Neural Correlates of Behavioral Measures of Motivation

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Introduction

- Understanding motivation at the neurological level may one day help us better understand the underlying mechanism of motivational processes.
- Studies looking at associations between Event Related Potentials (ERPs) and motivation have mostly ignored the academic context where motivation is important for achievement.
- This study aims to assess whether or not existing behavioral measure of motivation relate to students' electrophysiological responses to a Go/No-go task.
- **Measures of Cognitive Control and Error Monitoring**
  - Error Related Negativity (ERN): Thought to reflect automatic detection of conflict between correct and erroneous response.
  - Error Positivity (Pe): Thought to reflect conscious awareness of and attention to errors.

Research Question:

- What are the relationships between the ERN/Pe and behavioral measures of motivation?

Methods

- 42 undergraduate students (N_{female} = 33, M_{age} = 20.12)
- Participants completed four computerized tasks during which electrophysiological data was recorded using an ActiChamp system with 32 Ag/AgCl electrode cap (ActiCap).
- Afterwards participants answered a battery of questionnaires.
- **Survey Measures:**
  - Patterns of Adaptive Learning Scales (PALS)
    - Mastery Goal Orientation Revised (MGO)
    - Performance-Approach Goal Orientation Revised (PAGO)
    - Performance-Avoid Goal Orientation Revised (PAvGO)
  - Theory of Intelligence (TOI)
- **ERP Measures:**
  - ERN/CRN: Mean amplitude was calculated within a time window of -50ms before the response and 50ms after.
  - Pe: The mean amplitude was calculated within a time window of 150ms and 450ms after the response.
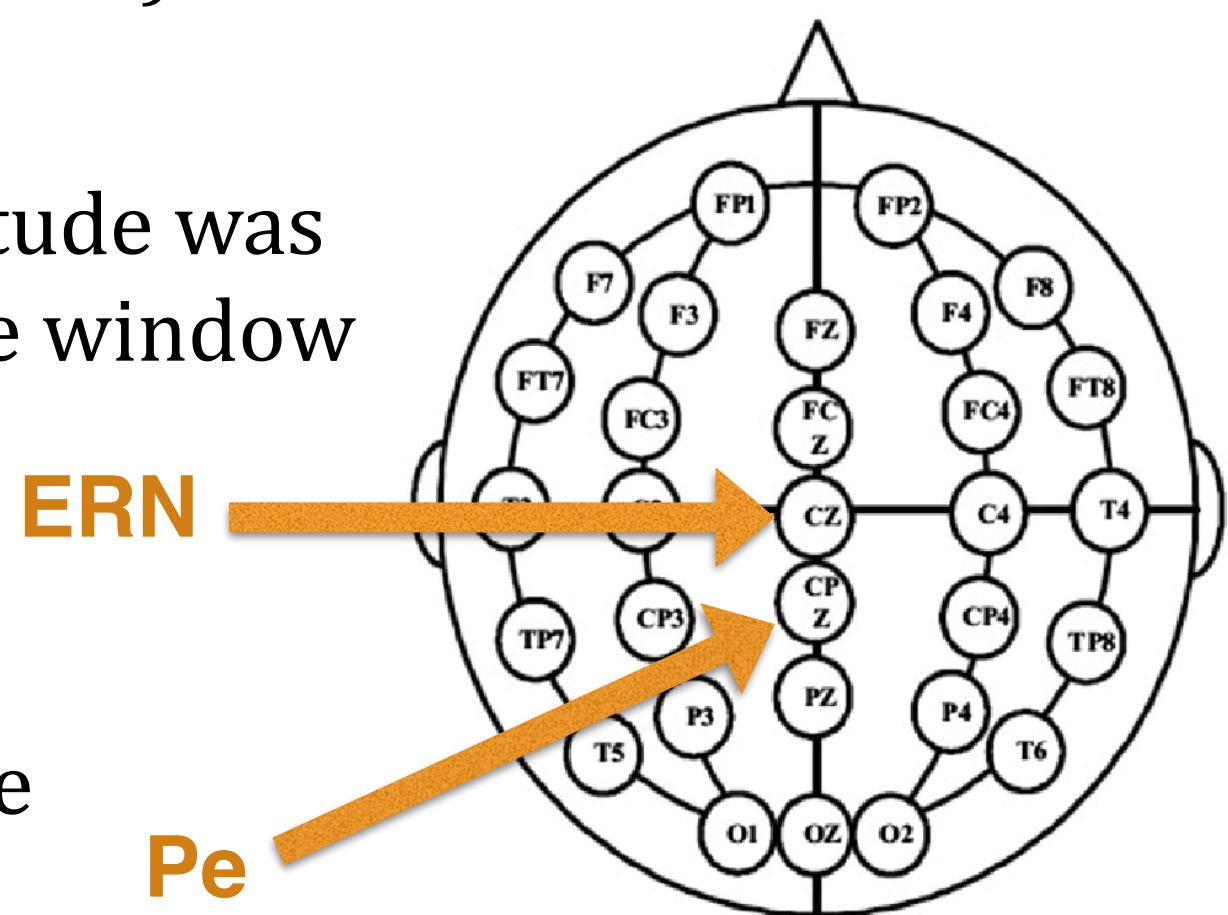
Computerized Task
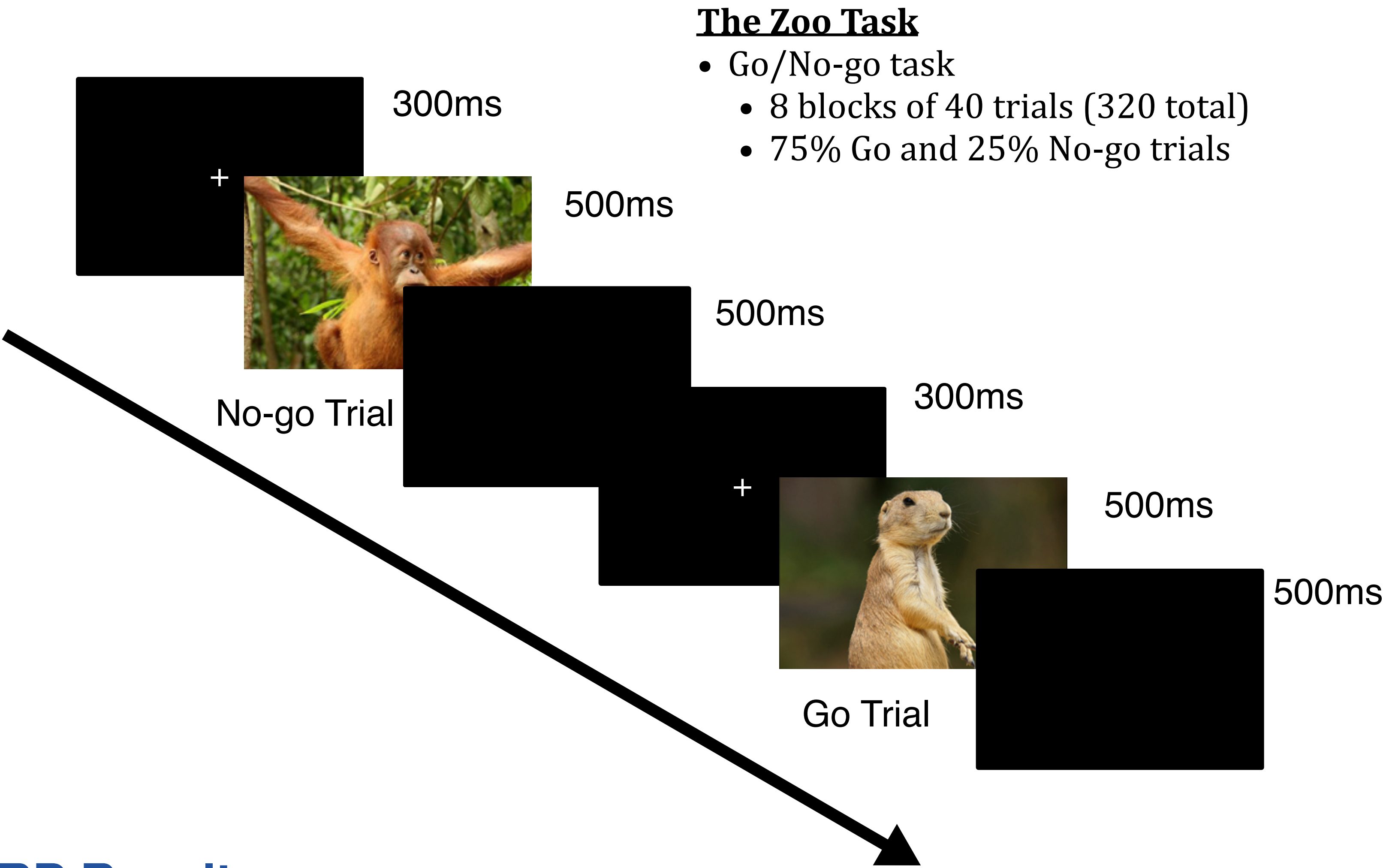
The Zoo Task
- Go/No-go task
  - 8 blocks of 40 trials (320 total)
  - 75% Go and 25% No-go trials

300ms

500ms

No-go Trial

500ms

300ms

500ms

500ms

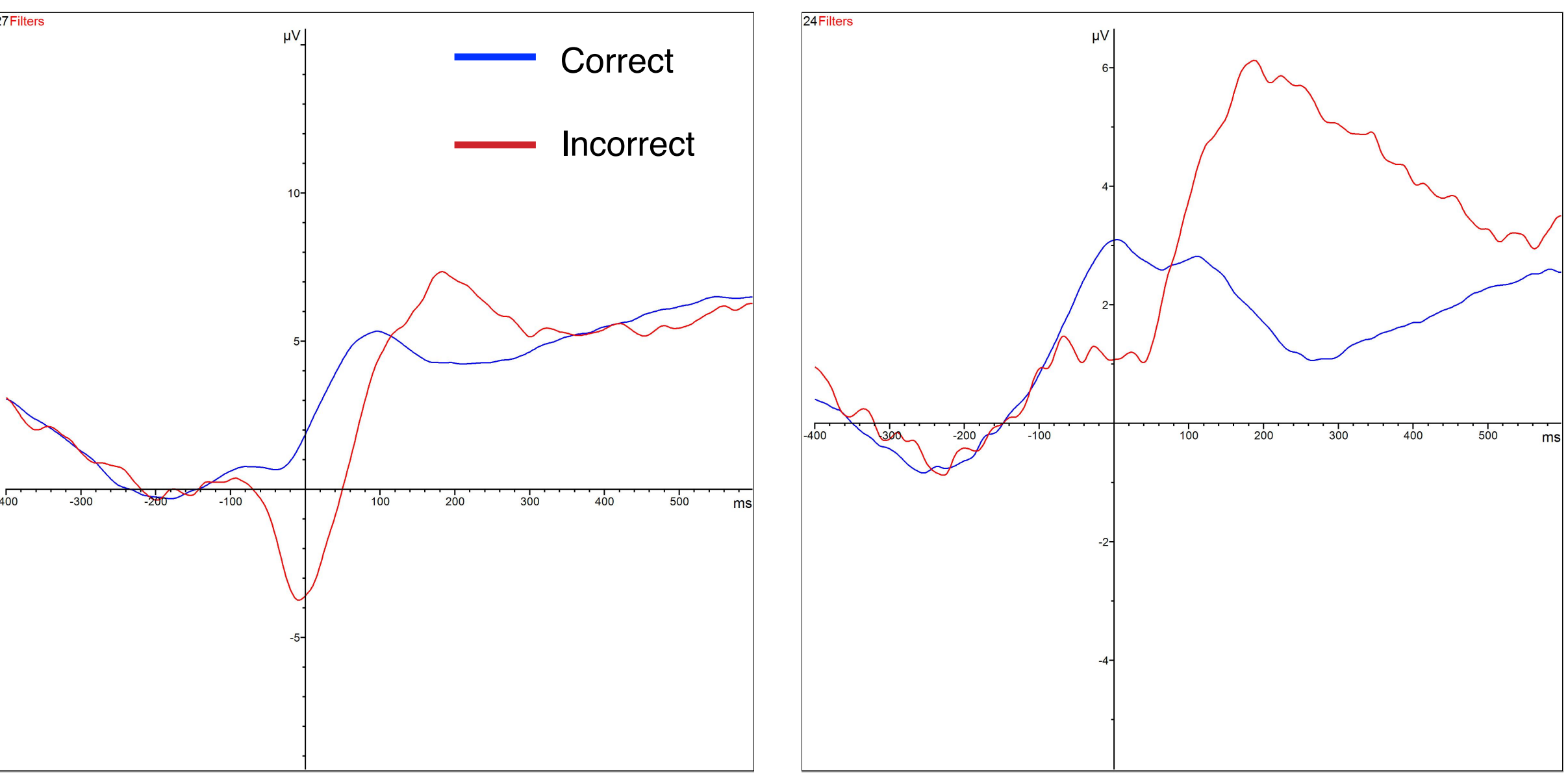Go Trial

ERP Results

Figure 1. ERN at Cz

Figure 2. Pe at CPz

- The ERN amplitude on correct trials vs. incorrect trials was significantly different, $F(1, 41)$ = 123.91, $p < .00$ with incorrect trials significantly more negative, M = -2.40μV, SD = 2.99 than correct trials, M = 2.09μV, SD = 1.95.

- The Pe amplitude on correct trials vs. incorrect trials was significantly different, $F(1, 41)$ = 91.2, $p < .00$ with incorrect trials significantly more positive, M = 5.04μV, SD = 3.22 than correct trials, M = 1.54μV, SD = 2.30.

	CRN_Cz	ERN_Cz	Pe_CPz
MGO	**-.37***	**-.32***	0.02
PAGO	0.04	-0.05	0.15
PAvGO	0.03	-0.16	**_0.30_**
TOI	-0.15	0.15	-0.14

Table 1. Associations between the ERN, CRN, and Pe and measures of motivation

- Both the CRN, $r(40)$ = -.37, $p < .05$, and ERN, $r(40)$ = -.32, $p < .05$, at Cz were negatively correlated with Mastery Goal Orientation such that students who reported higher values on the MGO scale also presented more negative CRN and ERN event related potentials.

- Correlation between Pe at CPz and Performance Avoidance Goal Orientation was marginally significant, $r(40)$ = .30, $p = .05$ with students who reported higher values in performance avoidance goal orientation also presented more positive Pe amplitudes.

Behavioral Results

- Overall mean accuracy was 84.55% (SD = 12.43%).
- Students were faster on error trials, M = 323.82ms (SD = 25.70ms) than on correct trials, M = 366.97ms (SD = 24.62ms), $F(1, 41)$ = 173, $p < .00$.
- Post-error reaction time, M = 368ms (SD = 30.35ms) and post-correct reaction time, M = 366.48ms (SD = 24.97ms) were not significantly different, $F(1, 41)$ = .23, $p = .63$.
- Students were less accurate after error trials, M = 79.80% (SD = 17.59%) than after correct trials, M = 86.22% (SD = 10.32%), $F(1, 41)$ = 15.07, $p < .00$.
- Neither measure of motivation correlated with student reaction times and accuracy on the Zoo Task.

Discussion

- This is the first study, to our knowledge, showing an association between the ERN and MGO.
- A more negative ERN in relation to MGO suggests that errors were more salient for students who rated high on the MGO scale.
- Marginal positive correlation between PAvGO and Pe suggests that students who rate high on the PAvGo scale are more aware of the mistakes they made.
- These findings in combination with previous findings may suggests that mastery goal oriented students' automatic detection of errors—as evidenced by large ERN amplitudes — may serve as an affective buffer when making mistakes.
- In contrast, students who rated high on the PAvGO scale may have a more affective or conscious awareness of their mistakes thus influencing their behavior to avoid situations in which they know they would underperform.

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