are then ranked on a 0-24 scale. Higher scores indicate more severe symptoms (see **Appendix A** for measure).

COVID-19 Impact. In light of recent research indicating an increase in depression and anxiety in U.S. adults over the course of the pandemic (Ettman et al., 2020; Ettman et al., 2022), we also administered Sections A and B of the *Environmental Influences on Child Health Outcomes* (ECHO) *COVID-19 Questionnaire—Adult Alternate Version* to quantify the impact of the COVID-19 pandemic on participant's personal/family life and overall mental well-being. The measure comes from a longitudinal study of child health outcomes sponsored by the National Institutes of Health (Buckley et al., 2020). In addition to this, we also asked participants if they had ever sought treatment, been recommended to seek out treatment, received treatment, or had been diagnosed with an anxiety disorder or depression either prior to or since the onset of the COVID-19 pandemic in the United States (February 29, 2020).

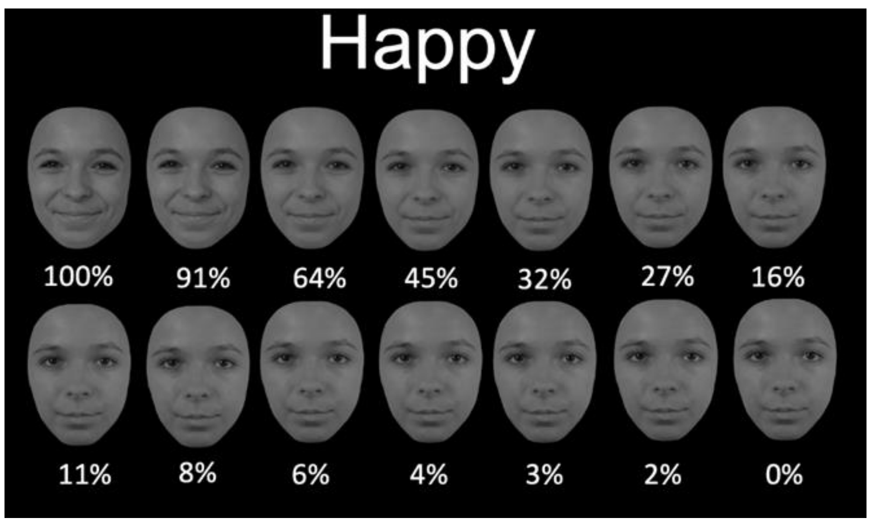
Sexual Preference. The *Sexual Preference Survey* (SPS) is a 1-item measure that asks participants to indicate their preference, whether that be men or women (exclusively or predominantly), both sexes, or other. A participant's selection in the SPS does not affect their eligibility in the study but may reveal potential biases.

Facial Emotion Expression Stimuli

The facial emotional expression stimuli included static grayscale images of professional young adult actors from the Complex Emotion Expression Database (CEED; Benda & Scherf, 2020). The stimuli included images of neutral (closed mouth, open mouth), basic (angry, fear, sad, happy), and complex (betrayed, brokenhearted, contempt, sexual interest) expressions composed by two female actresses with formal acting training. The complexity and valence of the expressions were balanced across the two actresses.

Figure 1

Expression Stimuli Morphed with Neutral Expressions



Note. Happy emotional expression morphed with a neutral expression at varying degrees. For example, 45% happy combines 45% happy emotional expression with 55% neutral expression.

In each image, the actor looked directly at the camera. The hair, neck, and shoulders were removed, and luminance was normalized across images. Each 100% expression was rated by an independent group of adults to ensure that the expressions were unambiguous (Benda & Scherf, 2020). Each of the eight 100% emotional expressions was separately morphed with a neutral expression from the same actress using Abrosoft Fantamorph 5 Delux (Version 5.4.0). This procedure generated 14 unique morphs per expression (100%, 91%, 64%, 45%, 32%, 27%, 16%, 11%, 8%, 6%, 4%, 3%, 2%, 0%). **Figure 1** illustrates the 100% expression and resulting morphed expressions tested in this experiment. For example, 45% happy combines 45% happy emotional expression with 55% neutral expression (Motta-Mena & Scherf, 2017).

Just Noticeable Difference Task

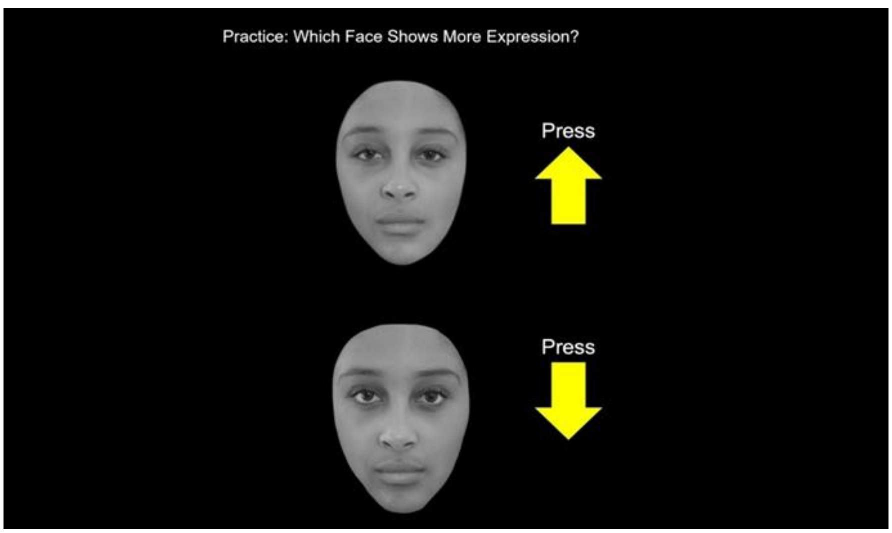
The **Just Noticeable Difference (JND) task** was designed to measure the minimum amount of perceptual information (i.e., perceptual threshold) needed to discriminate each expression from a neutral face (Motta-Mena & Scherf, 2017). It was a two-alternative forced choice task embedded in a fixed step-size perceptual staircase procedure (Cornsweet, 1962). The JND task was designed using PsychoPy Version 2020.2.0 (Pierce et al., 2019) and administered using the online platform Pavlovia (https://pavlovia.org/).

The task began with three practice trials in which an image of a third actor displayed 100% expression, which was paired with the actor's neutral face. Participants identified, 'Which face shows more expression?' and were required to respond correctly via button press on each practice trial prior to beginning the experiment (see **Figure 2**). During the task, there were eight blocks of trials, so each expression was tested in a separate block. The order of the blocks was randomized across participants. Each block began with an image representing the 100%

expression being tested with the instructions, 'Now you will see this expression.' Note that expressions are never labeled or verbally categorized. In each trial, participants viewed a central fixation between two face stimuli presented on the vertical axis of the screen (i.e., one directly above and the other directly below the fixation). Participants were instructed to identify 'which face shows more expression' with a button press. The pair of stimuli always included the neutral face and one of the morphed facial expressions from the same actor. The position of the stimuli was counterbalanced across trials within each block. The first trial always presented the neutral and 64% morph.

Figure 2

JND Task Face Selection



Note. Participants must choose which face shows more expression by selecting the up or down arrow key.

As in previous work, the staircase procedure of the JND task followed a 1-down/2-up step size along a $\log_2$ function until the participant experienced five failures (see Motta-Mena &

Scherf, 2017). In this procedure, when participants responded accurately and selected the morphed expression, the subsequent trial presented the neutral face and the next lowest morphed facial expression on the log_2 function (e.g., 45% if correct at 64%). When participants were incorrect and selected the neutral face, the subsequent trial presented the neutral face and the morphed facial expression two steps up the log_2 function (i.e., 91% if failed at 45%). Participants continued in a block until they failed five trials, which was determined in our earlier work to be an appropriate stopping rule (Motta-Mena & Scherf, 2017). For each failure, a trial-level perceptual threshold was computed as the average of the morphed stimulus from the failed trial and that from the most recent successfully completed trial. For example, if a participant failed on a trial in which a 16% morphed expression was presented, the trial-level perceptual threshold would be computed as (27% + 16%)/2 = 21.5%. To compute a final perceptual threshold for each block, we computed a running average of the five trial-level perceptual thresholds (see **Table 1**).

Table 1

JND Task Example

Trial Number	Error or Success	Expression Intensity	Most Recent Success	Most Recent Error
5	Error	16%	27%	16%
6	Success	32%	32%	16%
7	Success	27%	27%	16%
8	Success	16%	16%	16%
9	Success	11%	11%	16%
10	Error	8%	11%	8%
11	Success	16%	16%	8%
12	Error	11%	16%	11%
13	Error	27%	16%	27%
14	Success	16%	16%	27%
15	Success	11%	11%	27%
16	Error	8%	11%	8%

Note. An example of several trials in the JND task. After each successful selection, the threshold level decreases, and the task becomes more difficult. After each error, the threshold level increases, and the task becomes easier.

Data Analysis

The final data analysis was conducted using R software and R Studio interface (R Core Team, 2019; RStudio Team, 2020). The R packages included tidyverse, psych, interactions, and rstatix (Wickham et al., 2019; Revelle, 2020; Long, 2019; Kassambara, 2021). During this process, the original sample size was roughly 169 young adults in total. However, subjects were further excluded for not completing the JND task, not responding for multiple turns, completing the task twice, pressing the same key numerous times in a row, or being outside the study's age range of 18-25. After applying this exclusion criteria, 123 participants remained for the final analysis.

Behavioral Data. Perceptual threshold was the primary dependent measure of the JND task. Prior to analyses, any data point beyond 2 SD of the mean for the expression was replaced with the mean ± 2SD for that expression, which is a strategy for minimizing the effects of extreme scorers while maintaining the size of the sample and minimally affecting the mean of the distribution (Dixon & Tukey, 1968). The data were next examined for violations of normality. Distributions of perceptual sensitivity scores were consistently skewed. As a result, we transformed the data using a cube root function prior to submitting these data to the primary analytic models. We used the cube root data when reporting means and correlations in the descriptive data.

To maximize statistical power and account for non-independence (i.e., repeated measures) in observations, we used linear mixed-effects models to evaluate the relative influence of the fixed effects of complexity, valence, and depressive symptoms on the ability to perceive the emotional expressions. Participant was included as a random factor. All models included a random intercept to account for individual-level variability in the outcome measure and gender as a covariate.

Special Note. The analyses were guided by several questions:

Did we replicate original findings from emerging adults with new stimuli (additional actor), a broader population, and an online testing format? In our first model, we ran a repeated measures ANCOVA with valence (positive vs. negative) and complexity (basic vs. complex) as independent variables, sensitivity as a dependent variable, and participant age and gender as covariates. In this way, we tested for differences between four of the expression blocks: anger (negative, basic), happy (positive, basic), contempt (negative, complex), and interest (positive, complex). In previous reports (see Motta-Mena & Scherf, 2017), there were no main effects of valence nor complexity, and no interaction between the two, among young adults with low risk for MDD. Thus, we tested the hypothesis that emerging adults, who vary in their risk for MDD based on level of depressive symptoms, are differentially sensitive to either the complexity or valence of these 4 expressions.

Does the severity of depressive symptoms predict performance on the JND Task? To answer this question, we ran a mixed-effects linear model to test whether the magnitude of depression symptoms predicted perceptual sensitivity scores for each of the eight expressions.

Does the severity of depressive symptoms differentially predict the perception of negatively versus positively valenced emotional expressions? Additionally, we assessed if depression is differentially associated with positive versus negative expressions given their level of complexity (i.e., basic versus complex). Extending Question 1, we included interactions between complexity and valence, depression and complexity, depression and valence, and a three-way interaction between depression, complexity, and valence. In the model, we used depression scores as a predictor and threshold as the response. Given that this is a mixed linear model, our "within-subjects effect" included complexity and valence, while the "between-subjects effects" included gender, age, and depression score.

Furthermore, a reference is automatically set by the lmer function in R. In the model, the reference is anger, which represents basic, negative sensitivity. Thus, the interactions reveal whether the slope of depression on the reference differs from the slope of depression on non-reference levels. The two-way interaction between depression and complexity indicates whether depression is associated with the difference between basic and complex sensitivity, while the interaction between depression and valence indicates whether symptoms are associated with the difference between positive and negative sensitivity. The three-way interaction can be interpreted as whether the slope of depression is associated with the interaction between valence and complexity. In other words, this evaluates whether the difference between the differences of basic and complex in positive expressions, and basic and complex in negative expressions, are associated with individual differences in depression scores. The two-way interaction between valence and complexity, while not a focus of this model, replicates the same interaction in the two-way ANCOVA.

Results

Descriptive Data

Demographics. The participants' ages ranged from 18 to 25 years old (M = 22.5, SD = 1.8), which is within the period of emerging adulthood (Hochberg & Konner, 2019; Arnett, 2000). **Table 2** below summarizes the demographic information and provides details on gender, race, and age. Overall, it shows a nearly even distribution of females (*n* = 63, 51.2%) and males (*n* = 51, 41.5%), with the addition of non-binary (*n* = 3, 2.4%), non-listed (*n* = 1, <1.0%), and transgender (*n* = 4, 3.25%) individuals. Likewise, there is a relatively even split between those who identify as white (*n* = 65, 52.8%) versus non-white (*n* = 58, 47.2%). See **Appendix B** for a more in-depth breakdown of the subjects' racial/ethnic characteristics.

Table 2

Demographics of Participants

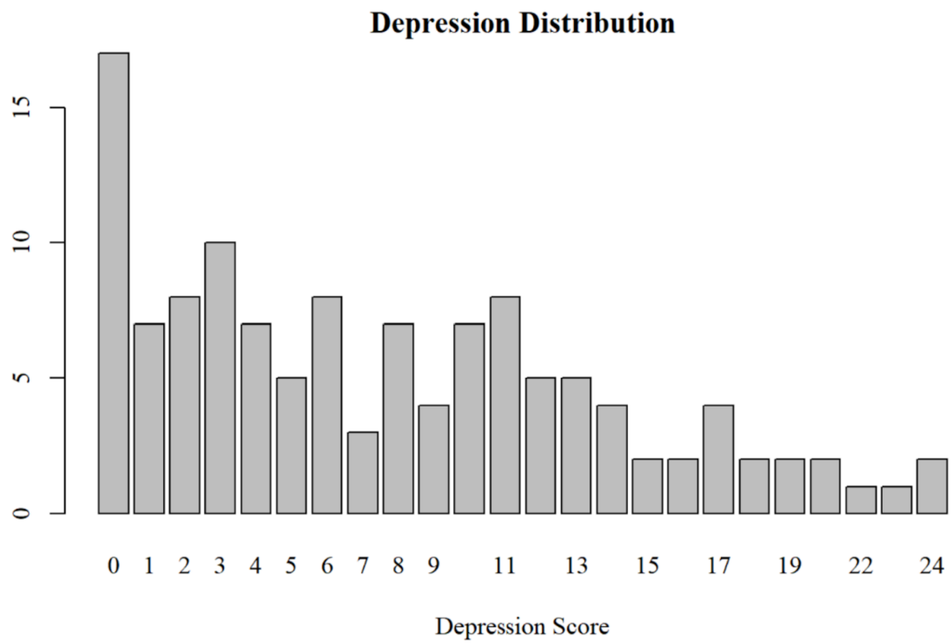
Demographics	**Participants (*N* = 123)**
Age (years)	
Range	18-25
Mean (±SD)	22.5 (±1.8)
Race	
Nonwhite	65 (52.8%)
White	58 (47.2%)
Gender/Sex	
Cisgender Female	63 (51.2%)
Cisgender Male	51 (41.5%)
Nonbinary	3 (2.4%)
Non-listed	1 (<1.0%)
Transgender Male	3 (2.4%)
Transgender Female	1 (<1.0%)

Note. Demographic characteristics of the total participants (*N* = 123) who completed the JND Task. Cells of Race and Gender/Sex include n (%).

Symptom Severity Distribution. The PHQ-8 is measured on a 0-24 scale, with higher scores indicating more symptoms (Kroenke et al., 2008). Overall, the participants scored an average of 7.67 (*SD* = 6.28), which falls in the mild category. Notably, a significant number of scores were within the low to moderate range of severity. As shown in **Figure 3**, the depressive symptom distribution is positively skewed, indicating that most of the participants had low to moderate levels of symptoms, with very few exhibiting severe levels of depressive symptoms.

Figure 3

Distribution of Depressive Symptom Severity



Note. Distribution of participants' depression scores from the PHQ-8 measure. The data is positively skewed, indicating that there is a low number of participants with severe depressive symptoms and a high number of participants with mild or no depressive symptoms.

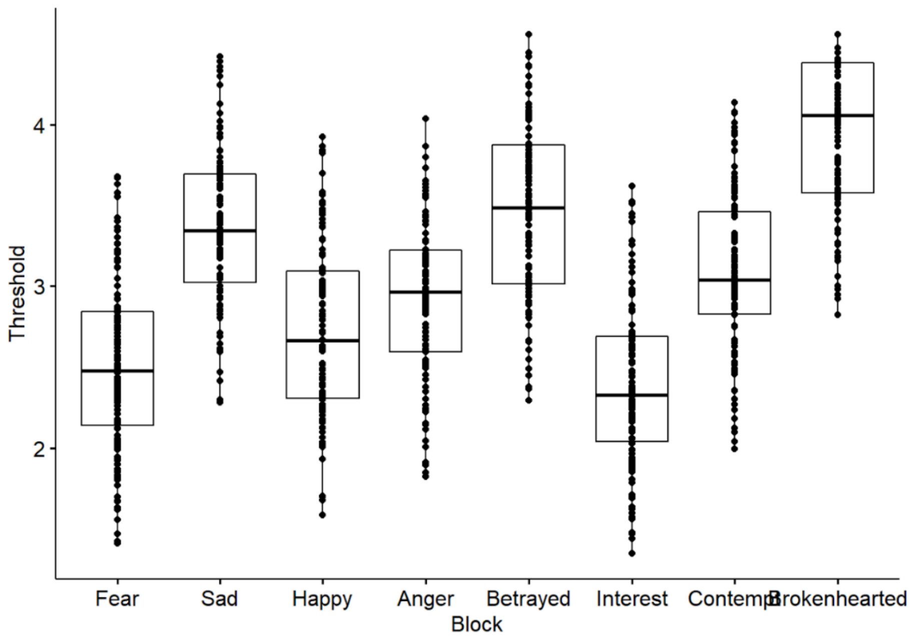
In general, participants reported mild levels of depressive symptoms. When accounting for other variables, depression levels did not change changed across age (b = -0.39, p = 0.210, d = 0.03). However, there were significant effects of gender (F(6,116) = 3.50, p = 0.003, ges = 0.153). Female participants, on average (M = 8.25, SD = 6.10), exhibited higher scores than did male participants (M = 6.10, SD = 5.69).

Expression Thresholds. Average perceptual thresholds indicate the minimal level of information required to detect a particular expression. Therefore, lower scores indicate greater sensitivity (i.e., less information required to detect the expression). **Figure 4** illustrates the average perceptual thresholds for each of the eight expressions (i.e., anger, sad, happy, fear, contempt, interest, brokenhearted, and betrayed). Overall, participants showed the greatest sensitivity for the expression of sexual interest (*M* = 2.41, *SD* = 0.55) but were the worst at detecting broken heartedness (*M* = 3.93, *SD* = 0.53). The large standard deviations reflect the difficult nature of the task; as some participants excelled, others may have struggled.

Gender was not significantly associated with differences in scores in each block (all p's > 0.500). In addition, there was no change in sensitivity to each expression as a function of age (all p's > 0.400).

Figure 4

Perceptual Threshold Averages for Individual Expressions

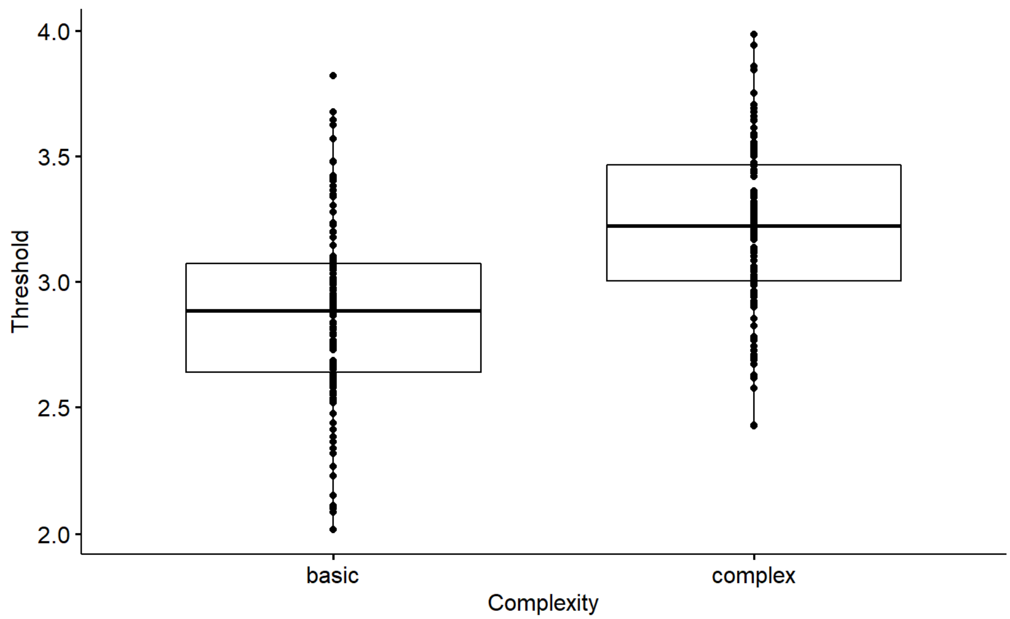


Note. Average thresholds for detecting the eight emotional expressions. The findings indicate greater detection of sexual interest and a worsened ability to detect broken heartedness.

Basic vs. Complex Thresholds. When factoring in emotional complexity, we see a significant difference ($F(1, 122) = 146.23$, p = <0.001, ges = 0.19) in average thresholds between the "basic" expressions (i.e., anger, sad, happy, and fear) and "complex" expressions (i.e., contempt, interest, brokenhearted, and betrayed). In this case, participants were more sensitive to basic emotions ($M = 2.88$, $SD = 0.36$) compared to complex emotions ($M = 3.21$, $SD = 0.33$; see **Figure 5**). Furthermore, we compared our basic versus complex sensitivity results to the findings of Motta-Mena & Scherf (2017). In the previous paper, the researchers only included two basic (i.e., happy, anger) and two complex expressions (i.e., interest, contempt) and found no significant differences between the two categories. These contradicting findings led us to believe that our significant results may be due to the inclusion of the four new expressions sad, fear, brokenhearted, and betrayed. If we compare sensitivity to basic versus complex expressions using just the new expressions, the difference in threshold averages are significant ($F(1,122) = 251.43$, $p < 0.001$, ges = 0.429). In contrast, if we exclude these new expressions and re-analyze our sample data with just the four expressions used by Motta-Mena & Scherf (2017), we find that basic and complex averages are no longer significantly different ($F(1,122) = 2.82$, $p = 0.095$, ges = 0.005). Consequently, we determined that the addition of the new expressions (i.e., sad, fear, brokenhearted, betrayed) may have added a new element to the task and produced significant findings when comparing sensitivity to basic versus complex emotions.

Figure 5

Perceptual Threshold Averages for Basic vs. Complex Expressions

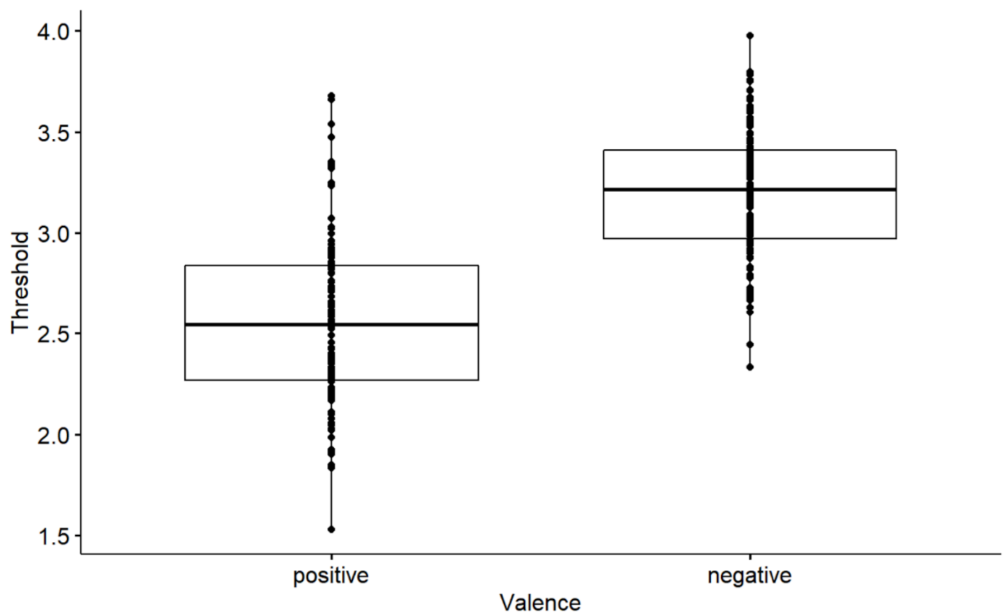


Note. Average thresholds for detecting basic expressions (*M* = 2.88, *SD* = 0.36) versus complex expressions (*M* = 3.21, *SD* = 0.33). Findings indicate greater detection of basic emotions compared to complex emotions when all eight expressions (i.e., anger, sad, happy, fear, contempt, interest, brokenhearted, and betrayed) are included.

Positive vs. Negative Thresholds. Furthermore, when we consider emotional valence, there appears to be a significant difference ($F(1, 122) = 277.99$, p = <0.001, ges = 0.389) in average threshold scores between “positive” expressions (i.e., happy and interest) and “negative” expressions (i.e., anger, sad, fear, contempt, brokenhearted, and betrayed). In this case, participants were more sensitive to positive emotions (*M* = 2.57, *SD* = 0.46) compared to negative emotions (*M* = 3.21, *SD* = 0.32) as depicted in **Figure 6**.

Figure 6

Perceptual Threshold Averages for Positive vs. Negative Expressions



Note. Average thresholds for detecting positive expressions (*M* = 2.57, *SD* = 0.46) versus negative expressions (*M* = 3.21, *SD* = 0.32). Findings indicate greater detection of positive emotions compared to negative emotions overall.

Models

Depression vs. Expression Thresholds. In the first model, we evaluated the associations between depression severity and each of the eight expressions. Overall, there was a marginal negative correlation between depression scores and sensitivity to sadness (r = - 0.165, p = 0.0678, CI [-0.33, 0.012]). As the participants' depression scores increased, their perceptual threshold levels decreased, and they became more sensitive. In other words, their ability to detect sad expressions went up as their depressive symptoms became more severe. On the other hand, we found a significant positive correlation between depression scores and sensitivity to fear (r = 0.187, p = 0.038, CI [0.010, 0.352]). As the participants' depression scores increased, their threshold levels also increased, and they became less sensitive. This means that their ability to detect fearful expressions went down. After further analysis, no other marginal or significant associations emerged between symptom severity and the remaining emotional expressions (see **Figures 7 & 8**).

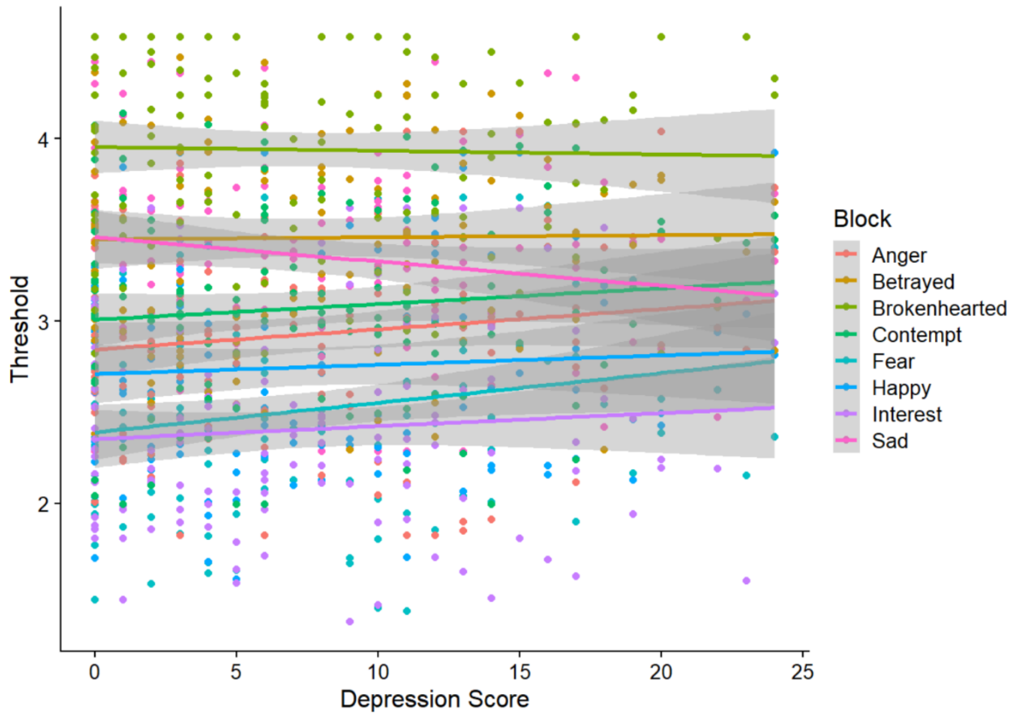
Figure 7

Correlations Between Depression and Individual Expressions

Note. Correlation matrix depicting the relationship between each expression and depressive symptoms. Negative correlations indicate that higher depression scores are associated with lower thresholds of sensitivity, while positive correlations are the opposite. Sadness and fear were the only expressions marginally or significantly related to depression severity.

Figure 8

Depression Scores vs. Thresholds of Individual Expressions



Note. Scatterplot depicting the associations between depression score and threshold averages of each of the eight emotional expressions. Overall, there was a marginal negative association with sadness and a significant positive association with fear.

Special Note. Due to the uneven divide between positive and negative expressions, we chose to reduce the data to the four expressions presented by Motta-Mena & Scherf (2017). While examining our remaining models, we based the following data analysis on the expressions of anger, contempt, happy, and interest.

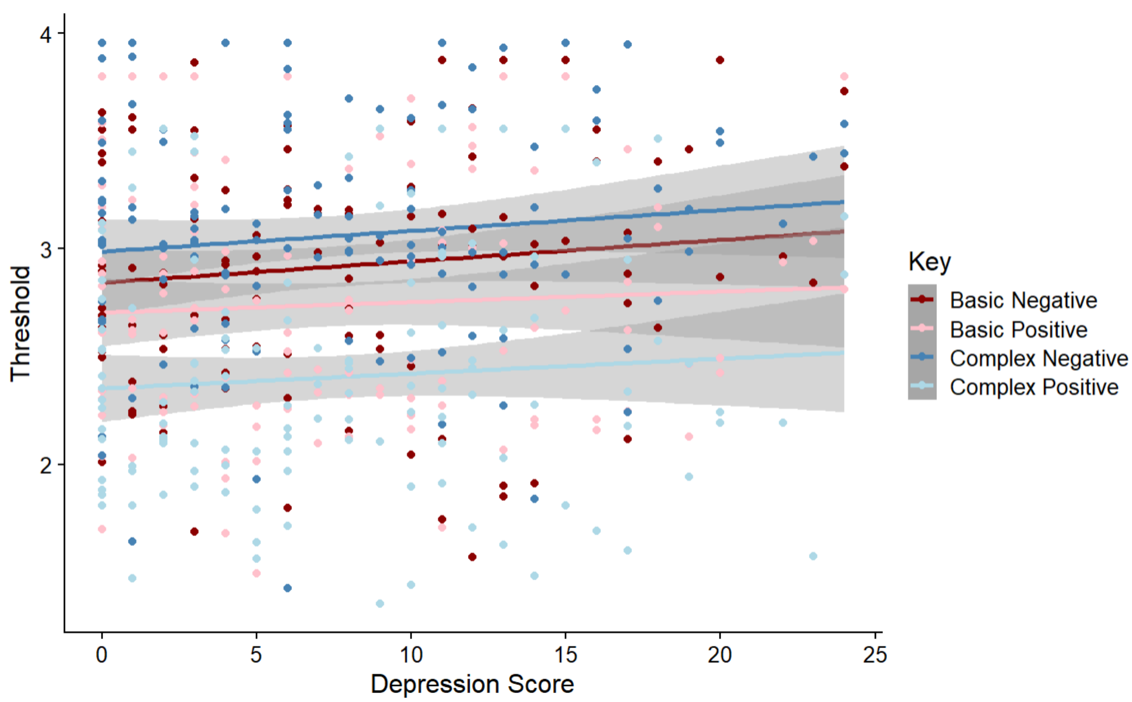
Depression Severity vs. Complexity and Valence. In the next set of models, we evaluated the associations between depression scores and sensitivity to complexity and valence, while also controlling for gender/age. Our original hypothesis stated that there would be a negative relationship between depressive severity and sensitivity to positively valenced expressions, particularly complex ones. To clarify, this means that participants with higher levels of depression would be worse at detecting positive complex expressions. On the other hand, it was expected that sensitivity to basic and complex negative expressions would be positively associated with depressive severity. Thus, participants with higher depression scores would be better at detecting these expressions. This is due, in part, to the negative bias that people with mental disorders often display.

Based on the graphs, participants appear to be the best at detecting positive complex expressions and the worst at detecting complex negative expressions (see **Figure 9**). However, the findings were insignificant across the board. In our analysis, depression scores were not significantly associated with basic (b = 0.007, p = 0.228, CI [-0.005, 0.019]) nor complex expressions (b = 0.008, p = 0.176, CI [-0.004, 0.020]). Likewise, symptom severity was not associated with the differences between these two groups as well (b = -0.0003, p = 0.975, CI [-0.019, 0.018]). The same can be said for the valence of the expressions. We also found that depression scores were not significantly associated with positive (b = 0.006, p = 0.377, CI [-0.007, 0.019]) nor negative expressions (b = 0.010, p = 0.106, CI [-0.002, 0.022]). Depression was not associated with the differences between these groups either (b = -0.005, p = 0.594, CI [-0.023, 0.0134]). Unsurprisingly, when we tested whether depression scores could explain the group differences between the complexity and valence, the results were not significant (b =

0.002, p = 0.861, CI [-0.024, 0.028]). In summary, although participants' threshold sensitivity was dependent on the complexity and valance of the expressions ($F(1,122) = 34.78$, $p < 0.001$, ges = 0.047), these differences could not be explained by depression levels. In fact, depression was not significantly associated with sensitivity towards basic, complex, negative, or positive expressions.

Figure 9

Depression Scores vs. Emotional Complexity and Valence



Note. Scatterplot depicting the associations between depression score and threshold averages of basic negative, basic positive, complex negative, and complex positive expressions. Although there appears to be a positive trend with participants being the most sensitive to complex positive expressions, we found no significant associations between depression and emotional complexity and valence.

Discussion

Summary

Based on past literature, we hypothesized that the presence of depressive symptoms might introduce impairments in one's ability to interpret facial expressions accurately. More specifically, it was believed that negative response biases often distort emotion perception, which could affect the way people interact in a social context. For this reason, we tested if perceptual sensitivity to positive and negative expressions at different levels of complexity (i.e., basic or complex) would differ depending on symptom severity. If depressive symptoms were associated with a negative bias towards emotions, then we expected to see that participants with greater symptom severity were better at distinguishing basic and complex negative expressions, while complex positive expressions may be more challenging. However, in our endeavors to establish a firm relationship between emotion perception and depressive symptoms, we mainly found marginal and nonsignificant results.

First, we addressed whether or not we replicated the data presented by Motta-Mena and Scherf (2017). If so, did we extend their findings in any meaningful way? In our descriptive data, we compared the average threshold sensitivity in basic versus complex emotional expressions. Overall, there was evidence that participants, in general, were better at detecting basic expressions. These results contradicted the previous paper, in which Motta-Mena & Scherf (2017) found no significant differences between the two groups. Interestingly enough, once we removed the newer expressions of fear, sad, brokenhearted, and betrayed, our results matched the previous paper. We concluded that the addition of the four extra expressions had some influence on our significant findings. However, given the wide range of emotions that are conveyed in typical social interactions, research on facial processing could benefit from studying a larger set of emotional expressions.

In our primary models, we considered the question, “does the severity of depression symptoms predict performance on the JND task?” Also, “does the severity of depressive symptoms differentially predict the perception of negatively versus positively valenced emotional expressions?” Although the participants differed in their ability to perceive basic versus complex expressions, these differences could not be explained by their depression severity. Similarly, we found that depression scores were not significantly associated with differences in positive and negative thresholds either. Finally, we assessed a three-way interaction between depression, complexity, and valence. The results were also insignificant, meaning there was no differential influence of depressive symptoms in the way participants perceive positive or negative regardless of their complexity.

On the contrary, evidence of negative bias began to emerge when we looked at the eight expressions individually rather than in groups. The correlation test reported that there is a marginal negative association between depression scores and sadness. The negative association indicates that increased depression severity is related to a reduced perceptual threshold. Thus, participants with greater symptoms were more sensitive to (or had a greater ability to detect) sad facial expressions. These findings support the notion that MDD, as a disorder, is connected to a perceived negative bias when viewing human faces. In previous research studies, participants were required to meet the diagnostic criteria for MDD, which is different for this study.

Nonetheless, we have found evidence that even participants with signs of mild to moderate depressive symptoms may experience similar perceptual deficits as individuals with the full-blown disorder. However, given that the correlation with sadness is only marginal, we can only come to a tentative conclusion regarding emotion perception and mild to moderate symptom severity.

In addition, there was a significant positive association between depression scores and fear. This implies that participants with more severe depressive symptoms were worse at detecting fearful expressions. These results were unexpected considering that prior literature, overall, suggests that enhanced fear recognition is related to MDD (Bourke et al., 2010; Le Masurier et al., 2007; Merens et al., 2008). However, the perception of fear in MDD patients is relatively understudied and some findings have shown no effect (Bourke et al., 2010; Kan et al., 2004).

Study Limitations

We must consider possible limitations that could have influenced the study’s outcomes—for example, the low distribution of symptom severity. Many of the participants reported having mild to moderate symptoms. Therefore, individuals with severe depressive symptoms were underrepresented in the sample. For this reason, our findings are more representative of a subclinical population who at risk for developing the disorder rather than those formally diagnosed with MDD. If we targeted individuals who we thought had more symptoms, we might have had a better chance of seeing an association. However, given our restricted range of symptoms, it was less likely that there would be a significant effect. Another important constraint in the project was the imbalance of positive versus negative expressions while assessing the level of complexity. Historically, researchers have recognized six basic emotions: happiness, sadness, anger, disgust, fear, and surprise (Ekman & Friesen, 1971). Since happiness is the only positively valenced basic expression, we only had one emotion to represent this category. This issue can be mitigated because there are more positive complex expressions that we can investigate. In future studies, researchers could focus solely on complex emotions and examine whether negativity bias extends to these expressions.

Future Directions

Despite these limitations, the study has produced intriguing findings that can be used to further the discussion of facial processing behaviors. For example, scientists should explore how MDD impacts the perception of select expressions such as sadness and fear at a clinical and subclinical level. They could also investigate if it is the abnormal processing of these emotions that contributes to the development of the disorder. Understanding these patterns will allow for the proper surveillance, management, and treatment of depression and other comorbid diseases.

Although past research tends to focus on the recognition of sadness, fear is another emotion heavily tied to mental disorders (e.g., anxiety; Bishop, 2007; West et al., 2011). In the case of depression, scientists have noted a heightened neural response to fearful facial expressions, which is often linked to overactivation within the amygdala (Chan et al., 2009; Stuhrmann et al., 2011). The amygdala is a brain structure housed in the limbic system and is responsible for processing threatening stimuli, detecting emotional significance in the environment, fear-conditioning, and regulating aggression (Guy-Evans, 2021; Pessoa, 2010; Ressler, 2010). This suggests that individuals with depression experience hyperarousal in brain areas important for identifying emotive stimuli, especially ones that may be relevant to danger or threats (Phillips et al., 2003; Stuhrmann et al., 2011).

Already, there has been a push to utilize emotion perception and functional imaging techniques in therapy to monitor patient health outcomes. For instance, Cognitive Behavioral Therapy and Cognitive Bias Modification are treatments that train depressed individuals to process information more positively. Overall, both treatments recognize negative response/attentional biases as core features of MDD and seek to eradicate these impairments by re-framing patients' biased perceptions (Roiser et al., 2012; Eguchi et al., 2017). Future research may want to consider more longitudinal studies that can track the progression of MDD symptoms and its treatment over time. Fortunately, this is made possible through neuroimaging techniques. Functional imaging suggests there may be a reduction in amygdalar activity and other subcortical areas following psychotherapy and anti-depressant medication (Bourke et al., 2010; Fu et al., 2004). Thus, emotion perception can give us great insights into both the development and reversal of the disorder.

Conclusion

Emotion perception is a powerful tool to aid in human connection. However, abnormalities in facial processing can have damaging effects on an individual's mental well-being and ability to develop healthy interpersonal relationships. This discussion of face-to-face social interactions is especially relevant in today's climate, where depression rates, isolation, and loneliness have all skyrocketed since the onset of the COVID-19 pandemic. Even at mild levels, depressive symptoms can be debilitating and cause disruptions in a person's daily life. For this reason, we must ask, if a large collective of the population is now experiencing depressive symptoms, what can we expect in terms of emotion perception? Will this change the way we interact as individuals and as a society? It is likely the case for those with severe depressive symptoms or have been diagnosed with MDD. However, for those with mild to moderate symptoms, not so much.

Although there is some evidence that negative bias is present at subclinical levels, the overall data is marginal and inconclusive. It is recommended that more research is done on at-risk individuals to better understand the consequences of milder symptoms. However, since we cannot see a noticeable effect of mild-moderate severity on emotion perception, it may be more of interest to concentrate on clinically diagnosed MDD patients. We could also shift the focus entirely to other relevant symptoms seen in mildly depressed individuals (e.g., motivation). Regardless, there are many avenues to explore on the topic of MDD. Whether or not the findings turn out to be significant, we are still one step closer to improving health.

Appendix A

Patient Health Questionnaire-8 (PHQ-8)

Over the *last 2 weeks*, how often have you been bothered with the following problems?

0 to 1 day = “not at all,” 2 to 6 days = “several days,” 7 to 11 days = “more than half the days,” and 12 to 14 days = “nearly every day,”

	Not at all	**Several days**	**More than half the days**	**Nearly everyday**
Little interest or pleasure in doing things	0	1	2	3
Feeling down, depressed, or hopeless	0	1	2	3
Trouble falling or staying asleep or sleeping too much	0	1	2	3
Feeling tired or having little energy	0	1	2	3
Poor appetite or overeating	0	1	2	3
Feeling bad about yourself or that you are a failure or have let yourself or your family down	0	1	2	3
Trouble concentrating on things, such as reading the newspaper or watching TV	0	1	2	3
Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3

Note. “The total score is determined by adding together the scores of each of the four items. Scores are rated as normal (0-2), mild (3-5), moderate (6-8), and severe (9-12). Total score ≥3 for first 2 questions suggests anxiety. Total score ≥3 for last 2 questions suggests depression” (Kroenke et al., 2009).

Appendix B

Full Demographics Table

Table 3

Full Demographics of Participants

Demographics	**Participants (*N* = 123)**
Age (years)	
Range	18-25
Mean (±SD)	22.5 (±1.8)
Race/Ethnicity	
Asian	21 (17.1%)
American Indian or Alaska Native	2 (1.6%)
African American or Black	11 (8.9%)
White	79 (64.2%)
Other	2 (1.6%)
More than one	8 (6.5%)
Hispanic	10 (8.1%)
Latinx	2 (1.6%)
Hispanic, Latinx	5 (4.1%)
Non-Hispanic or Latinx	105 (85.4%)

Demographics (Cont.)	**Participants (*N* = 123)**
Gender/Sex	
Cisgender Female	63 (51.2%)
Cisgender Male	51 (41.5%)
Nonbinary	3 (2.4%)
Non listed	1 (<1.0%)
Transgender Male	3 (2.4%)
Transgender Female	1 (<1.0%)

Note. Demographic characteristics of the total participants (*N* = 123) who completed the JND Task. Cells of Race and Gender/Sex include n (%).

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Biostatistics and Epidemiology Summer Training (BEST), Columbia University — **New York, NY**

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- Participated in an eight-week summer training program hosted by the Department of Biostatistics and Epidemiology at Columbia University Mailman School of Public Health.
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- Utilized statistical software such as R and Excel to perform simple linear regressions and generate graphical images.
- Completed introductory courses in biostatistics and R programming, attended research and public health related workshops, and presented summer project at the BEST Poster Symposium.

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Mentor: Patricia Muse, MPT, CSCS

- Worked with a small team to create an engaging multi-media platform focused on patient education and advocacy for youth diagnosed with anxiety and depression.
- Designed an Instagram page (@theRelaxationProject) with 50+ followers to provide resources and strategies for improving mental health.

The Pennsylvania State University, Department of Psychology **University Park, PA**
Research Assistant *January 2020 – Present*
Mentor: Dr. Suzy Scherf, Ph.D., Laboratory of Developmental Neuroscience

- Assisted in data management and verification for the Development of Adolescent Social Health (DASH) project.
- Collected stimuli from 60+ databases for the Identity and Race in Adolescents (IRA) project, which investigates how adolescents' ethnicity/race impacts their face processing behavior.
- Recruited participants through phone calls, flyers, and other recruitment strategies.
- Organized meetings and methods of internal communication.

LEADERSHIP EXPERIENCE

Epsilon Gamma Chapter of Delta Sigma Theta Sorority Inc **University Park, PA**
Financial Secretary *April 2021 – April 2022*

- Issued receipts and maintained a record of all income and related funds of the chapter.
- Prepared written and verbal reports to present at each executive board and chapter meeting.
- Served on the Finance Committee to assist in budgeting and managing chapter finances.

Internal Audit Chair *April 2020 – April 2021*

- Monitored the Finance Committee by performing quarterly audits of financial documents.
- Delegated responsibilities to the members of the Internal Audit Committee.

Committee Member *November 2019 – December 2022*

Raw Aesthetic Movement (R.A.M Squad) **University Park, PA**
THON President *May 2020 – April 2021*

- Organized R.A.M Squad's dance performance for Penn State's IFC/Panhellenic Dance Marathon (THON) including auditions, rehearsals, delegation of tasks, and all forms of communication with the THON executive board.
- Raised $4,500 for THON 2021 and childhood cancer research on behalf of R.A.M Squad.

WORK EXPERIENCE

Public Health Ambassador, Penn State, University Park, PA *January – May 2021*

- Engaged the campus and local community in healthy behaviors such as physical distancing, wearing face coverings, hygiene, and following other COVID-19 related guidelines.
- Served as a public health educator and representative to the State College community and supported Penn State's reopening operation plan.

HONORS & AWARDS

Dean's List, Penn State, University Park, PA *August 2018 – December 2022*
Schreyer Scholarship Grant, Penn State, University Park, PA *September 2021*
Alpha Epsilon Delta Honor Society, Penn State, University Park, PA *April 2021*

- Initiated member of AED, The National Health Preprofessional Honor Society

Erickson Discovery Research Grant, Penn State, University Park, PA *April 2021*

- One of 60 undergraduate students awarded a $3,500 grant to fund their independent research interests.

Psi Chi Honor Society, Penn State, University Park, PA *January 2021*

- Initiated member of Psi Chi, The International Honor Society in Psychology

PRESENTATIONS & PUBLICATIONS

Presentations

Sigler, J.E. & Valdez, K. (2022). Sleep Factors Contributing to Burnout and High Blood Pressure in Emergency Department Clinicians. Poster presentation. BEST Research Poster Symposium, Columbia University, New York, NY.

Sigler, J.E. (2022). THC Impact on Early Development and Behavior. Poster presentation. CNLM Spring Conference, University of California, Irvine, CA.

Sigler, J.E. (2022). Coming Face-to-Face with Depression: The Impact of Depression on Emotion Perception. Poster presentation. Undergraduate Exhibition, Penn State, University Park, PA.

Shaffer, M., Vescio-Franz, S., & **Sigler, J.E**. (2021). Attitudes Towards Remote Learning. Poster presentation. Psi Chi Research Conference, Penn State, University Park, PA.

Sigler, J.E. (2021). THC Impact on Early Development and Behavior. Poster presentation. CNLM Summer Research Symposium, University of California, Irvine, Virtual.

Publications

Arrington, M., Silber, S.P., Caboy, L., Scherf, S., & **Sigler, J.E.** (In Preparation) Internalizing Symptoms in the COVID-19 Pandemic and Face Processing Ability.

VOLUNTEER EXPERIENCE

COVID-19 Surveillance Testing, Penn State, University Park, PA *August 2021*
Crisis Text Line Counselor, Virtual *March 2021 – Present*
Habitat for Humanity, Greater Centre County, PA *January 2020, 2022*
UNICEF, Penn State, University Park, PA *August 2019*
Fresh START, Penn State, University Park, PA *August 2018*

SKILLS

Technical: R Coding, Qualtrics, Microsoft Office Suite (Word, Excel, PowerPoint), Google Workspace, and (Docs, Sheets, Slides, Forms)