Emotion-related Impulsivity and Altered Neural Connectivity Underlying Maladaptive Decision-making in Borderline Personality Disorder

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INTRODUCTION

- **Emotion-related impulsivity (ERI)** is the tendency to make impulsive decisions at times of intense emotions.[1]
- ERI in **Borderline Personality Disorder (BPD)** has been associated with **maladaptive decision-making**[2] and altered neural connectivity between the **ventromedial prefrontal cortex (vmPFC), basolateral amygdala (BLA), and central amygdala (CeN)**.[3]
- Maladaptive decisions are characterized by low exploration, suboptimal choices, and long decision times in a three-armed bandit reinforcement learning task.[4]
- To our knowledge, our study is the first study to investigate effective connectivity between vmPFC, BLA, and CeN to explain maladaptive decision-making in the BPD population.

HYPOTHESES

1. The BLA→CeN effective connectivity in BPD group would be positively correlated with ERI and that vmPFC→CeN effective connectivity in HC group would be negatively correlated with ERI.
2. The BLA→CeN effective connectivity would moderate ERI's effects on the BPD group's task performance such that individuals with BPD symptoms engage in maladaptive decisions.
3. The vmPFC →CeN effective connectivity would moderate ERI's effects on the healthy control (HC) group's task performance such that HCs engage in adaptive decisions.

METHODS

Our study used the data from a study conducted at the University of Pittsburgh, which was approved by the Institutional Review Board at the University of Pittsburgh (PRO13010486).

Characteristic		BPD (n = 39)	HC (n = 35)
Age (SD)		20.93 (4.44)	20.68 (4.33)
Sex	Male	13 (33.3%)	13 (37.1%)
	Female	26 (66.7%)	22 (62.3%)

Table 1: Characteristics of the final sample (n = 74) used for data analysis in the study.

Research Design

Self-reported Questionnaire Specifically, Negative Urgency from the UPPS-P Impulsivity Scale was used as a measure of ERI.[5,6]

Three-armed Bandit Decision-making Task

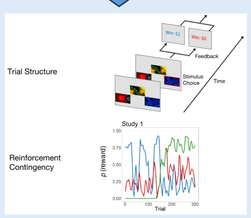

Figure 1: Three-armed bandit task structure.[4]

Resting-state fMRI Scan Specifically, the vmPFC→CeN and BLA→CeN effective connectivity data computed by a prior study conducted on the same dataset was used for the study.[3]

Data Analysis

- Multilevel models were conducted using lme4 package in R.[7,8]
- Linear regression models were conducted using the R stats package in R.[8]

RESULTS

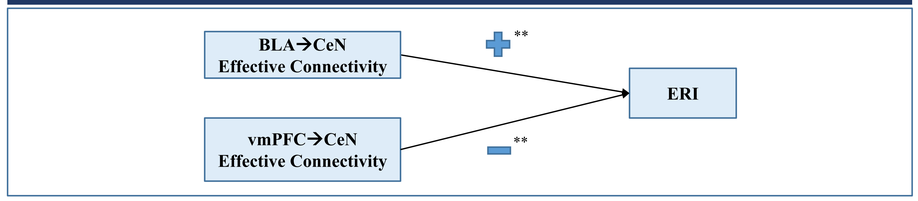

Figure 2. The correlation between the BPD-specific BLA→CeN effective connectivity, HC-specific vmPFC→CeN effective connectivity, and emotion-related impulsivity (ERI). ** p < .01.

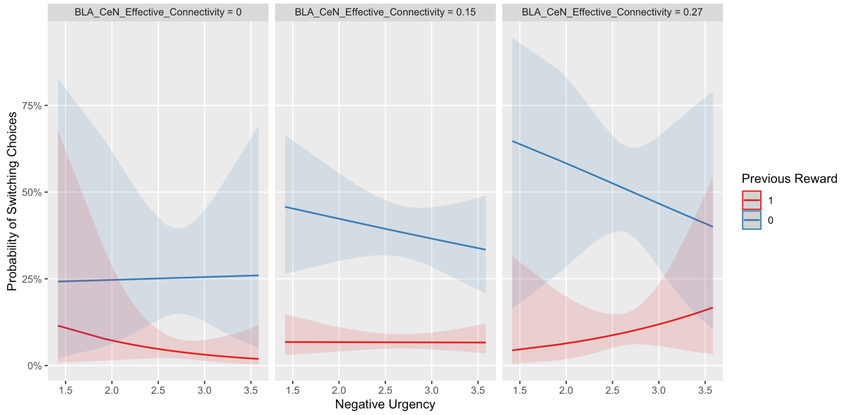

Figure 3. The effect of BLA→CeN effective connectivity and negative urgency (ERI) on switching behavior in the BPD group observed as a response to outcome in the previous trial (z = -6.79, p <.001)***.

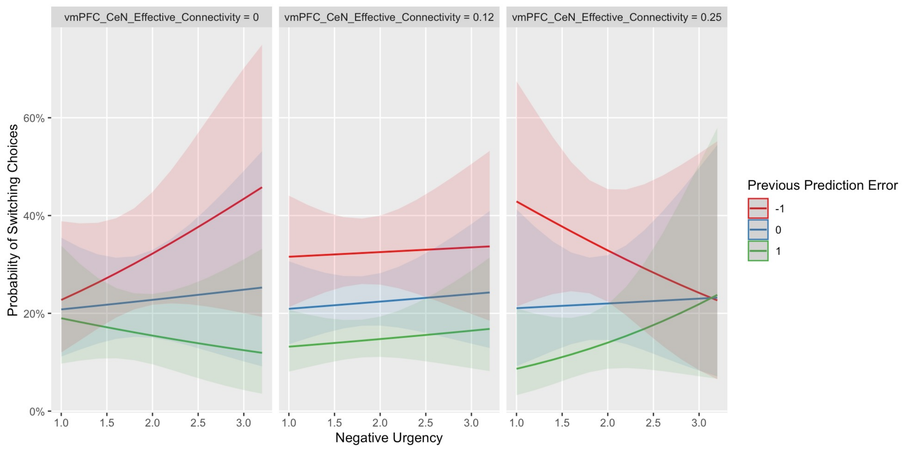

Figure 4. The effect of vmPFC→CeN effective connectivity and negative urgency (ERI) on switching behavior in the HC group as a function of prediction error in the previous trial (z = 3.36, p <.001)***.

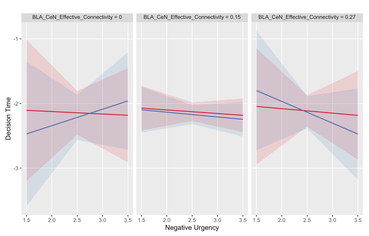

Figure 5. The effect of BLA→CeN effective connectivity and negative urgency (ERI) on decision time in response to value difference between the chosen and the best option in the previous trial. (t = -2.51, p < .05)*.

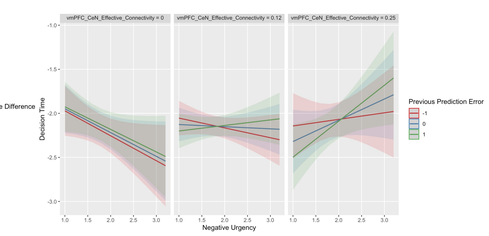

Figure 6. The effect of vmPFC→CeN effective connectivity and negative urgency (ERI) on decision time in response to previous prediction error (t = 2.39, p < .05)*.

CONCLUSIONS

- The BLA→CeN effective connectivity was positively correlated with ERI, while the vmPFC→CeN effective connectivity was negatively correlated with ERI.
- The BPD-specific BLA→CeN effective connectivity significantly moderated ERI's effects on task performance, such that the BPD group explored less and took longer to make their decisions.
- In contrast, the HC-specific vmPFC→CeN effective connectivity significantly mitigated ERI's effects on task performance, such that the HC group explored more and took less time to make their decisions.
- However, the effective connectivity in both groups did not significantly moderate ERI's effects on whether the total number of switching predicted choosing the best option.

Overall, we concluded that vmPFC→CeN effective connectivity protected HCs against making maladaptive decisions in the task. In contrast, the BLA→CeN effective connectivity did not offer such protection to the BPD group.

LIMITATIONS

- only investigated 3 brain regions
- did not examine how age could moderate the effects of decision-making

FUTURE DIRECTIONS

- investigate various brain regions associated with decision-making, such as ventral striatum[9] and hippocampus[10]
- examine the effects of age on decision-making

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REFERENCES