

Electrophysiology of Error Processing: Motivational and Affective Correlates

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Introduction

- Clinical Perfectionism is the overdependence on self-evaluation for the determined pursuit of personally demanding, self-imposed, standards in at least one highly-salient domain, despite adverse consequences (Shafran et al., 2002).
- Previously, non-clinical measures of perfectionism have been shown to correlate with anxiety, depression, and fear of failure.
- Non-clinical perfectionism is associated with larger amplitude ERP components following self-committed errors: the error-related negativity (ERN) and error positivity (Pe).
- Both components are thought to be generated by the anterior cingulate cortex (ACC), a brain region involved in error detection.
- The ERN, which is associated with subconscious processing of errors, and Pe, which is associated with conscious awareness of errors, may reflect their motivational and emotional impact.
- We hypothesize that either or both the ERN and Pe will be positively correlated with clinical perfectionism. We also aim to replicate classic ERN and Pe findings associated with error processing, anxiety, depression, and fear of failure.

Method

Participants

- 15 individuals who completed our survey of clinical perfectionism (see our other poster, Loew et al.) came to the laboratory and completed a flanker task during EEG recording (2 dropped due to eye artifact, 1 dropped due to recording error).
- Final sample: 12 (9 female; age 18-25)

Flanker task paradigm

- Participants seated 63 cm from the monitor
- 12 blocks of 48 trials each, each trial showing a string of 5 curly braces (stimulus duration = 200 ms each, but central brace did not appear until last 50 ms) with inter-trial interval = 2000 ms
- Participants pressed a key corresponding to direction of central curly brace
- Each string was either congruent } } } } } , { { { { { or incongruent } } } } } , { { { { {
- Following each block, if accuracy > 90%, response speed emphasized; if accuracy < 75%, response accuracy emphasized

Electrophysiology

- 64-electrode GSN (Electrical Geodesics Inc.)
- 250 Hz sampling; 0.1 to 30 Hz bandpass filter
- Vertex reference; re-referenced to average
- ERN**: mean amplitude calculated over a 20 ms window centered on peak amplitude 0-100 ms after response, using the electrode site with the largest negativity out of the following: (FC1, FCz, FC2, C1, C2, CZ, CP1, CP2, F1, FZ, F2)
- Pe**: mean amplitude calculated separately at Fz, Cz, and Pz over a 125-325 ms window after response

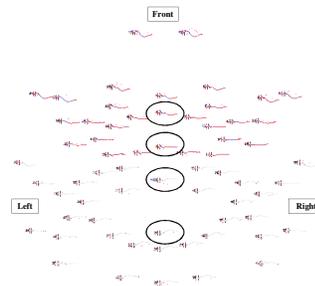
Survey Measures

- Clinical Perfectionism Questionnaire (CPQ)
- General Anxiety Disorder - 7 (GAD-7)
- Center for Epidemiological Studies Depression Scale Revised (CESD-R)
- The Performance Failure Appraisal Inventory (PFAI)

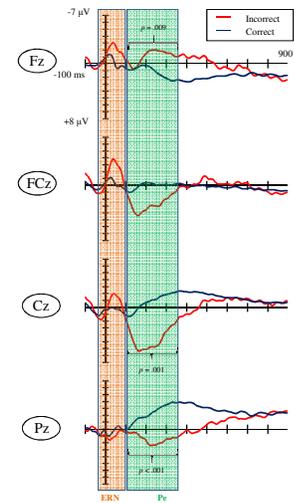
Results

- ERN**. Larger for **incorrect** responses ($M = -5.79$, $SD = 3.05$) than correct responses ($M = -2.35$, $SD = 0.86$, $p = .002$)
- Pe**. 2 x 3 ANOVA: Response (incorrect vs. correct) x Electrode (Fz, Cz, Pz).

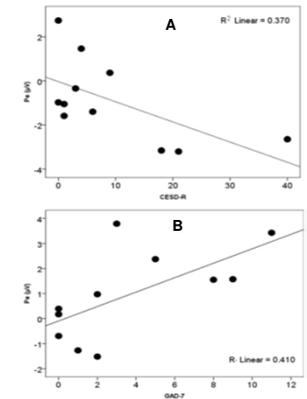
- Main effect of Response (larger for **incorrect** ($M = 1.82$, $SD = 1.93$) than correct ($M = -.77$, $SD = 1.50$, $F(1, 11) = 21.91$, $p = .001$)).
- Interaction between Response and Electrode, $F(1.6, 17.9) = 17.72$, $p < .001$.



ERPs time-locked to **Incorrect** and **Correct** responses, grand averaged across all subjects. Enlarged waveforms for **ERN** (at FCz) and **Pe** (at Fz, Cz, Pz) displayed at right.



Grand averaged waveforms at selected electrodes. ERN is observed during 0-100 ms window, Pe observed primarily during 125-325 ms window.



Pe amplitude for incorrect trials as a function of a) depression at electrode Fz ($r = -.61$, $p = .047$); and b) anxiety at electrode Pz ($r = .64$, $p = .034$). No significant correlations were observed for clinical perfectionism, fear of failure, or the ERN.

Discussion

- Preliminary findings replicate classic ERN effects as well as Pe effects at sites Cz and Pz, indicating a larger brain response when making errors
- Larger Pe for correct than incorrect responses at Fz may reflect inversion (deflecting upward/negative instead of downward/positive) of Pe at frontal sites.
- ERN amplitude was not correlated with any survey measures.
- Pe amplitude may correlate positively with anxiety and depression, taking into consideration the inversion of Pe amplitude from site Pz to Fz. Pe did not correlate with clinical perfectionism or fear of failure.
- With a larger sample size, potential correlations between ERN, Pe, and survey measures of motivation and affect may become more apparent.

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