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Psychopathy in Society: Understanding the Neural Mechanisms that Give Rise to Psychopathic Traits

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Psychopathy in Society: Understanding the Neural Mechanisms that Give Rise to Psychopathic Traits

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Abstract

Psychopathy is characterized as an individual exhibiting callousness, grandiosity, lack of empathy, and manipulative behavior towards others over a long period of time. Given these symptoms, psychopathy is associated with a markedly increased risk of arrest and imprisonment. Together, these findings highlight the importance of understanding the cause(s) of psychopathy, as doing so may help to develop treatments or preventative interventions. Prior work has suggested that structural abnormalities in the amygdala may play a role in clinical psychopathy; however, it is less clear whether amygdala abnormalities exist on a continuum of psychopathic traits. In this study, I aimed to determine whether psychopathic traits are associated with smaller amygdala volume. To this end, twenty-nine participants were recruited for this study. Each participant completed a short self-report assessment of psychopathic traits, after which time they entered the MRI scanner. Drawing on some prior clinical psychopathy work, I predicted that greater psychopathic traits would relate to smaller volume in the amygdala. In contrast to my hypothesis, however, I found a positive association between psychopathic traits and right amygdala volume. These results suggest potential differential associations with specific amygdala nuclei, or differential associations of amygdala volumes with psychopathic traits versus clinical symptoms—either of which point to important avenues for future research.

Keywords: psychopathy, psychopathic traits, MRI, structural imaging, amygdala

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Literature Review

Psychopathy is defined as a clinical condition consisting of central psychopathic personality traits (e.g., shallow affect and manipulative) and antisocial behavioral patterns (e.g., parasitic lifestyle and poor behavioral controls) (Yang et al., 2009). Individuals with psychopathy are commonly known to ignore events that hold emotional weight during social events, such as failing to recognize fear in facial expressions (Yang et al., 2009). Psychopaths are either unable to develop empathy or able to voluntarily refrain from it, meaning they either constantly do not, or can voluntarily choose not to, experience regret, remorse, or suffering as a result of any pain they or someone else caused another person. Across media, individuals depicting psychopathic traits are typically incarcerated individuals. However, psychopathic traits are seen in nonincarcerated individuals as well. Although psychopaths often find themselves in prison, there is a form of psychopathy that does not involve partaking in violent, criminal behavior (Boddy et al., 2010). Psychopaths can be seen in positions such as high-ranked corporate jobs where they are seen as successful by those who have yet to experience their lack of morality and inability to retain their ruthlessness (Boddy et al., 2010). Corporate psychopaths may only consist of 1% of people who work in corporations, however they are nonetheless impactful to the scientific literature surrounding psychopathy (Boddy et al., 2010).

There are a number of self-report or checklist-based measures of psychopathy. Although the most widely used is the Psychopathy Checklist-Revised (PCL-R; Hare & Neumann, 2005), this measure tends to work best for incarcerated samples given its emphasis on (caught) criminal behavior. A measure that works well in both nonincarcerated and incarcerated samples is the recently developed super-short form of Elemental Psychopathy Assessment, which is an 18-item scale rooted in both current personality theory and clinical psychopathy (Collison et al., 2016). A factor analysis of this scale has found that total scores are comprised of antagonism, disinhibition, and emotional stability (Collison et al., 2016). Similar to the dimensionality of this scale, the continuum on which psychopathic traits are seen in the general population is broad. For example, although the prevalence of clinical psychopathy is only estimated to be 1.2%, around 12% of the general population exhibits high levels of subclinical psychopathic traits, with the remainder of the population varying in these traits in a somewhat normal distribution (Colins et al., 2017). Given these statistics, it is likely that you know someone quite high in psychopathic traits. Despite this potentially surprising fact, relatively little work has aimed to understand the factors that give rise to high levels of subclinical psychopathic traits.

Work attempting to determine the neural bases of psychopathy has often focused on the amygdala. The amygdala is an almond-shaped area of grey matter located in the anterior portion of the temporal lobe, and it underpins functions ranging from stimulus-reinforcement learning to fear (Blair, 2008). Importantly, functional magnetic resonance imaging (fMRI) studies have observed reduced amygdala activity during aversive conditioning in psychopathic individuals (Blair, 2008). On a structural level, there are noticeable, significant deformations of the regional amygdala surfaces in psychopaths, which has been thought to contribute to symptoms of psychopathy (Yang et al., 2009). Associations of amygdala size and psychopathy vary: some findings reveal that smaller amygdala sizes are associated with psychopathy, while others report that larger amygdala sizes associate with psychopathy (Yang et al., 2009; Boccardi et al., 2011). In short, structural work suggests that abnormalities in the amygdala are related to psychopathy.

Findings from studies such as Hardee et al. (2008) present an explanation for how psychopathic traits are a direct result of amygdala functions. Overall, the amygdala is responsible for internal experiences of fear and detecting fear in others (Marsh, 2016). However, due to the lack of empathy and understanding of fear in psychopathic individuals, the ability to recognize fear in others is impaired or absent. Non-psychopathic, healthy individuals are able to recognize the obvious signs of fear in others, such as wide eyes, high pitched voices, and raised eyebrows (Marsh, 2016). Contrary to non-psychopathic individuals, psychopaths are unable to identify what causes people to feel fear and cannot directly empathize with feelings of fear, thus resulting in fear insensitivity and empathic fear deficits (Marsh, 2016). In summary, psychopaths are restricted in their ability to understand internal representations of fear, thus cannot recognize signs or causes of fear in others.

The laterality of the amygdala and its functions are crucial to fear representation and response (Phelps et al., 2001). While the specific functions of the left and right amygdala are not entirely understood, there are specific neural substrates found to respond differently to fearful stimuli, specifically with attention to the eyes of others. Hardee et al. (2008) conducted a study to assess the laterality of the amygdala in response to fear detection in images of eyes. To do this, alternating amounts of eye white area in human faces were used to discover how the left and right amygdala respond to witnessing fear in another person. Results show that there are noticeable differences between how the right and left amygdala analyze and respond to changes in eye white area. The right amygdala strongly responded to fear as well as gaze shifts unrelated to fear while the left amygdala only had significant responses to fear detection. These results support the idea that the right amygdala serves as a fear detector regardless of situational factors while the left amygdala has higher selectivity to eye changes related to fear. Hardee and colleagues (2008) explain that perhaps the left amygdala assesses more features of eyes when detecting fear, such as iris and pupil size. In addition, Hardee et al. (2008) found that participant responses to fearful eyes were greater in the right hemisphere than the left hemisphere, however, there were more specific responses in the left hemisphere. Implications from Hardee and colleagues' (2008) study suggest that the right amygdala may serve as a rapid detection mechanism for potential threats, while the left amygdala simultaneously works to pinpoint whether the potential threat is legitimate. Altogether, Hardee et al. (2008) provide a framework for fear detection in right versus left amygdala and the lateral functioning differences between the amygdala hemispheres.

The differences between right and left amygdala functioning in psychopathic versus non-psychopathic individuals can be explained by a study conducted by Birbaumer et al. (2005). In their study, Birbaumer et al. (2005) used an aversive differential delay conditioning design during neuroimaging to assess fear conditioning in psychopathic and non-psychopathic men. Results showed that during the acquisition phase of the conditioning task, healthy individuals maintained consistent activation of the left amygdala while psychopathic individuals only had activation in the right amygdala. Furthermore, during the learning stages of the experiment, psychopathic individuals had less activity in the left amygdala than the healthy individuals. Due to lack of extensive research on structural differences between the left and right amygdala structure and activation, there is yet to be a singular explanation for the differences found in amygdala activation in the study conducted by Birbaumer et al. (2005). Certainly, more research needs to be done on left and right amygdala differences and the implications of the lateralization of amygdala activation in psychopathic and non-psychopathic individuals.

Current Study

Although prior work has linked structural differences in the amygdala to psychopathy and fMRI work has established laterality differences in the amygdala as being important to psychopathy, no work has examined whether lateralization of the amygdala is associated with psychopathy traits within a community sample not explicitly recruited for psychopathy. I address that gap in the current study by examining MRI data in relation to psychopathic traits in particular. FreeSurfer was used to quantify left and right amygdala volume, and super-short form of Elements of Psychopathy Assessment (SS-EPA) quantified psychopathy symptoms in a sample of 29 participants. I hypothesized that psychopathic traits, and primarily emotional instability, will be related to smaller amygdala volume. In addition, I hypothesized that there will be differences between left and right amygdala structure in individuals high in psychopathic traits versus low psychopathic traits.

Method

Participants

A total of 29 community participants from the Tulsa, Oklahoma area were recruited for this study as part of a broader project being conducted in the lab related to depression. Participants were 34 years old on average (M = 34.1, SD = 11.2, range: 19-64). Most participants identified as women (n = 19). As for primary race/ethnicity, 62% of participants identified primarily as White, 13.8% as Asian or Asian American, 10.3% as Black or African American, 10.3% as Hispanic or Latino/a/x, and 3.4% as Native American/Alaskan Native. Within the sample, there were 10 participants with no history of an axis I disorder and 19 individuals with a history of depression. Individuals were compensated for their participation at the rate of $30/hour.

Materials

Psychopathy Assessment

The super-short form of the Elemental Psychopathy Assessment (SS-EPA; Collison, 2016) was used to measure psychopathic traits. The SS-EPA consists of 18 items and has a three-factor structure including antagonism, disinhibition, and emotional stability (α = .76). Example items include, "I'm not the type to get depressed about the things I've done wrong," and, "I could make a living as a con artist." Participants provided responses using a five-point Likert scale ranging from strongly disagree to strongly agree.

Neuroimaging

MRI data were collected at the Laureate Institute for Brain Research in Tulsa, OK, using a 3T GE scanner. A high-resolution T1-weighted anatomical scan was acquired and used for analyses. All scans were processed for volumetric data using FreeSurfer (http://surfer.nmr.mgh.harvard.edu/). FreeSurfer uses a fully automated processing pipeline to reconstruct cortical thickness, subcortical volumes, and surface area. The processing pipeline involves motion correction, removal of non-brain tissue using a hybrid watershed/surface deformation procedure (Clarkson et al., 2011; Segonne et al., 2004), and automated segmentation of white matter, gray matter, subcortical structures, and cerebellar structures (Fischl et al., 2004a,b; Sederevičiuset al., 2021). Technical details have been described in detail previously (e.g., Fischl, 2012). FreeSurfer identifies subcortical volumes by automatically assigning a neuroanatomical label to each voxel based on probabilistic information estimated from a manually labeled training set. For the purposes of the present study, I focused on the left and right amygdala.

Procedure

After arriving and providing informed consent, participants completed a number of questionnaires, including the SS-EPA. After completing the structural scan and functional scans during tasks not described here (total scan time = 1 hour), participants were thanked, debriefed, compensated, and dismissed.

Results

Primary study variables of interest (see Table 1) were analyzed using Jamovi Statistical Software. Correlations among psychopathic traits, left amygdala, and right amygdala were examined (see Figure 1).

Table 1

Descriptive statistics for psychopathic traits, left amygdala volume, and right amygdala volume.

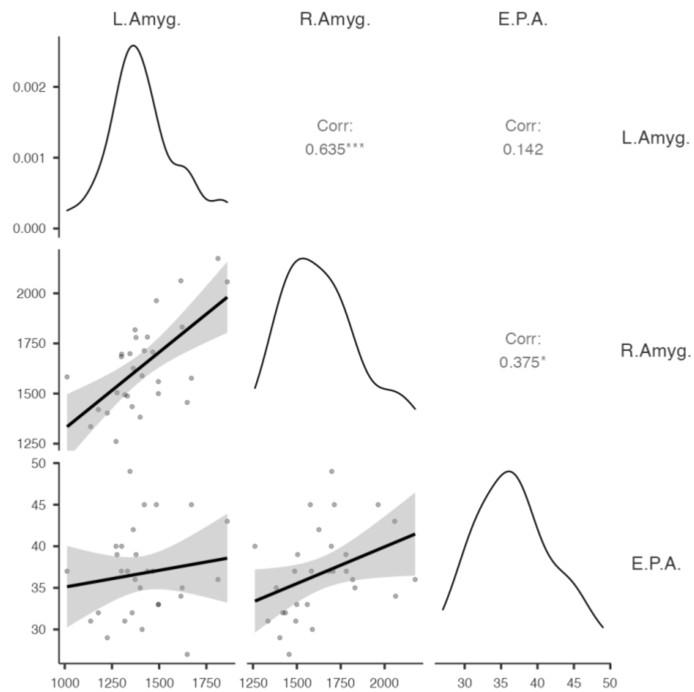
	Psychopathic traits (SS-EPA)	**Left Amygdala**	**Right Amygdala**
N	29	29	29
Missing	0	0	0
Mean	36.8	1414	1641
Median	37	1378	1588
SD	5.37	190	228
Minimum	27	1012	1261
Maximum	49	1861	2174

Note: Left amygdala and right amygdala volumes are measured in mm^3.

My primary hypothesis was that psychopathic traits will be related to smaller amygdala volume, and that there will be differences between left and right amygdala structure in individuals high in psychopathic traits versus low psychopathic traits. Inconsistent with my hypothesis, analyses revealed a positive association between right amygdala volume and psychopathic traits, *r* = .38, *p* = .045. No correlation was found between left amygdala volume and psychopathic traits, *r* = 0.14, *p* = .461. Therefore, these results do not support my hypothesis that decreased amygdala volume is related to psychopathic traits.

Figure 1

Correlations among left amygdala volume, right amygdala volume, and psychopathic traits.



Discussion

The present study examined associations among psychopathic personality traits and amygdala volume. These analyses took place within the context of a larger, ongoing project being conducted by our lab that aims to understand the effects of stress on cognitive and emotional processes that differentiate depressed from nondepressed individuals. As such, my analyses were conducted on a neuroimaging sample of 29 community participants. I hypothesized that psychopathic traits would be related to smaller amygdala volumes. My hypothesis was not supported due to the positive association found between right amygdala volume and psychopathic traits. However, with the small sample size I was unable to examine whether results were robust when covariates were included or whether they differed by sex or race/ethnicity.

The current study replicated the concept that amygdala sizes can be larger in psychopathic individuals compared to healthy individuals (Boccardi et al., 2011). In the study conducted by Boccardi et al. (2011), the central nucleus area within the amygdala was enlarged in psychopathic participants. The central nuclei provide a direct connection to the periaqueductal gray area of the brain, which serves to trigger fight-or-flight, hypothalamus, and serotoninergic/dopaminergic responses (Boccardi et al., 2011). Structural abnormalities of the central nuclei within the amygdala may cause deficits in fear conditioning and functional connections with other areas of the brain responsible for fear conditioning (Boccardi et al., 2011). Traits of psychopathy including impulsivity, lack of empathy, and increased aggression can be explained by the abnormal morphology of the central nuclei within the amygdala due to their impacts on fear conditioning. With the results of the present study combined with findings from Boccardi et al. (2011) and Yang et al. (2009), it is possible that some subregions in the amygdala may be reduced or enlarged depending upon relative contribution of specific nuclei to amygdala morphology. Previous literature has mostly described amygdala structures in psychopaths as reduced, however, findings from Boccardi et al. (2011) and the current study suggest enlargement of the amygdala is also an important marker for psychopathic traits.

Limitations

Due to time constraints, I was unable to collect a sample size larger than 29 participants. In future studies, recruiting a larger range of participants would help to increase our understanding of the associations between psychopathic traits and amygdala structure. In addition, my sample consisted of strictly W.E.I.R.D. (western, education, industrialized, rich, and democratic) participants, which limited my ability to apply the results to the general population (Henrich et al., 2010). The majority of participants from the U.S. tend to be W.E.I.R.D. relative to individuals living in nonW.E.I.R.D. countries (Muthukrishma et al., 2020). Conducting a study that includes participants from different cultural, socioeconomic, and ethnic backgrounds would help to apply findings in a broader sense. In addition, the small sample size could have prevented the discovery of significant associations within the data. It should also be noted that roughly half of the participants in this study had a history of depression, which could have altered the results.

Future Directions

A primary direction for future research lies in the limited literature surrounding the individual traits that constitute psychopathy and their neural correlates. The present study suggests avenues for future search, such as potential sex differences between left and right amygdala functions in psychopathic individuals and how deformations within the amygdala associate with each subclinical trait of psychopathy. Overall, more research is required to better understand how the amygdala varies within psychopathic individuals from healthy individuals with an important emphasis on each psychopathic trait.

Another direction for future research is directed by the potential for functional connectivity abnormalities between the amygdala and other brain regions. The amygdala is not an isolated region, and connectivity between the amygdala and prefrontal cortical regions that typically exert top-down control over the amygdala may be important to understanding psychopathy as well. A longitudinal study conducted on low-income males in early adulthood discovered that weakened functional connectivity between the amygdala and ventromedial prefrontal cortex is related to psychopathic traits (Waller et al., 2019). The ventromedial prefrontal cortex is responsible for a variety of functions including decision-making, reversal learning, and emotional regulation (Blair, 2008). Impairment of ventromedial prefrontal cortex functioning results in impaired decision making, which is a common feature of psychopathic individuals (Blair, 2008). Located within the prefrontal cortex lies the orbitofrontal cortex, the part of the brain that is involved in motivational behavior such as eating/drinking, emotional behavior, and social behavior (Rolls, 2004). The orbitofrontal cortex is suggested to also involve rapid stimulus-reinforcement learning via primary enforcers such as taste and somatosensory stimuli (Rolls, 2004). The connections between the orbitofrontal cortex and amygdala are profound: In fact, there is a possibility that orbitofrontal cortex deficits in psychopathic adults may develop as a result of earlier abnormalities in amygdala function (Mitchell et al., 2002). Therefore, it is possible that abnormalities in amygdala structure and function, as well as abnormalities in prefrontal cortex-amygdala functional connectivity, may confer higher levels of psychopathic traits in the general population.

Conclusion

Prior to the current study, no work examining psychopathic traits and amygdala volume had been done. This study was the first to assess psychopathic traits in relation to amygdala volume and could suggest some important differences between left and right amygdala morphologies pertaining to individuals high in psychopathic traits. Furthermore, this imaging study of associations between psychopathic traits and amygdala structures revealed a positive association between psychopathic traits and right amygdala volume. Consistent with prior work, results from the current study suggest that increased psychopathic traits have varying implications for lateral amygdala morphology, such as enlargement in a singular hemisphere. Further research is needed to better understand amygdala laterality in relation to psychopathic traits and how abnormalities in amygdala morphology can predict high psychopathic traits.

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