# Exploring the Relation between Post-Error Slowing and Electrophysiological Indicators of Error-Processing

Gabriel Niazov & Malachi Tzumi
Under the supervision of Mr. Maor Yeshua and Prof. Andrea Berger

## Background

Within parenthood, low cognitive control is associated with increased risk of engaging in child maltreatment, whereas higher cognitive control is associated with sensitive, involved parenting (Crandall et al., 2015). The aim of the study was to examine the relation between behavioral measures of cognitive control (as index by Post-Error Slowing [PES]) and electrophysiological measures related to error detection and processing within a sample of mothers. PES refers to the slowing in response time that occurs immediately after an error, compared to response times after correct response (Rabbitt, 1966). At the electrophysiological level, Error-Related Negativity (ERN) is a component with negative amplitude that appears shortly after an erroneous response and is considered a marker of early, automatic error detection (Gehring et al., 1993). The Error Positivity (Pe) appears after the ERN and has been found to be associated with the processing stage of the error and error awareness (Nieuwenhuis et al., 2003). A previous study on students showed that Pe amplitude is strongly associated with PES, whereas ERN was only weakly or inconsistently related to PES (Chang et al., 2014). Based on these findings, we hypothesized that in our sample of mothers PES will be positively correlated with Pe and weakly correlated with ERN.

## Method

### Sample

21 neurotypical mothers
*Mage* = 36.72 years (SD = 4.63 years, Range = 28.95 - 42.86)
*M*education years = 16.81 (SD = 1.86 years, Range = 12 - 20)

### Measures

#### Pe and ERN

Calculated within the Emotion-Induction Go/NoGo Task: Three blocks, manipulating Mothers' emotions by rating in a fake competition (Farbiash & Berger, 2016).

EEG acquisition:

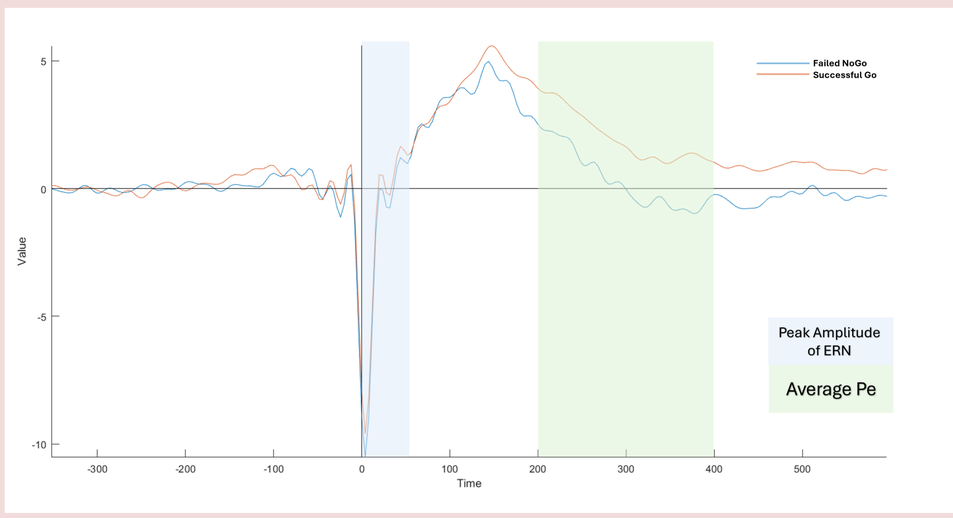
- Net station EGI
- 128 electrodes (250 Hz recording rate)
- Pre-processing included filtering, segmentation, manual artifact removal, ICA removal of eye movements and muscles, trial by trial (automatic interpolation of noisy segments).
- ERN and Pe were averaged across blocks A and B.
- Only failed No-Go responses were analyzed.
- Minimum trials: N = 8.

#### PES

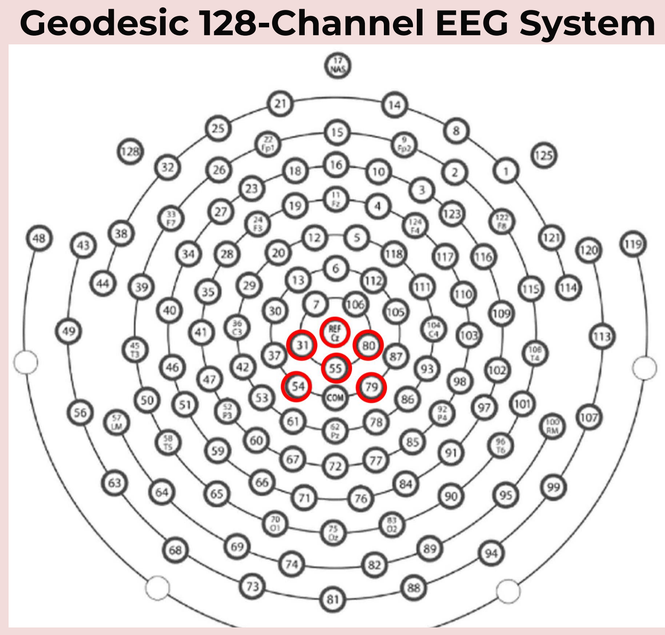
Post-Error Slowing (Emotional Day-Night Task; EDN): Twelve blocks (six congruent and six incongruent, fully randomized) with different image no-go rule.

$$\mathrm{PES} = \overline{\mathrm{RT}}_{\mathrm{post-error}} - \overline{\mathrm{RT}}_{\mathrm{post-correct}}$$

## Stimulus Locked ERP




## Electrode Selection for Analysis: Geodesic 128-Channel EEG System



## Results

Linear Regression Model Explaining Post-Error Slowing by Electrophysiological Indicators of Error Processing

| Variables | | $\beta$ | $p$ value | 95% CI |
|---|---|---|---|---|
| ERN | | -.18 | .42 | [-.63 .27] |
| Pe | | .50 | .033 | [.04 .95] |
| $F$ | 2.66 | | .096 | |
| $R^2$ | .229 | | | |

($N = 21$)

## Discussion

As hypothesized, Pe, rather than ERN, is the electrophysiological component that was found to be associated with PES. This is consistent with previous finding highlighting the relation between Pe and PES in students (Chang et al., 2014), and extending it into the context of motherhood. As Pe has been associated with error awareness (Nieuwenhuis et al., 2003), it is possible that when there is an increased recruitment of cognitive resources for processing the error, there is more significant slowing after errors, as indicated by PES effect.

**References**

Chang, A., Chen, C. C., Li, H. H., & Li, C. S. R. (2014). Event-Related Potentials for Post-Error and Post-Conflict Slowing. PloS One, 9(6), Article e99909.

Crandall, A., Deater-Deckard, K., & Riley, A. W. (2015). Maternal emotion and cognitive control capacities and parenting: A conceptual framework. Developmental review, 36, 105-126.

Farbiash, T., & Berger, A. (2016). Brain and behavioral inhibitory control of kindergartners facing negative emotions. Developmental Science, 19(5), 741-756.

Gehring, W. J., Goss, B., Coles, M. G. H., Meyer, D. E., & Donchin, E. (1993). A neural system for error detection and compensation. Psychological Science, 4(6), 385–390.

Nieuwenhuis, S., Ridderinkhof, K. R., Blom, J., Band, G. P. H., & Kok, A. (2003). Error-related brain potentials are differentially related to awareness of response errors: Evidence from an antisaccade task. Psychophysiology, 40(6), 836–845.

Rabbitt, P. M. A. (1966). Errors and error correction in choice-response tasks. Journal of Experimental Psychology, 71(2), 264–272.