Neural Correlates of Empathy and their Association with Psychopathology

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Introduction

The current study investigates whether associations between ***empathy*** processing and patterns of ***neural activity*** in the dorsolateral prefrontal cortex (DL-PFC) are linked to symptoms of ***psychopathology***, including depression and anxiety. Neural activity was assessed using functional near-infrared spectroscopy (fNIRS), which measured changes in blood oxygenation across 16 locations on the DL-PFC. Neural activity was recorded as participants completed two empathy-related tasks: a theory of mind (ToM) task and an emotion recognition task. We expected that individual variation in empathy would be associated with unique patterns of neural activity. Moreover, we expected that individual differences in empathy abilities and neural activity would be associated with symptoms of psychopathology. It is possible that some patterns of empathy and neural activation may represent a form of hypervigilance that predicts symptoms of depression and anxiety (Yan et al., 2021). Findings from this study will shed light on neural processes associated with the cognitive functions required for empathy. They may also provide evidence of patterns of neural vulnerability involved in the association between empathy and symptomatology.

The objectives of the current study are as follows:

1. To determine whether individual differences in empathy-related skills are associated with unique patterns of neural activity across the DL-PFC.
2. To determine whether individual differences in empathy-related skills are associated with symptoms of psychopathology.
3. To examine how patterns of neural activity mediate and/or moderate the association between empathy-related skills and symptoms of psychopathology.

Method

Participants were recruited through the online Sona Systems participant pool. Participants completed two different tasks to assess skills related to empathy. Participants first were hooked up to the fNIRS brain imaging device (see Figure 1). fNIRS is a procedure that uses infra-red light to measure changes in blood oxygenation across the cortex. Once participants were hooked up, resting state neural activity was recorded for two minutes before administering the empathy tasks.

Frith-Happé Animations: ToM assesses one's ability to understand the mental states of another person. This skill is a prerequisite component of empathy. ToM was assessed using the Frith-Happé Animations Test, consisting of 12 videos in which animated triangles move in a way that indicates either a mental interaction, physical interaction, or no interaction (White et al., 2011; see Figure 2). Participants were asked to categorize the type of interaction depicted in each video. Animations correctly identified as ToM had follow up questions about the "mental states" of each triangle.

EU-Emotional Stimulus Set: Emotion recognition is another component of empathy. This component was assessed using an abbreviated form of EU-Empathy Stimuli consisting of brief videos depicting an emotionally salient social interaction (O'Reilly et al., 2015; see Figure 3). After viewing each video, participants were asked to identify the emotions displayed by each person in the video.

Self-report measures of empathy and well-being: After completion of the two tasks with the fNIRS, participants completed a brief questionnaire containing scales that assessed **empathy** reactions, **anxiety**, **depression**, **happiness**, and **self-harm**.

Figure 1. fNIRS apparatus

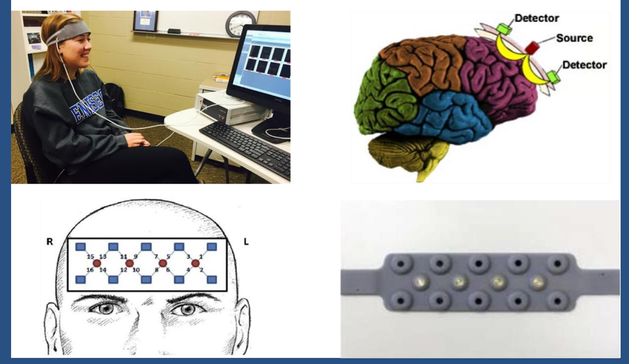

Figure 2. Frith-Happé Animations

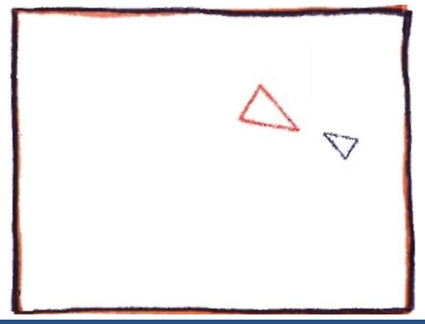

Figure 3. EU-Emotional Stimulus

Preliminary Results

Preliminary findings show ***significant correlations between empathy and psychopathology*** (see Table 1). We found that the correct identification of theory of mind vignettes – as well as correct identification of the emotions within these vignettes – was positively correlated with depression scores and negatively correlated with subjective levels of happiness. In addition, accuracy in the identification of all the Frith-Happé vignette categories was negatively associated with subjective happiness and positively associated with worry. Finally, scores on the self-report empathy measure (TEQ) were positively correlated with levels of worry.

Table 1. Pearson Correlations Between Empathy and Wellbeing

	TEQ	Total Correct	TOM Correct	Correct Emotion
Worry	.289*	.252	.092	.016
Depression	.164	.189	.278*	.264
Happiness	-.023	-.295*	-.401**	-.303*

Note. * significant at p = .05; ** significant at p = .01
Pink shading indicates correlations approaching significance

Conclusions

This study had several aims, and to date the data collection is still underway. However, preliminary findings suggest that some ***components of empathy are associated with elevated levels of symptomatology***, most notably depression. These findings present interesting implications. Primarily, they suggest that greater empathic abilities may contribute to poorer mental health outcomes. Though seemingly counterintuitive, previous research by Yan et al. (2021) also found this trend when studying depression and empathy. It is possible that this relationship may be attributable to greater overall emotional sensitivity – both for internal emotional states and the emotional states of others – which could lead to patterns of distress that are characteristic of some types of psychopathology.

Additionally, hypervigilance – which reflects heightened attention to one's environment and is characteristic of some forms of psychopathology – may lead people with those conditions to attend more to their surroundings – including the emotional states of others – resulting in greater empathic success.

The neural data from the study still need to be processed. Once that data is available, we will identify distinct patterns of neural activity across the DL-PFC and determine the nature of their association with both empathy and symptoms of psychopathology.