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The role of affective feedback on Cognitive Flexibility- A preliminary study

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Introduction

- Cognitive flexibility measures one's ability to adapt to the external environment and feedback to achieve the set goals (Robbins 2022).
- It has relevance to neuropsychiatric conditions from obsessive-compulsive disorder to depression
- Affective stimuli/input has shown to modulate cognitive flexibility (Kraft et al. 2020). However, it is still unclear how feedback in the form of affect influences cognitive flexibility.
- Extra-dimensional Intra-dimensional set shifting task (EDID) has been well known to capture deficits in OCD with specific neural signatures in the prefrontal cortex (Chamberlain et al. 2008)
- In this pilot study, we utilised a modified version of the EDID task (Hampshire and Owen 2006) to study if affective feedback could influence cognitive flexibility.

Aim

- To study the effect of affective feedback on cognitive flexibility using EDID task
- Quantify the effect of affective feedback on behavioural performance (error and reaction time) and identify the neural signature using electrophysiological recordings.

Method

- We adapted the EDID task (Hampshire and Owen 2006) and used shapes and numbers as the input stimuli
- Two versions of the task were tested. The task design is shown below in Figure 1
  - **Control Group** completed the non-affect version – Feedback is provided as 'Correct' or 'Incorrect' based on the response
  - **Affect Group** completed the affect version- Feedback is provided using images with positive and negative valence for correct and incorrect response from the Nencki Affective Picture System (NAPS).
- Additionally, all participants completed a visual working memory task and an obsessive-compulsive trait questionnaire

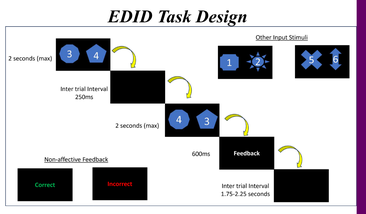
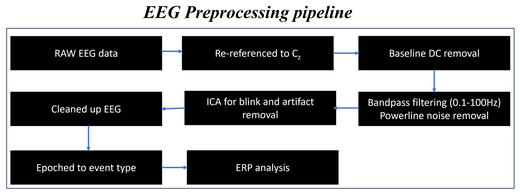


Figure shows the non-affect version of the EDID task adapted from Hampshire and Owen 2006. In the affect version, the feedback is an image with positive (negative) content adapted from NAPS dataset for correct and incorrect responses respectively.

- The behavioural analyses focused on error rates and response time
  - Acquisition
  - Intradimensional shifts (within same dimension)
  - Extradimensional shifts (across dimension)
- We also collected participant's brain activity using 64channel EEG (BioSemi, Netherlands) which was analysed using EEGLAB and ERP LAB packages in MATLAB and the task was coded in Psychtoolbox. The preprocessing pipeline is shown in figure (next column)



The figure shows the preprocessing pipeline followed in EEG analysis using EEG LAB software

Results

- We recruited 22 participants (11 per group with 6 Female participants in each group).
- The two groups did not differ in age, working memory score and OCI questionnaire score (table below)

Metric	Affect	Control
Sample size (n)	11	11
Gender	F(6), M(5)	F(6), M(5)
Age (years)	23.55 ± 2.66	23.91 ± 2.88
Working Memory	73.54 ± 9.81	80.27 ± 11.34
OCI score	53.55 ± 31.44	37.82 ± 27.32

Behavioural findings

- We then evaluated the number of errors for Acquisition, ID and ED trials.

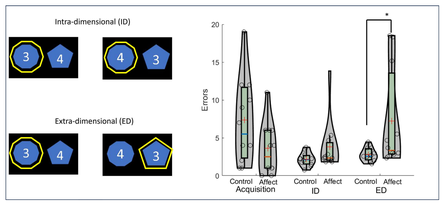


*Figure compares the number of errors in Acquisition, Intra-dimensional (ID) and Extra-dimensional (ED) trials between control and the affect group. * indicates ($p<0.05$)*

- We also evaluated the reaction times for correct and incorrect trials for each of event types.

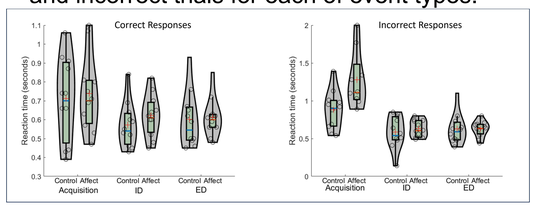


Figure compares the reaction times for Correct and Incorrect trials for Acquisition, ID and ED conditions for control and Affect group

- We evaluated the neural activity (ERPs) for ED trials in Control and Affect groups

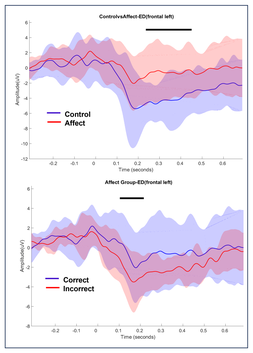


Figure compares the event related potential activity for correct ED trials in control (blue) and the affect (red)group in frontal left. The black horizontal bar indicates significant difference in neural activity ($p<0.025$) using non-parametric t-test

Figure compares the neural activity (ERPs) in the Affect group for Extra-dimensional (ED) for correct and incorrect responses. The horizontal bar indicates significant difference in neural activity ($p<0.025$) using non-parametric t-test.

Discussion and Future work

- The Affect group made significantly more errors in Extra-dimensional shift condition compared to others
- Affect group had lower negative potential than the control group during correct ED trials in left-frontal regions
- This pilot study shows a potential link between affective processing and cognitive flexibility.

References

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