MEANNESS AND AFFECTIVE PROCESSING: A META-ANALYSIS OF EEG FINDINGS ON EMOTIONAL FACE PROCESSING IN INDIVIDUALS WITH PSYCHOPATHIC TRAITS

A Thesis

Presented to

The Faculty of the Department of Psychology & Philosophy

Sam Houston State University

In Partial Fulfillment

of the Requirements for the Degree of

Master of Arts

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by

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December 2022

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DEDICATION

This work is dedicated to my wonderful family, without whom I would not be who I am today. To my parents, Tim and Denise Brown, thank you for your unwavering support in my academic pursuits and your numerous words of encouragement throughout the years. To my brother, Nelson, thank you for always having my back and being there for me when I need it. Last, but certainly not least, I want to thank my loving husband, Adam. Your constant validation and encouragement throughout this process have meant the world to me, and I could not have made it this far without you. I love you!

ABSTRACT

Brown Spivey, Rebekah, *Meanness and affective processing: A meta-analysis of EEG findings on emotional face processing in individuals with psychopathic traits*. Master of Arts (Clinical Psychology) December, 2022, Sam Houston State University, Huntsville, Texas.

The triarchic model (Patrick, Fowles, & Krueger, 2009) conceptualizes psychopathy as a multidimensional construct encompassing three biobehavioral dimensions: meanness, boldness, and disinhibition. The biological correlates of meanness, which encompasses low empathy, shallow affect, and lack of guilt or remorse, are currently less well elucidated than boldness or disinhibition (Patrick & Drislane, 2015). At the behavioral level, meanness is related to decreased accuracy on tasks involving facial and emotion recognition (Brislin et al., 2018). Emotional face processing can be examined on a neurophysiological level using event-related potentials (ERPs) such as N170, P200, and LPP (Shannon et al., 2013). Research indicates the magnitude of these responses may be modulated by psychopathic meanness (Clark et al., 2019); however, discrepant findings have also been reported. Therefore, the current study performed random-effects model meta-analyses of nine studies meeting study inclusion criteria to provide an overall effect size for the association between meanness and affective face processing ERPs across studies. Results of the meta-analysis indicated a significant effect for N170 amplitude and meanness when processing fearful faces (r = 0.18). Significant effects were not found for N170 amplitude when processing angry or happy faces, nor were significant effects found for LPP and P200 amplitudes when processing fearful faces. Meta-regression analyses indicated the type of facial stimuli utilized across studies was significant in explaining some between-study heterogeneity of the N170-fear meta-analysis model. Through examining physiological indicators of

meanness, the current study contributes to ongoing research on the etiology of psychopathy and may guide future research in establishing a multi-domain framework for the measurement of psychopathy.

KEY WORDS: Psychopathy, Triarchic model, Meanness, EEG, Event related potentials, Meta-analysis.

ACKNOWLEDGEMENTS

I would first and foremost like to thank my mentor, Dr. Laura Drislane, for her support and guidance throughout this project. Her mentorship has driven me to grow academically and further develop my interests in research. I eagerly look forward to working on future research project together! I would also like to thank my thesis committee members, Dr. Jared Ruchensky and Dr. Marcus Boccaccini, for their feedback and service on my committee. Lastly, I want to give a special thanks to my friend and research lab mate Brianna Davis for her assistance in data coding for this project. I would not have been able to complete this project without the help of each of you.

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CHAPTER I

Introduction

Psychopathy, or psychopathic personality, is an aggressive externalizing disorder characterized by deficits in interpersonal and affective functioning (e.g., superficial charm, grandiosity, lack of empathy or remorse) accompanied by behavioral deviancy. Psychopathy is of particular interest to researchers due to its serious negative impact on society. For example, psychopathy is associated with increased aggression and rule breaking (Leistico et al., 2008) and individuals displaying high levels of psychopathic traits commit a disproportionate number of violent crimes and have higher rates of recidivism compared to other offenders (Douglas, Vincent, & Edens, 2018). Although a considerable amount of research has been dedicated to understanding the external correlates and nomological network of psychopathy, there is no consensus among researchers regarding its underlying etiological mechanisms. Furthermore, psychopathy research has been somewhat hindered by long-standing disagreements regarding how best to conceptualize and operationalize this construct. The triarchic model of psychopathy (Patrick, Fowles, & Krueger, 2009) was advanced as a means for reconciling these varied perspectives by conceptualizing psychopathy in terms of three distinct but interrelated constructs: meanness, boldness, and disinhibition. Rather than being solely descriptive, one key feature of the triarchic model of psychopathy is its connection with biobehavioral referents, or biological correlates reliably associated with the triarchic domains, which has the potential to greatly assist research aimed at elucidating the etiology of psychopathy.

To date, several robust neurobiological correlates have been identified for disinhibition and boldness, which reflect the externalizing behavior component and fearless/social dominance component of psychopathy, respectively (Patrick & Drislane, 2015). However, the etiological mechanisms underlying meanness, the affective component of psychopathy, are less well understood. Meanness, defined by callousness, lack of empathy, flat affect, and predatory exploitativeness, encompasses the core emotional element in psychopathic personality. At the behavioral level, meanness is associated with decreased accuracy in identifying emotions in others (Dawel et al., 2012; Marsh et al., 2008) implicating that neurobehavioral systems involved in face processing may be etiologically relevant to the affective features of psychopathy. More broadly, some have argued that meanness likely reflects deficits in neurobiological processes necessary for attachment and affiliation (Patrick et al., 2009; Patrick, Drislane, & Strickland, 2012), which require appropriate identification and resonance with the emotions of others.

Neuroscientific methods have been employed to better understand the core affective, cognitive, and biological processes implicated in face processing. One popular method is electroencephalography (EEG), which uses electrodes on the scalp to measure electrical signals in the brain. EEG research often involves examining event-related potentials (ERPs), or small voltages in brain activity evoked in response to a particular stimulus or event. Research on ERPs evoked in response to viewing emotional faces has identified several ERPs relevant to affective face processing, in particular early ERP components such as N170 and P200 (Bruchmann, Schindler, & Straube, 2020).

However, ERP research specifically examining facial processing in individuals with high levels of meanness is limited and has yielded inconsistent findings.

Thus, the current study sought to address these mixed findings by aggregating the outcomes of EEG studies involving emotional face processing in individuals high in meanness. In further clarifying the neural functioning of those high in meanness, researchers may better understand the etiological mechanisms contributing to the core affective features of psychopathy. Furthermore, this study may guide future research in establishing a multi-domain framework for the measurement of psychopathy.

Psychopathy

Psychopathy refers to a syndrome characterized by a pervasive pattern of impulsive irresponsible behavior along with personality traits such as grandiose and manipulative interpersonal style and callous/restricted affect. Early conceptualizations of psychopathy relied on clinical observation, such as Cleckley's seminal work, *The Mask of Sanity* (1976), in which he described traits and behaviors observed in psychiatric patients he considered psychopathic (as opposed to other patients like the "psychotic," the "psychoneurotic", or the "alcoholic"). Cleckley's clinical descriptions suggested a paradoxical nature of psychopathy, as he observed that these individuals were predisposed to behavioral deviance (e.g., inadequately motivated antisocial behavior, poor judgment, and unreliability) yet possessed "adaptive" features such as superficial charm and absence of anxiety that served to mask their psychopathology – hence, the "mask of sanity." In addition to behavioral deviance and "mask" features, Cleckley also described shallow-deceptive features such as lack of remorse, untruthfulness, and shallow affect. These clinical descriptions became foundational for the theoretical conceptualization of psychopathic personality (Cleckley, 1941). However, it was not until the publication of the Psychopathy Checklist (PCL; Hare, 1980) in 1980 that there was an empirically rigorous method for assessing psychopathy. The revised PCL (PCL-R) is comprised of 20 items thought to reflect traits and behaviors that constitute the construct of psychopathy informed by early clinical observations by Cleckley and others (e.g., McCord & McCord, 1964). Rather than reflecting a unitary construct, the items of the PCL-R appear to be multidimensional, with alternative structural models proposing two (Hare, 1991), three (Cooke & Michie, 2001) or four (Neumann, Hare, & Newman, 2007) underlying factors. In the original two-factor model, all 20 of the PCL-R items cluster into two distinct factors: Factor 1 Interpersonal-Affective, which includes items such as glibness/superficial charm, pathological lying, shallow affect, and callous/lack of empathy, and Factor 2 Lifestyle-Antisocial, which includes items such as impulsivity, irresponsibility, early behavioral problems, and criminal versatility. The four-factor model deconstructs the two-factor model into four distinct facets, of which 18 of the PCL-R items load appreciably. Confirmatory factor analysis has revealed the four-factor model encompassing interpersonal (facet 1), affective (facet 2), lifestyle (facet 3), and antisocial (facet 4) factors best represents the construct of psychopathy as measured by the PCL-R (Neumann et al., 2007; Hare & Neumann, 2008).

Although the PCL-R is often considered the “gold standard” of psychopathy assessment, there are several criticisms, such as the exclusion of traits related to low anxiety and the overemphasis on forensic populations through the inclusion of items that index overtly antisocial actions, which overlooks non-criminal manifestations of psychopathy (Skeem & Cooke, 2010). This emphasis on antisocial features as central to psychopathy somewhat drifts from Cleckley's conceptualization, which emphasized trait-like features rather than observable antisocial behaviors (other than his "inadequately motivated" antisocial behavior descriptor). To address some of these limitations of the PCL-R, a number of alternative psychopathy assessments including self-report measures have been developed to assess psychopathic features in a broader range of samples. Several of these instruments are modeled off the PCL-R, such as the Antisocial Process Screening Device (APSD; Frick & Hare, 2001) and the Self-Report Psychopathy Scale (SRP-III; Paulhus, Hemphill, & Hare, 2009). However, other instruments rely on broader conceptualizations of psychopathy, including Cleckley's. For example, the Psychopathic Personality Inventory (PPI; Lilienfeld & Andrews, 1996; Lilienfeld & Widows, 2005), which was originally designed to assess psychopathy in non-forensic populations, indexes psychopathy as a dimensional construct and utilizes a personality trait approach in attempting to capture the construct as described by Cleckley and his contemporaries. The PPI subscales load onto two overarching factors (with the exception of the Coldheartedness subscale, which does not appreciably load onto either factor) of Fearless Dominance (PPI-FD) and Impulsive Antisociality (PPI-IA) (Benning et al., 2005). The PPI-Fearless Dominance component in particular is distinguished from the factors of the PCL-R as it reflects low anxiety, stress immunity, and social boldness, and thus may be especially relevant to assessing psychopathy in non-clinical samples.

The Triarchic Model

Another notable model of psychopathy, the triarchic model (Patrick, Fowles, & Krueger, 2009), integrates early and contemporary conceptions of psychopathy as a multidimensional construct encompassing three domains: 1) meanness, which reflects coldheartedness, callousness, and lack of empathy; 2) boldness, which reflects emotional resiliency, social dominance, and venturesomeness; and 3) disinhibition, which reflects impulsivity, emotion dysregulation, and weak restraint (Patrick, Fowles, & Krueger, 2009). Empirically and conceptually, there is considerable overlap between boldness and PPI-FD, disinhibition and PPI-IA (although with some elements of meanness such as Machiavellian Egocentricity), and meanness and PPI Coldheartedness (Drislane, Patrick, & Arsal, 2014). The triarchic domains also share overlapping representations with the facets of the PCL-R. Specifically, boldness is correlated with the PCL-R interpersonal facet (r = .23) and disinhibition is correlated with the lifestyle facet 3 (r = .36) and more broadly, Factor 2 (r = .39; Patrick, 2022. Meanness, however, correlates with both PCL-R Factor 1 (r = .23) and Factor 2 (r = .32; Patrick, 2022).

The triarchic model is distinguishable from other conceptualizations of psychopathy in that it provides a framework for guiding research on the etiological pathways of psychopathy by identifying biobehavioral referents (i.e., biological correlates or biomarkers) for each domain. Disinhibition is linked to the neurobehavioral domain of inhibitory control, thought to reflect dysfunction in the prefrontal cortex, a brain area implicated in decision making, planning, and other executive functions (Patrick, Durbin, & Moser, 2012). Disinhibition, which can also be conceptualized as a general externalizing proneness, is highly heritable, as research has demonstrated ~80% of variance in disinhibitory traits or behaviors (impulsivity, aggression, substance use, etc.) can be explained by additive genetic influences (Krueger et al., 2002). Furthermore, at the physiological level, disinhibition is reliably associated with reduced amplitude of the P300 ERP in target detection tasks (Yancey, Venables, Hicks, & Patrick, 2013). Boldness corresponds with the neurobehavioral domain of threat sensitivity, in that it reflects differences in the amygdala and associated areas implicated in defensive activation in response to a perceived threat (Patrick & Drislane, 2015). One of the biobehavioral referents of boldness is deficient aversive-potentiated startle, such that individuals high in boldness demonstrate a blunted startle reflex following exposure to threatening or aversive stimulus cues (Oskarsson et al., 2021). Meanness, however, has been less clearly defined in neurobiological terms as compared with boldness and disinhibition, and is therefore the focus of the proposed study.

Meanness

Like boldness, meanness was first theorized to reflect fearless temperament (Patrick et al., 2009). Operationalized as a genetic predisposition of reduced sensitivity toward threat cues, fearlessness can be expressed phenotypically as boldness *or* meanness: whereas boldness reflects a more "adaptive" form of fearlessness, meanness reflects a maladaptive and hostile manifestation of fearlessness (Patrick et al., 2009). Another referent of meanness is callous-unemotional (CU) features underlying child psychopathy, which entails lack of empathy, shallow affect, and interpersonal callousness (Patrick et al., 2009). Indeed, scores on the Inventory of Callous-unemotional traits (ICU; Frick, 2004), an instrument developed to measure CU traits, correlate appreciably with Triarchic Psychopathy Measure (TriPM) meanness subscale scores, r = .48 (Drislane, Patrick, & Arsal, 2014). Within the child psychopathy literature, fearlessness is considered the substrate underlying CU traits (Frick & White, 2008). The question, then, is in what contexts would fearlessness develop into meanness/callousness versus boldness? It is plausible that other mechanisms such as affiliative capacity are also relevant.

Centrality of Meanness. The construct of meanness is of particular importance to researchers due to its centrality to psychopathy (Drislane & Patrick, 2017; Verschuere et al., 2018). While there is pervasive disagreement among researchers regarding the relevance of certain features (i.e., adaptive or boldness-related traits; criminality) to the construct of psychopathy (Lilienfeld et al., 2012; Lynam & Miller, 2012), meanness is generally accepted as a core characteristic and appears to be emphasized in most if not all conceptualizations of psychopathy and measures for assessing it (Drislane et al., 2014). Indeed, Cleckley's conceptualization of psychopathy included traits that reflect the core affective features of psychopathy, such as lack of remorse or shame and general poverty in major affective reactions. Other early conceptions of psychopathy also included some component of affective deficits, such as McCord and McCord's (1964) emphasis on "lovelessness" and "guiltlessness" in psychopathic offenders. Furthermore, several validated measures of psychopathy include an affective component, such as the PCL-R facet 2 including items such as shallow affect and callousness.

Behavioral Correlates of Meanness. We propose that one of the core neurobehavioral mechanisms central to meanness is lack of affiliative capacity indexed in part by deficient empathic sensitivity. Empirically, this has been demonstrated by a weak physiological reactivity to distress cues in others among individuals high in meanness. For example, Blair and Coles (2000) found a reduced ability to recognize negative emotions in others, particularly fear, in adolescents high in psychopathic traits. Furthermore, in a meta-analysis on facial affect recognition, Marsh and Blair (2008) found a robust association between adult antisocial populations and deficits in recognizing fearful and sad facial expressions. Although a considerable amount of research on facial affect recognition in psychopathic populations focuses primarily on fearful expressions, a meta-analysis conducted by Dawel et al. (2012) which included both adult and adolescent samples high in psychopathic traits, found significant deficits in emotional recognition across several emotions (happiness, sadness, fear, and surprise) in relation to global psychopathy scores. However, when solely considering the affective component of psychopathy, significant deficits were observed for fearful faces only. Similarly, Brislin et al. (2018) found a significant negative correlation between TriPM Meanness and fearful face recognition, but not for angry or sad facial recognition. Additionally, they found both Meanness and Disinhibition were negatively associated with recognition accuracy for happy faces; however, multiple regression analysis using all three TriPM subscales demonstrated neither Meanness nor Disinhibition remained a significant predictor. Therefore, a deficit in fear recognition in those with psychopathic tendencies is well-established in the research; however, it is unclear whether this deficit also pertains to other emotions due to discrepancies in research findings.

Neural Mechanisms of Face Processing

Neuroscientific methods have been used to better understand the processes implicated in affective face processing. Common methods are structural and functional brain imaging, which provide information about neural spatial activation in the context of viewing faces or other stimuli (Deming & Koenigs, 2020; Yang & Raine, 2009). Neuroimaging research on face processing has revealed that the presentation of emotional face stimuli elicits activity in several brain areas. For example, a meta-analysis conducted by Fusar-Poli et al. (2009) which examined fMRI face processing studies found that exposure to emotional face stimuli elicited activity in the occipital, prefrontal, limbic, and tempo-parietal areas. Additionally, they found that fearful, sad, and angry faces specifically increased activity in the amygdala, with fearful faces having the greatest effect on amygdala sensitivity. Furthermore, activation of the visual cortex and cerebellum was found across all emotion conditions.

Neural Correlates of Meanness

Several neuroimaging studies have explicitly examined neurobiological deficits associated with psychopathy, providing converging evidence for a role of deficient right amygdala activation. White and colleagues (2012), for example, found decreased right amygdala activation in response to viewing distressing cues (i.e., others with fearful facial expressions) for those high in psychopathy compared with those low in psychopathy. Furthermore, they found reduced functional connectivity between the right amygdala and certain brain areas, such as those associated with higher-order emotional processing (ventromedial prefrontal cortex) and regions of the brain specifically associated with processing of faces and facial expressions (fusiform gyrus). These findings have also been replicated in youth populations with CU traits (Jones et al., 2009; Marsh et al., 2008). Notably, meanness appears to play a central role in the relationship between psychopathy and amygdala under-activation in response to viewing fearful faces. Although earlier studies did not differentiate between meanness and other features of psychopathy such as disinhibition in their samples, Viding and colleagues (2012), for example, compared two groups of adolescents both high in conduct problems, but differing in their levels of CU traits. They found the high conduct problems/high CU traits group demonstrated reduced activation in the right amygdala in response to viewing fearful facial expressions. In contrast, those in the high conduct problems but low in CU traits demonstrated *increased* activation of the right amygdala during the task. These findings further support the conceptualization of meanness as reflecting a brain-based deficit in reduced empathic sensitivity. Ultimately, the current literature demonstrates consistent significant findings regarding the relationship between psychopathy, particularly the affective facet of psychopathy (i.e., meanness), and hypoactivity in the amygdala in response to threatening/fearful stimuli (however, see Deming, Heilicher, & Koenigs, 2022 for a different perspective). However, physiological indicators of meanness derived from neuroscientific methods other than fMRI such as EEG are less clear. Therefore, the current study aims to examine correlates of meanness on the physiological level rather than the level of brain circuitry.

EEG and Emotional Face Processing

At the physiological level, electroencephalography (EEG) is a commonly used method of examining neural activity with a high degree of temporal specificity. EEG uses scalp electrodes to measure electrical signals in the brain. Using EEG technology, researchers can examine event-related potentials (ERPs), which are fluctuations in the EEG waveform that reflect a summation of postsynaptic potentials when neurons fire in synchrony during processing of sensory, motor, or cognitive information. As ERPs are time-locked changes, researchers can measure the amplitudes of elicited ERPs at a specific time period following presentation of a stimulus. ERPs are typically measured in the context of a behavioral task involving presentation of a stimulus followed by an action from the participant. For example, the oddball paradigm is a commonly used task in ERP research in which the participant is exposed to repetitive stimuli which is interrupted with an aberrant or “oddball” stimulus, which is designed to elicit an ERP (i.e., P300). ERP research specifically related to face processing often involves a task in which an emotional or neutral face is presented, and participants are then prompted to identify the emotion displayed. Unlike fMRI, EEG has poor spatial resolution (i.e., it is difficult to ascertain specifically where in the brain electrical activity is generated); however, it has excellent temporal resolution (on the order of milliseconds), making it a particularly useful methodology for examining in-the-moment cognitive and emotional responses to stimuli.

There are several ERPs specifically associated with affective and facial processing. One ERP of note is the N170, which is a negative deflection that occurs approximately 170 ms after presentation of a stimulus. In typically functioning individuals, the N170 ERP is evident following the presentation of images of faces, thus reflecting neural processing of faces (George et al., 1996). The P200 and P300 ERPs, which are positive deflections approximately 200 and 300 ms after a stimulus, respectively, are also associated with affective processing of facial expressions in typically functioning individuals (Paulmann & Pell, 2009). Additionally, the late positive potential (LPP) ERP, which is a late onset response approximately 400-900 ms after an event, is also associated with emotionally salient stimuli (Hajcak et al. 2006).

A handful of studies have demonstrated specifically how meanness moderates these brain responses associated with affective face processing. Brislin et al. (2018) found a significant reduction of the N170 and P200 amplitudes, but not the LPP amplitude, in response to viewing fearful faces as a function of increasing callousness. Conversely, Eisenbarth and colleagues (2013) compared groups of low-psychopathy and high-psychopathy female forensic inpatients and found significant group differences in the N200 amplitudes, but not the N170 and P200 amplitudes, in response to viewing images of happy, angry, and fearful faces. Another study by Almeida et al. (2014) found that participants with high PPI Fearless-Dominance scores had *reduced* N170 amplitudes to facial expressions, whereas those with high PPI Coldheartedness scores demonstrated *enhanced* N170 responses upon viewing emotional faces.

The Current Study

The affective component of psychopathy is central to its conceptualization; thus, it is pertinent to delineate the underlying neurobehavioral mechanisms of meanness. Research has established affective facial processing as a behavioral marker of meanness, which can be measured at the physiological level by tasks designed to elicit specific ERPs. Although there have been several research studies examining face-processing related ERPs in individuals high in psychopathy, there have been inconsistent findings regarding which ERPs are relevant, which emotions are associated with processing impairments, and the magnitude and direction of the effect sizes. Therefore, the current study performed random-effects model meta-analyses to provide an overall effect size for the association between meanness and affective face processing ERPs for several different emotions across studies. As the N170 component appears to be the most widely studied component in face processing ERP research, the current study's first hypothesis was that the strongest effect sizes would be observed for N170 as compared with other ERP components (i.e., P200, P300, LPP). Furthermore, given converging evidence for specific deficits in the processing of *fear* faces as opposed to other emotions, the study's second hypothesis was that there would be a significant effect for the association between psychopathic meanness/callousness and N170 amplitude specifically in the context of fearful face conditions.

CHAPTER II

Method

Search Strategy

A systematic search was conducted using the PsycInfo, PubMed, and Web of Science databases to search for articles published in English from January 1, 1985, to March 15, 2022, that included the following key terms: *psychopathy*, *PCL-R*, *PPI, coldheartedness, callousness, ICU, meanness, TriPM*, *face processing*, *face viewing, emotional faces*, *EEG*, *ERP*, *P300*, *P200*, *N170*, and *LPP*. Key terms were used in the appropriate combinations to limit search results only to studies that include at least one term associated with each of the following: 1) psychopathic traits, 2) facial processing, and 3) event-related potentials.

Inclusion and Exclusion Criteria

The following criteria must have been met for a study to be included in the present meta-analysis: (1) studies must have included a validated measure of psychopathy or callousness/meanness (e.g., PCL-R, ICU, TriPM, PPI), (2) studies must have included a behavioral task involving viewing/identifying emotional facial expressions, (3) studies must have included a measure of ERP component amplitude elicited from viewing emotional faces, and (4) studies must have been written in the English language. Studies were excluded if the behavioral task component involved general affective processing rather than facial processing specifically. Both full-text published peer-reviewed journal articles and unpublished theses and dissertations were considered for inclusion. Further, the authors put out a request to researchers studying psychopathy for relevant unpublished data, but none was received.

Selection of Studies

Studies were first identified from the electronic database searches using relevant key terms. The initial search yielded k = 119 records. After removing duplicates (k = 41), the researcher screened study titles and abstracts to exclude irrelevant studies. With the remaining k = 30 records, the researcher conducted a full-text review and excluded studies that did not meet the inclusion criteria (k = 19). In the remaining k = 11 studies, three studies did not report necessary information needed to compute effect sizes. The researcher attempted to contact study authors to obtain necessary information and received a reply from one author. Therefore, the final meta-analysis included k = 9 studies. The researcher examined the independence of publications to ensure that samples did not overlap between selected studies. See Appendix A for flowchart of the selection of studies.

Data Extraction

The nine studies that were included in the meta-analysis were coded by two independent coders for effect sizes and moderators. For each study effect sizes (typically Pearson's *r*) and SEs were recorded for each ERP (N170, P200, and LPP) component for each emotion (fear, angry, sad, happy, disgust, surprise, and neutral). For studies that did not report effect size, the coders computed the effect sizes (Cohen's *d*) from reported *M*s and *SD*s. General study characteristics including sample size, age, sample type (e.g., community, student, or forensic), gender recorded as % male, and race/ethnicity (coded as % White, % African American, % Hispanic, % Asian American/Asian, % Native Hawaiian/Pacific Islander, % Indigenous, and % Other) were also coded by the two independent coders. Additionally, other variables that were extracted and coded from the selected studies included the type of behavioral task paradigm, psychopathy measure, electrode sites, and ERP measurement method (mean or peak amplitude). The inter-rater reliability as estimated by ICC for the two independent coders was 0.97 (CI = 0.88 – 0.99). Discrepancies were discussed between the coders and a doctoral level faculty member until consistency was established.

Data Analytic Strategy

First, all studies were converted to a consistent measure of effect size. For correlational studies, *r* values (typically reported as correlations between psychopathic traits and ERP amplitude) were used as the effect size for the meta-analysis. For studies that provided *M* and *SD* for ERP amplitude for two groups, Cohen's *d* and standard error were calculated (if not reported in the study) and this effect size was converted to Pearson's correlation coefficient, $r = d/\text{sqrt}(d^2+4)$. The researcher also calculated standard errors for each study effect size, $s_r = \text{sqrt}\,[(1-r^2)/(n-2)]$.

The current study aimed to examine several ERP components across a variety of emotional face conditions (i.e., the N170, P200, and LPP across fear, happy, angry, sad, disgusted, surprised, and neutral faces). However, after coding for effect sizes across the nine studies included in the meta-analysis, only six conditions had enough studies ($k \geq 3$) to conduct a meta-analysis: N170-fear, N170-neutral, N170-anger, N170-happiness, P200-fear, and LPP-fear. These random-effects model meta-analyses were performed in JASP to calculate the overall effect sizes. Next, to examine the variance between study true effect sizes (i.e., between-study heterogeneity), Cochran's *Q* was calculated by summing the squared deviations of study effects from the overall effect weighted by the inverse of the study's variance, thus providing a ratio of observed variation to within-study error. Next, subtracting the expected value of *Q* if all studies shared the same effect size (i.e., degrees of freedom; *k*-1), from observed *Q* yielded the excess variation, or variation in true effects from study to study. As *Q* is on a standardized scale, the researcher also used *Q* to calculate measures of estimated variance on the same scale as the effect size, such as τ^2 and τ, which are the variance and standard deviation of study true effect sizes, respectively. I^2, which is a statistic expressed as a percentage reflecting the ratio of true heterogeneity to total variance, was also used to examine variance across studies.

Publication Bias

A multi-faceted approach was used to address publication bias. First, to address small-study effects, visual inspection of a Funnel Plot was used to identify the presence of publication bias. The inclusion of studies with smaller samples increases the risk of publication bias as smaller samples require a larger effect to be statistically significant, therefore small-sample studies with small effect sizes are likely to be unpublished and thus not included in the meta-analysis. As the funnel plot is a scatter plot of each study's effect size (x axis) plotted against its standard error (y axis, typically inverted so that higher values on the plot represent lower standard errors), we expect a funnel plot with no publication bias to form a relatively symmetrical upside-down funnel shape. However, asymmetry in the funnel plot (specifically a gap in the lower left corner of the funnel where high-error/small-effect studies should be) reflects the file-drawer effect in which only small-sample studies with *large* effects are published and small-sample studies with *smaller* effect sizes are not. Although visual inspection of the Funnel Plot is a technique often used in addressing publication bias, its interpretation can be somewhat subjective.

Therefore, Egger's test (Egger et al., 1997), which is a linear regression model of study effects and their standard errors, was also used to quantitatively test for asymmetry in the Funnel Plot. The intercept value of the linear regression model indicates the presence of asymmetry, such that values closer to zero indicate no asymmetry, and values that differ significantly from zero indicate some degree of asymmetry likely attributed to an overrepresentation of small sample studies with large effects. Begg's test (Begg & Mazumdar, 1994), which is another test commonly used to assess funnel plot asymmetry, was also used. This method uses Kendall's tau as the statistic of rank order correlation between study effect sizes their variances, with a high correlation indicating asymmetry in the funnel plot. Additionally, the researcher used the *Fail-safe N* method to estimate the number of unpublished studies that would be needed to nullify significant results. Rosenthal's *Fail-safe N* (1979) assumes unpublished studies have a mean effect of 0. Thus, a small *Fail-safe N* means that only a few studies would be needed to nullify the true effect of the meta-analysis. However, the *Fail-safe N* should interpreted with caution, as there are several criticisms of this method including the assumption that missing studies effect size is 0 and the overemphasis on statistical significance rather than substantive significance.

Moderator Analyses

Meta-regression analyses were performed to examine whether any between-study heterogeneity can be explained by other variables, such as demographic characteristics of the samples. As with conventional regression, meta-regression is used to estimate the relationship between the dependent variable and one or more covariates; however meta-regression analysis refers to covariates at the *study* level rather than the *subject* level.

Additionally, as conventional regression uses a predictor variable (*x*) for subject (*i*) to predict an outcome variable (*y*), in meta-regression the value being predicted is the observed effect size of a study (θ_k). The meta-regression equation, $\theta_k = \theta + \beta x_k + \epsilon_k + \zeta_k$, includes two additional error terms: ϵ_k, which represents sampling error and ζ_k, which represents between-study heterogeneity. Thus, meta-regression analyses assume a mixed effects model, as the equation includes a fixed effect (β) and random effect (ζ_k). To examine continuous predictors, the researcher performed a meta-regression for variables including age, percentage male, and percentage race. In performing meta-regression analysis, the fixed weights θ (intercept) and β (regression coefficient) are estimated using the weighted least squares method and are added to the equation with x_k and the error terms ϵ_k and ζ_k. Subgroup analyses (i.e., meta-regression with a categorical predictor) were used to examine potential categorical moderators such as sample type, behavioral task type, facial stimulus type, and psychopathy measure. The researcher dummy coded categorical variables for the subgroups and used the regression equation $\theta_k=\theta+\beta D_g+\epsilon_k+\zeta_k$, in which the covariate x_k is replaced by D_g, the value of which is either 0 or 1 depending on which subgroup the study belongs to. For subgroup and meta-regression analyses, model fit to data were examined to determine whether predictor variables explained some amount of the heterogeneity variance in the meta-analyses.

CHAPTER III

Results

Study Characteristics

Population characteristics of included studies are reported in Table 1. Total sample size per study ranged from 26 to 507. Seven studies used adult samples and two studies used child or adolescent samples. Three studies used male-only samples and one study used a female-only sample. All other studies used mixed sex samples, with proportion male reported in the table. Studies of adults (k = 7) included community, forensic, and undergraduate samples. Studies of children and adolescents also used a mix of community (k = 1) and forensic samples (k = 1).

There were 9 studies included in the meta-analysis that examined the aggregated effect size of studies that examined the relationship between psychopathic meanness and amplitude of the N170 component following the presentation of fearful face stimuli. Of these 9 ERP studies, 3 utilized group designs comparing ERP responses in individuals low and high in meanness, whereas the remaining 6 studies utilized correlational designs. The sum of participants from these 9 studies was 1131. The average age of participants was 22.53. Four studies employed a task involving facial viewing which required a behavioral response of identifying the emotion presented. One study presented the facial stimuli and asked participants to respond to unrelated stimuli. Two studies employed a passive viewing task, in which participants viewed the facial stimuli without giving a behavioral response. Finally, one study employed a facial e-stroop task (i.e., participants were asked to identify the emotional expression of each face with a co-occurring word, either congruent or incongruent with the expression, superimposed across the face), and one study involved an emotional face stop-go task (i.e., participants were asked to respond to angry faces as “Go” stimuli and extinguish their responses to fear and sad faces as “Stop” stimuli).

Table 1

Study Characteristics

Study	Total *N*	*M* age	% Male	Sample	Measure of Psychopathic Meanness	Facial Stimuli	Task
Almeida et al., 2014	52	29.4	100	Community	PPI-R Coldheartedness	Low and high spatial frequency of fear, angry, disgust, happy, and neutral faces	Facial viewing and responding to non-related stimuli
Brislin et al., 2018	254	19.53	64.6	Community	ESI Callous-Aggression	Fear and neutral faces	passive facial viewing
Brislin & Patrick, 2019	127	19.9	49.0	Student	TriPM Meanness	Fear, happy, sad, disgust, and angry faces at six levels of intensity ranging from low to high	Facial viewing and identifying emotion
Eisenbarth et al., 2013	28	36.39	0	Forensic	PCL-R Total	Fear, happy, and angry faces	Passive facial viewing

(continued)

Study	Total *N*	*M* Age	% Male	Sample	Measure of Psychopathic Meanness	Facial stimuli	Task
Fido 2015	57	19.25	38.5	Student	ICU Uncaring	Fear, sad, angry, and neutral faces	Emotional face Stop-go task
Halty 2019	48	17.1	100	Forensic	ICU Total	Eye region of fear and neutral faces	Facial viewing and identifying emotion
Hoyniak et al., 2019	26	4.1	46	Community	ICU Total	Inverted and non-inverted happy and fear faces	Facial viewing and identifying emotion
Palumbo et al., 2020	507	29.5	49.5	Community	ESI Callous Aggression	Fear and happy faces	Facial e-stroop task
Weissflog 2017	32	21.5	100	Student	SPR-IV Total	Fear, happy, and neutral faces	Facial viewing and identifying emotion

Note. PPI-R = Psychopathic Personality Inventory-Revised; ESI = Externalizing Spectrum Inventory; TriPM = Triarchic Psychopathy Measure; PCL-R = Psychopathy Checklist-Revised; ICU = Inventory of Callous-Unemotional Traits; SRP-IV = Self Report Psychopathy Scale, 4th edition

Overall Effect Sizes

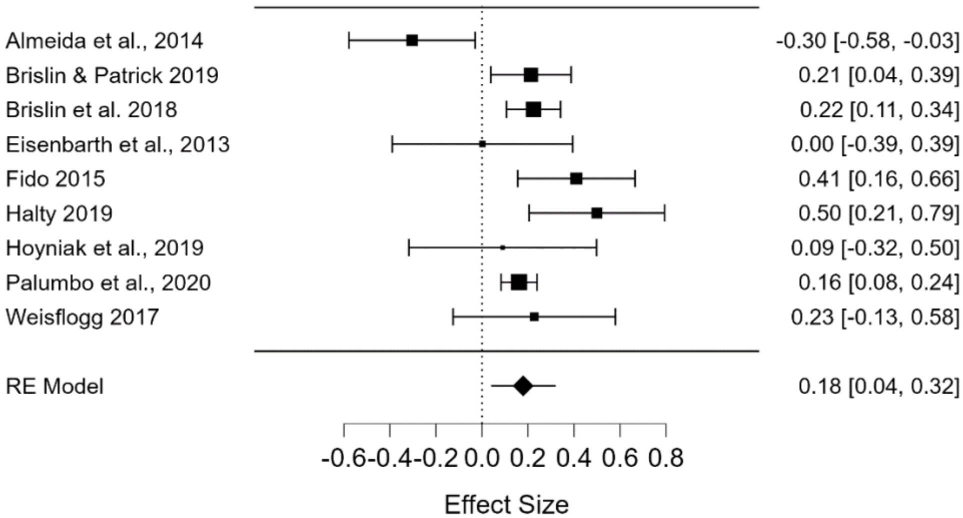
Individual effect sizes (Pearson's *r*) and their 95% confidence interval (CI) for ERP amplitudes across fear, happy, angry, and neutral conditions are presented in Table 2. Forest plots for individual emotions showing effect sizes for each study weighted by *N* are shown in Figure 1. For N170 amplitude in the fear condition, a significant mean effect of $r = .18$ (CI = .04 – .32, $p = .013$) was found, indicating individuals with higher levels of callousness have smaller N170 amplitudes when viewing fearful face stimuli (N170 is a negative deflection in the overall waveform; thus positive correlations indicate a *less negative*, or lower amplitude of the N170 component). Non-significant effects were found for N170 amplitude when viewing happy ($r = -.05$, CI = = - .29 – .20; $p = .72$) and angry ($r = .08$, CI = - .19 – .37; $p = .56$) faces. Similar to the fear face condition, for N170 amplitude while observing neutral faces, an effect of $r = .19$ was obtained; however, this small effect was not statistically significant due to a smaller number of studies ($k = 4$) contributing to this analysis.

Meta-analyses were also conducted for the P200 and LPP ERP components across fear conditions. Non-significant effects were found for both P200 amplitude ($r = -.06$, CI = = - .30 – .17; $p = .61$) and LPP amplitude ($r = -.07$, CI = - .24 – .09; $p = .39$) when viewing fearful faces. However, the results of these analyses should be interpreted with caution due to the very few number of studies included ($k = 3$). As such, tests of heterogeneity and moderator analyses focused on the N170 given the larger *k* and *N* contributing to these aggregate effect sizes.

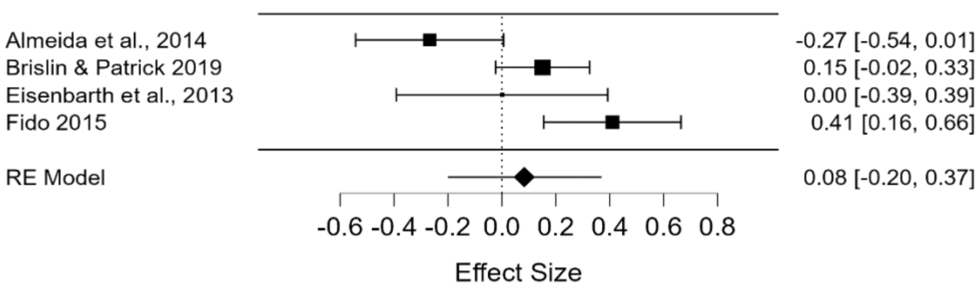
Figure 1

Forest Plots of Study and Random-Effects Model Mean Effect Sizes for N170 Amplitude for Fear, Happy, Anger, and Neutral Emotions

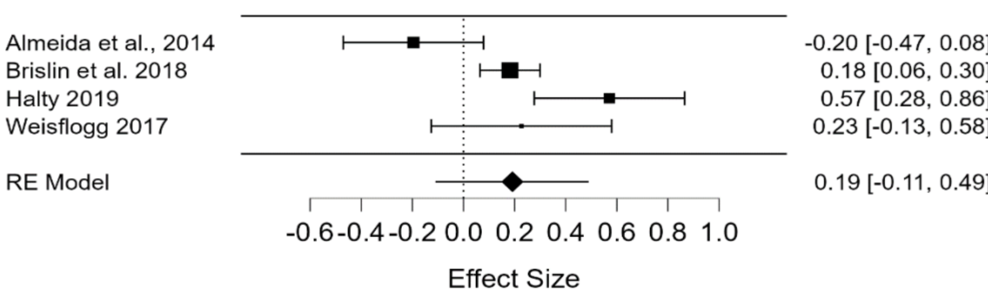
Fear



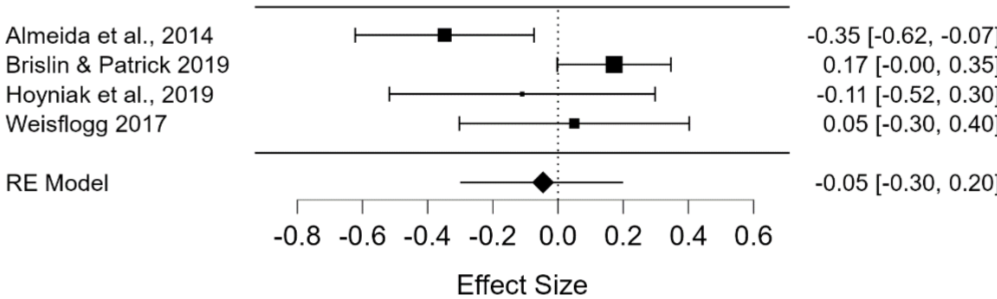
Anger



Neutral



Happy



Note: Correlations based on Fisher's *z* transformation.

Table 2

Summary of Effect Sizes for ERP Amplitude Across Emotions

	k	*N*	Pearson's correlations	*p* value	95% CI
N170*Fear	9	1131	.18	0.01	[0.04 – 0.32]
N170* Happy	4	237	-.05	0.71	[-0.30 – 0.20]
N170*Angry	4	264	.08	0.57	[-0.20 – 0.37]
N170*Neutral	4	386	.19	0.21	[-0.11 – 0.49]
P200*Fear	3	888	-.06	0.61	[-0.30 – 0.17]
LPP*Fear	3	888	-.07	0.39	[-0.24 – 0.09]

Heterogeneity of Effect Sizes

After examining overall effect size, additional tests of heterogeneity were performed in order to quantify the variability between effect sizes in each study included in the meta-analysis. Table 3 summarizes the heterogeneity statistics from the N170 fear, angry, happy, and neutral meta-analyses. For each meta-analysis, Cochran's *Q* was computed as a measure of residual between-study heterogeneity. Additionally, the I^2 statistic is computed from Cochran's *Q* and provides the proportion of the variance (expressed in a percentage) that is due to variance in true effects rather than chance. Table 3 also provides an estimate for the variance (τ^2) and standard deviation (τ) of true study effect sizes. For N170-fear meta-analysis, the test of heterogeneity was significant

(Q[8] = 21.5, p = .006), indicating variability in effect sizes was present. The amount of unexplained heterogeneity was large (I^2 = 76.26%), indicating the differences in effect sizes across studies cannot be solely attributed to sampling error or chance. For the N170-happy analysis, Cochran's Q test for heterogeneity was significant (Q[3] = 10.23, p = .017), and the I^2 value (66.88%) indicated a moderate amount of unaccounted variance across studies. Cochran's Q test for the N170-angry meta-analysis was also statistically significant (Q[3] = 13.12, p = .004), and there was a large amount of variability across samples included in the analysis (I^2 = 78.73%). Lastly, for the N170-neutral meta-analysis, Cochran's Q test was significant (Q[3] = 14.08, p = .003), and there was a very high amount of variability in effect sizes across studies (I^2 = 83.33%).

Table 3

Between-Study Heterogeneity Estimates

	Q	p	τ^2	τ	I^2 (%)
N170*Fear	21.50	0.006	0.03	0.17	76.26
N170*Happy	10.23	0.017	0.04	0.21	66.88
N170*Angry	13.12	0.004	0.06	0.25	78.73
N170*Neutral	14.08	0.003	0.08	0.27	83.33

Moderator Analyses

Categorical Moderators

To understand possible sources of between study heterogeneity, moderator (i.e., meta-regression) analyses were performed. Moderator analyses were performed only for N170-fear, given this was the only significant meta-analytic effect size. Table 4 summarizes the categorical moderator analysis findings from all of the N170-fear studies. For stimulus type, the test for subgroup differences was significant (Q[2] = 10.83, p = .004). The pooled correlation for studies utilizing manipulated facial stimuli (i.e., lower spatial frequency or inversion of stimuli) was $r = -.10$, suggesting an effect in the opposite direction (i.e., higher callousness associated with *increased* N170 amplitude) compared to unmanipulated faces ($r = .19$), which was statistically significant $p = .012$). Additionally, the study that presented stimuli of only the eye region showed an increase in effect size ($r = .50$) compared to unmanipulated faces, which approached statistical significance ($p = .051$). For sample type (i.e., forensic, student, community), the test for subgroup differences was not statistically significant ($Q[2] = 2.10$, $p = .35$). Additionally, the test for subgroup differences was not significant for psychopathy measure used (PCL-R, ESI, ICU, PPI, SRP, or TriPM; $Q[5] = 3.31$, p = 0.19). Lastly, moderator analysis was conducted for task type, which fell in one of three conditions: 1) passive viewing, in which participants were asked to view emotional faces and did not engage in a behavioral task, 2) affect identification, in which participants viewed an emotional face and were then asked to identify the emotion, 3) Estroop task, in which participants were asked to identify the emotional expression of each face with a co-occurring word, either congruent or incongruent with the expression, superimposed across the face, and 4) Stop/Go task, in which participants were asked to respond to angry faces as “go” stimuli and extinguish their responses to fear and sad faces as “stop” stimuli. For task type, the test for subgroup differences was not statistically significant ($Q[3] = 0.87$, $p = .83$).

The researcher planned to conduct a moderator analysis for electrode site. However, there was not a consist means of reporting electrode site across studies, with several studies reporting averages across multiple electrode sites corresponding to different scalp regions, and some studies not reporting electrode site placement at all.

Therefore, this variable could not be reliably coded to run a moderator analysis. Additionally, the researcher planned to run a moderator analysis for ERP amplitude measurement method (peak vs. mean). However, there was no variability as every study included in the meta-analysis used a peak measurement method for the N170, therefore the moderator analysis was not conducted.

Continuous Moderators

Meta-regression analyses were conducted for continuous variables including age, gender, race, and year published. For race, only analyses of % White and % African American were conducted due to limited reporting of racial demographics in the included studies. Results of the meta-regression analyses did not yield significant results for any of the continuous moderators ($p > .05$). Table 5 summarizes the meta-regression findings from all of the N170-fear studies.

Table 4

Categorical Moderator Analyses for N170-Fear

Variable	*k*	*b*	*SE* of *b*	95% CI	Z	*p*
Stimulus Type						
Unmanipulated face	6	.19	.03	[.14 – .68]	5.72	<.001
Manipulated face	2	-.29	.12	[-.59 – -.04]	-2.52	.01
Eye region	1	.31	.16	[-.002 – .61]	1.95	.05
Sample						
Community	4	.07	.10	[-.13 – .28]	0.68	0.50
Forensic	2	.21	.20	[-.18 – .61]	1.05	0.29
Undergraduate	3	.21	.16	[-.11 – .53]	1.28	0.20
Psychopathy Measure						
PCL-R	1	.002	.20	[-.39 – .39]	0.01	0.99
ESI	2	.18	.20	[-.22 – .58]	0.88	0.38
ICU	2	.36	.23	[-.10 – .82]	1.53	0.13
PPI	1	-.31	.24	[-79 – .17]	-1.25	0.21

(continued)

Variable	*k*	*b*	*SE* of *b*	95% CI	Z	*p*
SRP	1	.23	.27	[-.30 – .75]	0.84	0.40
TriPM	1	.21	.22	[-.22 – .64]	0.96	0.34
Task						
Passive viewing	2	.006	.19	[-.45 – .44]	0.73	0.46
Viewing + response	5	.15	.23	[-.10 – .39]	0.03	0.98
E-stroop task	1	.02	.30	[-.51 – .54]	0.07	0.94
Stop/go task	1	.26	.33	[-.31 – .84]	0.83	0.41

Table 5

Continuous Moderator Analyses for N170-Fear

Variable	*b*	*SE of b*	*Z*	*p*	*Q*
Age	-0.004	0.247	1.005	0.32	18.13
% Male	0.055	0.274	0.20	0.84	18.32
% White	-0.002	0.003	-0.61	0.54	0.77
% African American	0.006	0.008	0.73	0.46	0.40
Year Published	0.040	0.031	1.30	0.20	20.36

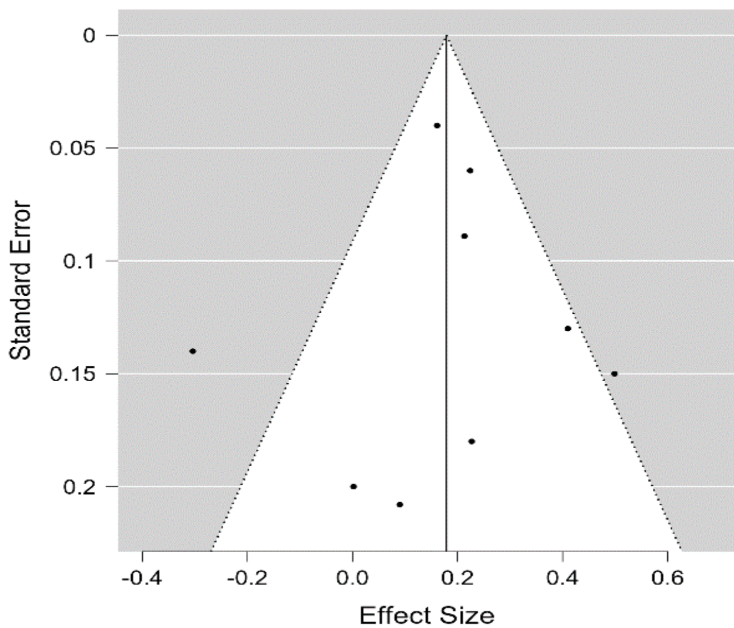
Publication Bias

To assess for publication bias, Rosenthal's *fail-safe N* (Rosenthal, 1979) was used to estimate the number of unpublished studies that would be needed to reduce the *p* value to a nonsignificant level. For the N170-fear analysis, 88 studies with an effect of 0 would be needed to reduce the overall effect size to nonsignificant. Visual inspection of the funnel plot (see Figure 2) indicated no evidence for publication bias, as seen by the funnel's relative symmetry and the presence of studies in the lower left corner of the funnel (where high-error/small-effect studies should be). Additionally, The Begg-Mazumdar rank correlation test (Kendall's tau = -0.11, $p = 0.76$) and Egger's test (t = -

0.36, p = 0.72) were nonsignificant and thus confirmed the absence of funnel plot asymmetry.

Figure 2

Funnel Plot of Effect Sizes for N170-Fear



CHAPTER IV

Discussion

Meta-Analytic Findings

The current meta-analysis sought to investigate the relationship between brain responses evoked in the context of emotional face-processing and dispositional meanness, a core component of psychopathy. No meta-analytic research to date has examined face-processing ERPs and psychopathy, as previous research has primarily focused on face processing from a behavioral measurement standpoint (i.e., accuracy in identifying emotional faces) rather than on measurement at the physiological level.

In line with hypotheses, the current meta-analysis found a small relationship between meanness and the N170 component ($r = .18$, $p < .05$), specifically in the context of viewing fearful faces. Thus, in aggregate, the research suggests individuals with high levels of meanness have a blunted (i.e., less negative) N170 amplitude when viewing fearful facial expressions. Moreover, meta-analyses of associations between meanness and the N170 ERP in the context of viewing non-fear faces such as happy and angry faces did not yield statistically significant relationships. These results are consistent with the broader literature outlining specific deficits in identification of fearful emotions in individuals with psychopathic traits (Dawel et al., 2012; Marsh et al., 2008), and points to the potential for developing a multi-method framework approach in investigating affective facial processing anomalies in this population.

Conceptually, these results indicate an abnormality in the early, automatic stages of face processing for individuals high in meanness. The N170 occurs nearly instantaneously after stimulus presentation and is thought to measure the earliest stages of perceptual encoding and face categorization. Specifically, research on the N170 suggests it is an index of the configural processing stage (Luo et al., 2009), which involves perceiving relations among the features of a stimulus (i.e., detecting and configuring facial features). As ERP amplitude reflects the magnitude of electrical energy generated by neurons, decreased amplitude of the N170 suggests diminished neural activity in individuals high in meanness immediately following presentation of a face. Due to poor spatial resolution, however, EEG studies provide little information on the localization of the exact brain region(s) where neural activity occurs. Thus, the results of the current study suggest individuals high in meanness have diminished neural activity in response to fearful facial expressions, specifically at the early stage of face processing where individuals configure, or piece together individual features of faces.

One hypothesis regarding the cognitive mechanisms at play during the evocation of the N170 is the role of attention in modulating the neural response. It is possible that reduced amplitude of the N170 occurs in psychopathic individuals because they do not attend to emotional faces in the same way as others, thus explaining the diminished neural activity when processing faces. This hypothesis is somewhat supported by previous research demonstrating reduced N170 amplitude when participants are distracted by an irrelevant task which inhibits early attention allocation (Dou et al., 2021).

On a mechanistic level, the reduced N170 amplitude in individuals high in meanness appears to serve as a potential neurobiological substrate leading to poor emotion identification. This is particularly relevant in connecting the neural aspect of face processing with the behavioral component of correctly detecting and labeling the emotional expression of faces. In other words, if psychopathic individuals have decreased brain activity during the processing stage involving the encoding of facial features, this would likely contribute to downstream deficits in accurately identifying emotional facial expressions at the behavioral level.

Moderator Effects

Results of the meta-regression analyses suggest the magnitude of the psychopathy-N170 fear relationship seems to be influenced by the nature of facial stimuli utilized across studies. Specifically, the effect was stronger when participants viewed emotional faces that were unmanipulated compared to those that were modified in some way. When facial images were distorted (e.g., inverted, altered spatial frequency, etc.), observed effect sizes were actually in the opposite direction; that is, those higher in meanness had *enhanced* (more negative) N170 responses to stimuli, albeit at a statistically non-significant level. However, it should be noted that this effect appears to be primarily driven by a single study (Almeida et al., 2014), which could potentially be an outlier. Furthermore, the strongest effect was found for individuals viewing the eye region of faces specifically; however, this finding should be interpreted with caution as only one study examining eye region was included in the meta-analysis. Although there is very limited research specifically examining the N170 response to eye regions of emotional faces, this avenue should continue to be explored. Several research studies have examined eye-tracking in individuals with psychopathy and have found psychopathic individuals show reduced fixations to the eye regions of faces (Dargis, Wolf, & Koenings, 2018). It is plausible, therefore, that one explanation of blunted N170 response in psychopathic individuals may be attributable to a failure to focus on the eye region; however, substantially more research needs to be conducted in this area in order to draw any reliable conclusions.

Altogether, these moderator results seem to suggest that visual processing of *natural* faces, or the components of the face that mostly clearly convey emotion (i.e., the eyes; Blau et al., 2007), are particularly relevant for understanding the nature of the social-emotional impairments observed in psychopathy. As the N170 reflects the automatic configural processing stage of face perception, distorting facial stimuli complicates this process. Indeed, basic cognitive neuroscience research indicates inversion of face stimuli modulates N170 amplitude and impedes emotion detection (Song et al., 2017). Thus, it appears the N170 is a more reliable physiological indicator of meanness when presenting natural faces. Therefore, future studies seeking to examine the relationship between psychopathy, face processing, emotion identification, and the N170 ERP component may detect the largest effects by including un-altered facial stimuli in their task design.

The current study also investigated whether the N170-fear relationship varied as a function of the task paradigm used in each study. Results of the meta-regression analysis suggests there was no significant difference between tasks solely involving viewing facial expressions and tasks prompting participants to make a behavioral response (namely, identifying the emotion shown) after viewing the stimuli. One study utilizing a stop-go task paradigm had the strongest effect, however, this effect was not statistically significant. Although results investigating task type were not significant, this is likely due to the small number of studies included in the analyses.

Given the relevance of natural faces, it is possible that tasks requiring participants to identify the emotion may show a larger effect than tasks that require passive viewing, as the former directs more attention to the facial stimuli. However, it is also possible that the N170-psychopathy effect is picking up on automatic processing of faces regardless of specifically attending to or trying to identify the emotion. The two-stage model of face processing indicates the N170 ERP component is related to the automatic, structural encoding of faces (Liu et al., 2013), whereas later ERP components are thought to reflect more elaborated cognitive post-processing including processing of facial affect. However, other research findings have challenged this notion, suggesting the N170 is modulated by emotional facial expression rather than solely being sensitive to structural facial features (Blau et al. 2007). Therefore, future research should continue to explore whether specific elements of task paradigms have a moderating effect on the N170-psychopathy relationship, particularly regarding passive viewing versus adding an emotion identification behavioral response component to the procedure.

Psychopathy is a heterogeneous construct which can be expressed phenotypically in a number of ways. One of the many sources of heterogeneity in psychopathy is the sample setting; for example, whether participants are in the community versus a forensic setting, with the latter reflecting higher overall and ostensibly more maladaptive expressions of psychopathic traits. Thus, sample type was also considered as a factor that would potentially impact the magnitude of the N170-meanness effect. Results of the moderator analyses indicated an increase in the size of the effect in forensic samples compared to community samples, as would be expected based on psychopathy literature demonstrating higher levels of psychopathic traits in these settings. However, this finding was not statistically significant, likely due to the small number of studies included in the analysis. Interestingly, however, for studies using undergraduate student samples, the N170-psychopathy effect size was of similar magnitude to studies using forensic samples. Given substantial similarities between undergraduate and community samples, it is therefore difficult to conclude decisively whether the relationship between meanness and N170 amplitude differs as a function of psychopathy severity or sampling method. Lastly, demographic variables such as age, gender, and race were also examined as moderators of the N170-psychopathy effect; however, these variables did not appear to account for substantial between-study heterogeneity in effect sizes.

Limitations

While the current study provides important findings that advance the understanding of meanness and affective processing, there are some limitations that should be addressed. One major limitation to this meta-analysis is the number of studies included. Although research examining psychophysiological processing of faces is not new, the degree to which these processes are modulated by individual difference characteristics is relatively under-studied. While there are several studies which have examined the N170 in relation to general face processing, surprisingly few studies to date have investigated the N170 and psychopathy. Ultimately, more robust findings are contingent on the further development of research in this area. Additionally, the significant variability in methodology across studies made it difficult to get an accurate sense of the true overall effect size. Indeed, there was significant variation across studies regarding methodological factors such as electrode site selection, behavioral task design, and nature of the facial stimuli. Additionally, some studies failed to report relevant information related to EEG data collection method. For example, moderator analyses for electrode site could not be conducted due to the lack of consistency in reporting. Another limitation of this study was the lack of information regarding internal consistency of ERP components, which is endemic of broader EEG research. The observed overall effect for the current study was relatively small, which is to be expected based on prior EEG research. However, it is possible true effects were obscured or constrained due to unreliability of measurement. Future physiological research would greatly benefit from adopting an established manner of calculating and reporting reliability estimates at both the group and subject level (Clayson et al., 2021).

Implications/Future Directions

The current study also sought to examine the relationship between psychopathy and additional ERP components related to emotion and face processing such as the LPP and P200. Results of these meta-analyses indicated no significant relationships between meanness and other ERP components. However, it should be noted that these findings, while not statistically significant, do not necessarily indicate that no relationship exists between meanness and other ERP components. It is possible these findings were underpowered to detect significant effects due to the small number of studies included in the analyses, because few studies reported results for ERP components other than N170. Rather than prematurely concluding that other ERP components are irrelevant to understanding the neurobiological basis of meanness, we encourage researchers to report results for a broader range of psychophysiological indicators in order to clarify the specificity of meanness and N170 amplitude or identity other potential candidates. Additionally, though the N170-meanness effect found in the current study was specifically found in the context of fearful faces, there is far more literature investigating physiological responses to fearful facial expressions compared to other emotions. Indeed, several of the studies included in the present meta-analysis *only* investigated fearful faces. Therefore, future research in this area should include a range of emotion conditions so as to determine if the reduction in the N170 brain response is specific to viewing fearful faces, or whether this effect can be found across emotions. Indeed, the meta-analytic effect for N170 amplitude in response to neutral faces was of similar magnitude to the N170-fear effect (r = .19), but was non-significant due to the very small number of studies (k = 4) contributing to this analysis.

Results of the current study support the hypothesis that individuals with high levels of meanness demonstrate a decreased neural response to fearful expressions in others. Moreover, the findings of this study identify the N170 ERP component as a potential bio-behavioral referent of meanness. As this study identifies a referent of meanness specifically at the physiological measurement level, the findings of this study may guide future research toward the possibility of establishing a multidomain approach to the conceptualization of psychopathy. This concept of assessing psychological constructs across several measurement domains is a central focus of NIMH's RDoC framework, which advocates for psychopathology research that examines clinical phenomena across multiple units of analysis such as self-report, behavior, and biological systems. Indeed, the Social Processes RDoC domain includes the construct of social communication (and the subconstruct, reception of facial communication) which is particularly relevant to the findings of the current study. Additionally, in working toward establishing a multidomain approach to psychopathy conceptualization, it is important to consider whether identified indicators such as the N170 are specific to psychopathy or transdiagnostic. For example, there is research to suggest differences in this ERP component are also present in individuals with autism spectrum disorder (ASD), a disorder characterized by deficits in social communication. A meta-analysis by Kang and colleagues (2018) found that there was a small, significant effect for difference in the N170 response in individuals with ASD compared to typically developing individuals. However, this effect was specific to *latency* of the N170, indicating individuals with ASD were overall slower in processing faces. Interestingly, there was no difference in N170 amplitude between ASD and typically developing individuals. Thus, it seems the N170 acts as a physiological indicator for both ASD and psychopathy, but there may be some specificity in terms of different aspects of the ERP component (delayed timing vs. diminished strength). Therefore, it appears individuals with ASD tend to invest the same level of neural resources to processing faces as typically developing individuals, but at a slower pace, whereas individuals high in psychopathy process facial information at the same speed as others but do not allocate the necessary neural resources to produce the same level of neural energy when processing faces. Notably, however, few studies in the present meta-analysis reported information regarding latency. Thus, in future studies we encourage researchers to examine *both* N170 amplitude and latency in relation to psychopathic features. Ultimately, more research should be conducted in this area to determine the robustness of these findings and whether the N170 has transdiagnostic utility.

Overall, the current study provides insight regarding the physiological differences in face processing for individuals high in meanness. Continued research in this area can ultimately provide further clarity in understanding the development of psychopathy. Additionally, better understanding the etiological mechanisms of meanness can contribute to developing targeted intervention approaches for a condition that has had a significant negative impact on society.

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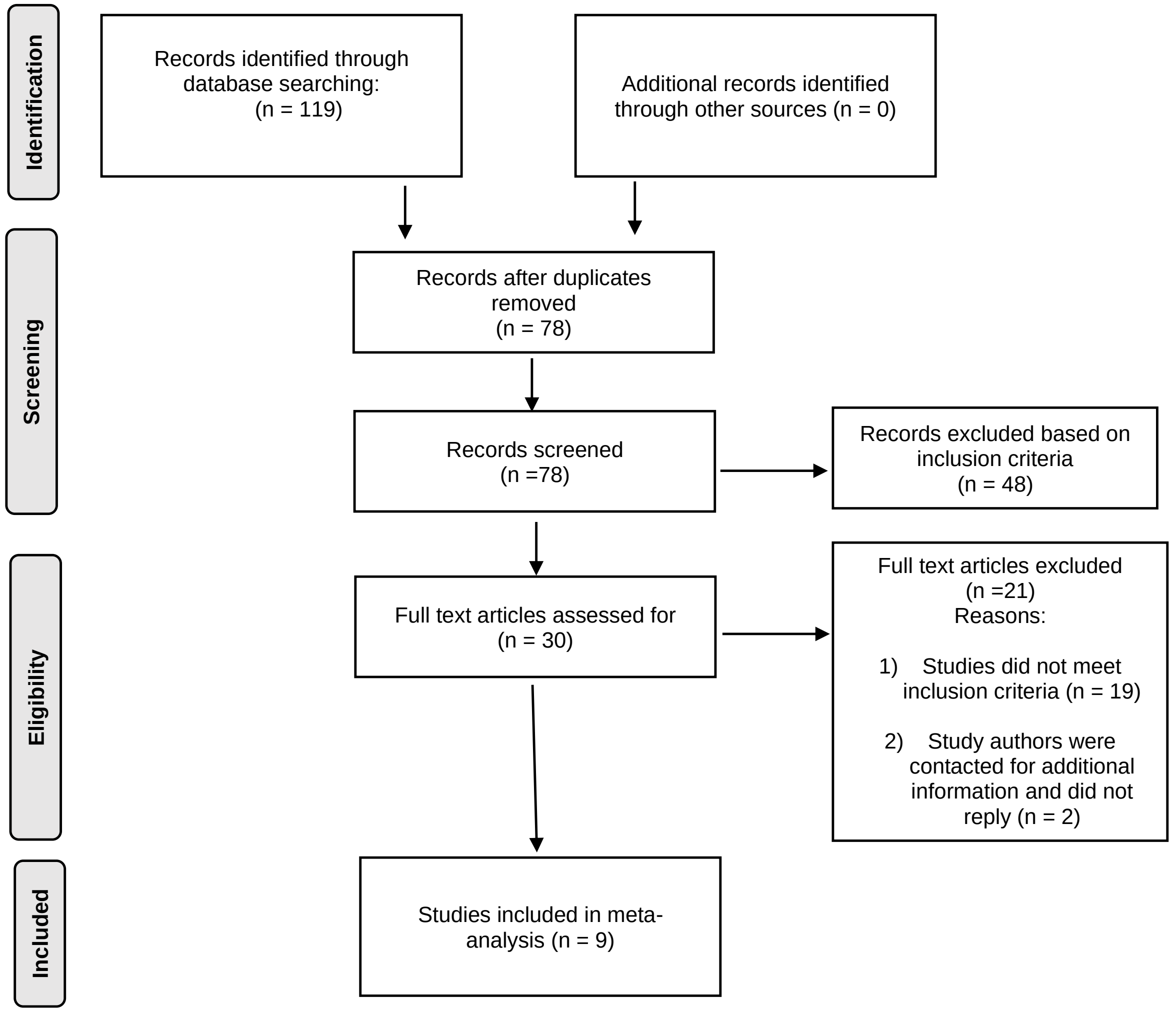
APPENDIX

PRISMA Flow Diagram



VITA

REBEKAH J. BROWN SPIVEY

Sam Houston State University
Department of Psychology and Philosophy
Huntsville, TX 77341

EDUCATION

Doctor of Philosophy Candidate, Clinical Psychology Present
Sam Houston State University
Advisor: Laura E. Drislane, Ph.D.

Bachelor of Science, Major in Psychology (Summa Cum Laude)
Minor in Neuroscience May 2020
The University of Alabama
Honors Thesis: *The Influence of Defendant Psychopathic Traits on Prosecutorial Decision Making*

Bachelor of Arts, Major in Criminal Justice (Summa Cum Laude) May 2020
The University of Alabama

RESEARCH INTERESTS

Research interests include biological factors contributing to psychopathy and externalizing behaviors (antisocial behavior, aggression, impulsivity, etc.), dimensional models of personality, psychophysiology, and conceptualization/assessment of psychopathy.

RESEARCH EXPERIENCE

Graduate Research Assistant: Measurement and Etiology of Externalizing Problems Lab August 2020-Present
Sam Houston State University
Department of Psychology and Philosophy
Advisor: Laura E. Drislane, Ph.D.

- Research study: *Examining Shared and Unique Cognitive Profiles Among Externalizing Problems*
  - Designed online survey and ran pilot tests
  - Managed undergraduate research assistants: ran meetings and delegated tasks
- Co-authored book chapter: Drislane, L. E., & Brown Spivey, R. (accepted). Psychopathy and antisocial personality disorder. To appear in L. R. Kurtz (Ed.), *Encyclopedia of violence, peace, and conflict* (3rd ed.). Elsevier.

- Master's thesis (expected to defend Fall 2022): Meanness and Affective Processing: A Meta-Analysis of EEG Findings on Emotional Face Processing in Individuals with Psychopathic Traits

Honors Thesis Principal Investigator August 2018-May 2020
University of Alabama Psychology Honors Program
Advisors: Andrea Glenn, Ph.D.; Jennifer Cox, Ph.D.
The Influence of Defendant Psychopathic Traits on Prosecutorial Decision Making

- Investigated the relationship between prosecutors' perceptions of a capital defendant's psychopathic traits and the punitiveness of their legal decision making regarding pursuing the death penalty and plea bargaining
- Collected and analyzed Qualtrics survey data of prosecutors practicing in death penalty states

Research Assistant: Intellectual Disability and the Law Lab May 2017-Dec. 2019
University of Alabama
Department of Psychology
Advisor: Karen Salekin, Ph.D.

- General Responsibilities
    - Conducted multiple literature reviews regarding various aspects of individuals with intellectual disability in the context of the criminal justice system
    - Assisted in creating an *Atkins* decision database
- Research Study: "*Fake it till you make it: a replication of simulated malingering of adaptive behavior deficits"*
    - Ran multiple data collection sessions involving administering measures of adaptive behavior for college student participants who attempted to successfully malinger adaptive functioning deficits
    - Scored measures of adaptive behavior
- Research Study: "*Atkins Decision: The impact of crime and mock juror characteristics*"
    - Ran multiple data collection sessions involving administering several measures of personality characteristics to student participants
    - Assisted in editing the manuscript for publication

Research Assistant: Psychology & Legal Decision Making Lab June 2019-May 2020
University of Alabama
Department of Psychology
Advisor: Jennifer Cox, Ph.D.

- Ran multiple data collection sessions to examine juror implicit racial bias
- Administered measures of social desirability, guilt and shame proneness, locus of control, and other variables related to juror decision making to college student participants

Research Assistant: Center for Youth Development and Intervention June 2019-May 2020

University of Alabama

Advisor: Susan W. White, Ph.D

- SENSE Theater Intervention
  - Scored several assessments of child mental health
  - Data entry of assessments
- Research study: *"Validation of gaze indicators of attention bias: Insights from cross-modal measurement"*
  - Assisted with participant recruitment
  - Administered cognitive and screening measures to adolescents with social anxiety disorder
  - Aided in running of the eye-tracking portion of the study

PUBLICATIONS

Drislane, L.E., **Spivey, R.B**., 2022. Psychopathy and Antisocial Personality Disorder. In: Kurtz, L.R. (Ed.), Encyclopedia of Violence, Peace, and Conflict, vol. 2. Elsevier, Academic Press, pp. 622–629.

PRESENTATIONS

American Psychology and Law Society Conference March 2020

- **Brown, R.J**, Glenn, A.L., and Cox, J. *The Influence of Defendant Psychopathic Traits on Prosecutorial Decision Making.* Poster presentation for the American Psychology-Law Society Conference in New Orleans, LA.

Texas Psychological Association Convention November 2021

- **Brown, R.J**., and Drislane, L.E. *Examining Shared and Unique Cognitive Profiles Among Externalizing Problems.* Poster presentation at the Texas Psychological Association Convention in Austin, TX.

Society for Scientific Study of Psychopathy May 2022

- **Spivey, R.B.** and Drislane, L.E. *Meanness and Affective Processing: A Meta-Analysis of EEG Findings on Emotional Face Processing in Individuals with Callous-Unemotional and Psychopathic Traits.* Poster presentation at the Society for Scientific Study of Psychology Conference (virtual).

Clinical Experience

Student Clinician August 2021-Present
Psychological Services Center (Huntsville, TX)
Supervisor: Craig Henderson, Ph.D.

- Individual therapy with child, adolescent, and adult clients
- Conducted psychological assessments including intellectual assessments and personality measures

Assistant Forensic Evaluator
Psychological Services Center (Huntsville, TX) August 2021-Present
Supervisors: Mary Alice Conroy, Ph.D., ABPP,
and Darryl Johnson, Ph.D.

- Conducted court-ordered forensic evaluations (e.g., competence to stand trial, mental state at the time of the offense, treatment recommendations) consisting primarily of a clinical interview and review of collateral records
- Conducted court-ordered forensic, psychodiagnostic evaluations to provide recommendations for treatment of juvenile offenders.
- Co-author reports for forensic evaluations

The Center for Youth Development and Intervention May 2019-May 2020
Advisor: Susan W. White, Ph.D.

- Tackling Teenage Training (TTT) Intervention Program Counselor
    - Education program for youth with ASD
    - Responsible for rating of fidelity to TTT program curriculum
    - Assisted in teaching weekly lessons on adolescence and puberty including psychological, social, and sexual development
    - Assisted in behavior management of participants
- Coping Power Intervention Program
    - Preventative intervention program designed to reduce delinquency and lower aggression in children
    - Assembled approximately 200 intervention kits with supplies necessary to implement the intervention program
- SENSE Theater Intervention Program Counselor
    - Monitor for EEG assessments of SENSE and TTT participants
    - Assisted in behavior management of participants
    - Responsible for rating of fidelity to SENSE program curriculum

Brewer-Porch Children's Center August 2019-Dec. 2019
Advisor: Sara Stromeyer, Ph.D.

- Weekly practicum for Child Mental Health psychology course
- Mentor for adolescents with behavioral problems and/or serious mental illness
- Observed group therapy sessions

The University of Alabama's Autism College Transition and Support Program August 2019-May 2020
Advisor: Megan Davis, Ph.D.

- Mentor for university student with Autism Spectrum Disorder
- Attended 1-hour meetings three times per week with student mentee and provided support in academic, social, and emotional domains
- Wrote weekly notes tracking the student's progress in each of these domains

TEACHING EXPERIENCE

Instructor, Introduction to Psychology August 2021-Present
Sam Houston State University, Huntsville, TX

- Instructor of record of large (140+ students) undergraduate classes
- Created lectures, exams, and assignments

LEADERSHIP

SHSU Graduate Student Psychology Organization August 2021-Present

- Treasurer

HONORS AND AWARDS

- Sam Houston State University Graduate School General Scholarship Fall 2021, Spring 2022
- University of Alabama Honors College Fall 2015-Spring 2020
- University of Alabama Psychology Honors Program Fall 2018-Spring 2020
- University of Alabama President's List (4.0 GPA) Fall 2016-Spring 2020
- Psi Chi Psychology National Honor Society Spring 2018-Spring 2020
- Foundation in Excellence Academic Scholarship Fall 2015-Spring 2020

PROFESSIONAL AFFILIATIONS

Society for Scientific Study of Psychopathy Spring 2022- Present

- Student Member

American Psychology-Law Society Spring 2020- Present

- Student Member