Insight into the Before and After of Problem Solving using Event Related Potentials

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INTRODUCTION

One reason studying the neural basis of problem solving is challenging lies in the various types of problems that can be solved. Research utilizing Chinese characters, riddles, or other puzzles in conjunction with various forms of neural imaging or recording techniques (for review see Sprugnoli et al, 2017) provided insight on how the brain processes those types of problems. We have attempted to understand the potential differences in similar types of problem solving tasks using both mental rotation task (MRT) as well written riddles. Employing event related potential data (ERP) of the readiness Potential (RP) is an indicator of conscious decision-making processes (Fifel, 2018; Hari, 2018) to look for differences between the MRT and the written riddles. We hypothesized that RP would be different between the two types of decision processing.

METHODS

Data was collected using iWorx (Dover, NH) IX-EEG hardware using a 10/20 Electro-Cap (Eaton, OH). LabScribe v3.61 software was used to run, collect, and analyze the ERP data. A total of 20 participants were exposed to a sequence consisting of MRTs alternating with written riddles. Participants pressed a button held in their right hand when they believed they had the answer and triggered the next trial.

ERP analysis was done at the Fz, Pz, and Cz electrodes with the -1000 to -650 msec pre-stimulus mean used as baseline compared to stimulus onset to 1000 msec.

Data collected from the FP1, F3, & F7 electrodes was averaged and analyzed for RP measures using -2000 to -1000 msec pre-stimulus mean as baseline. Analysis of the latency of the minimum and maximum voltages, and the values at those times along with at -200 msec & at the time of pushing the button as the stimulus (0) data were performed using repeated measures general linear models in SPSS with α = 0.05 were used to test for significance. One participant's image data was removed as an outlier.

Task type influenced latency of RP
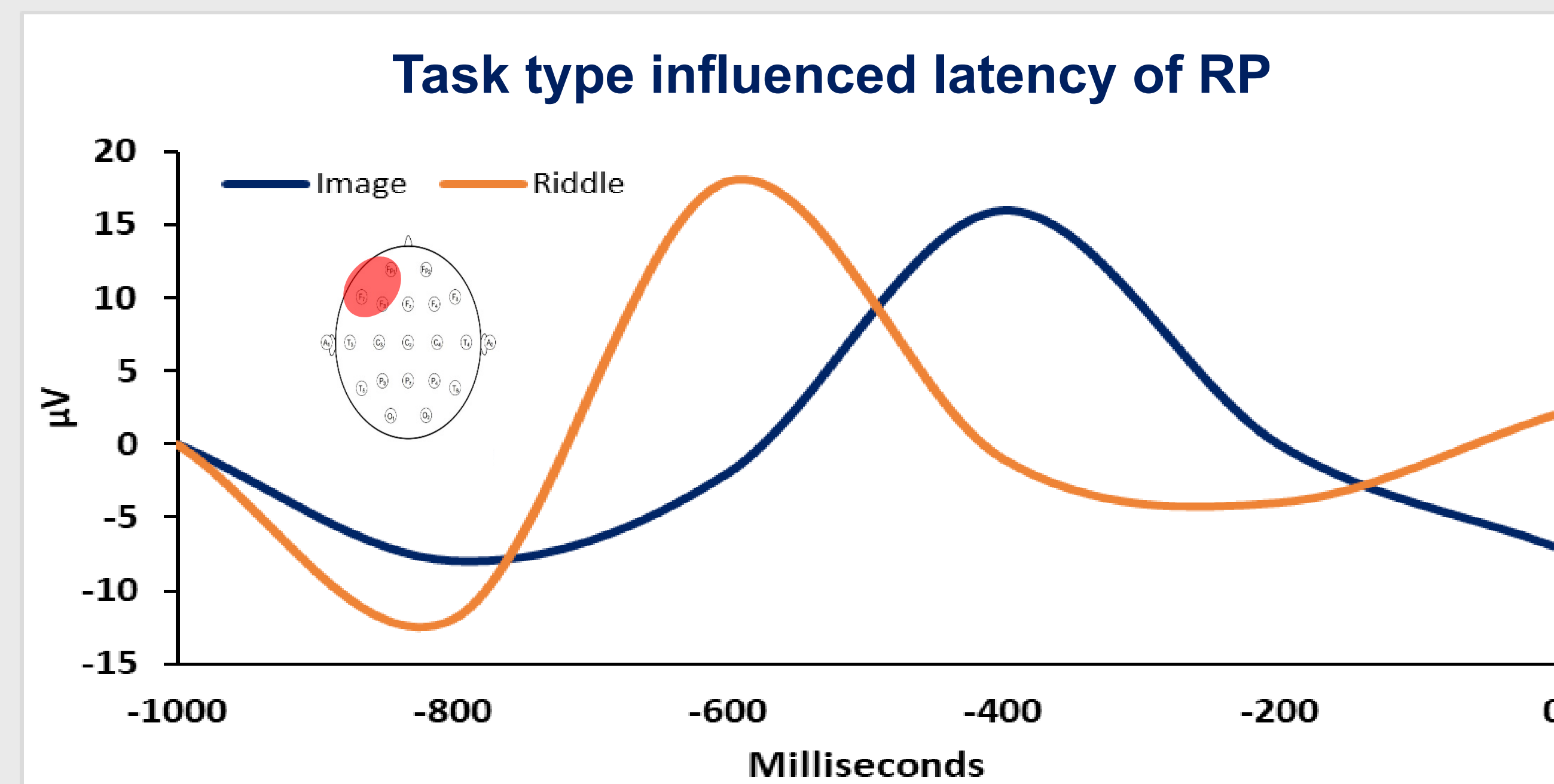
Puzzle type interacts with voltage measures

Raw Data

Image

Riddle
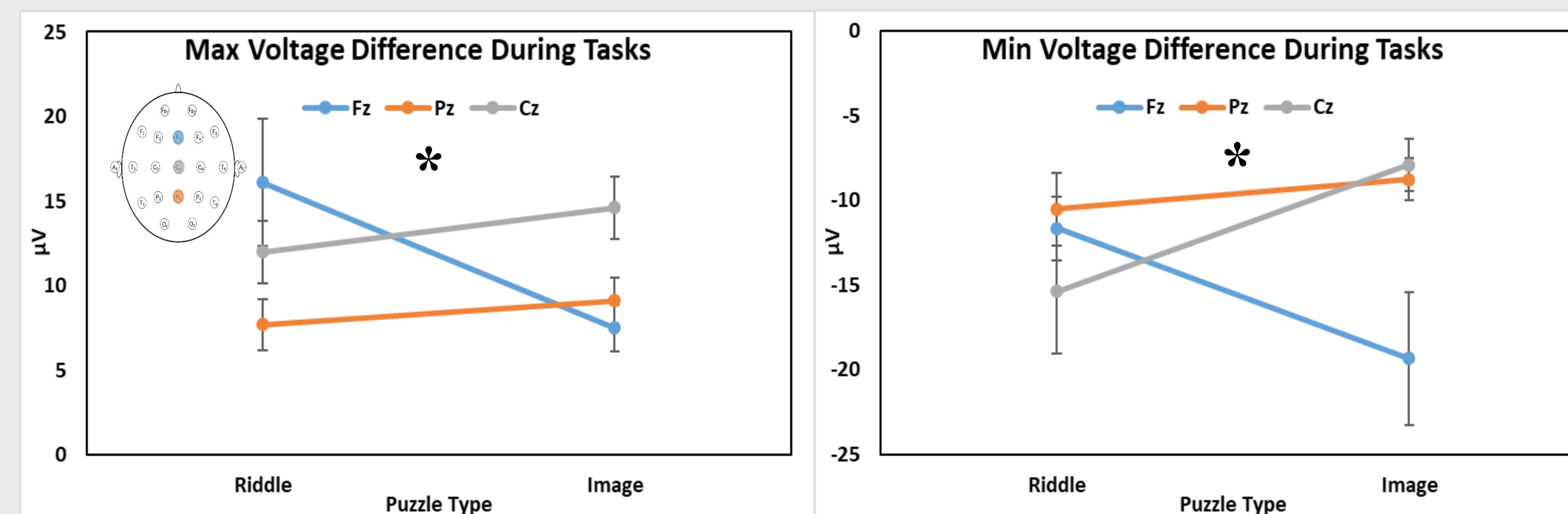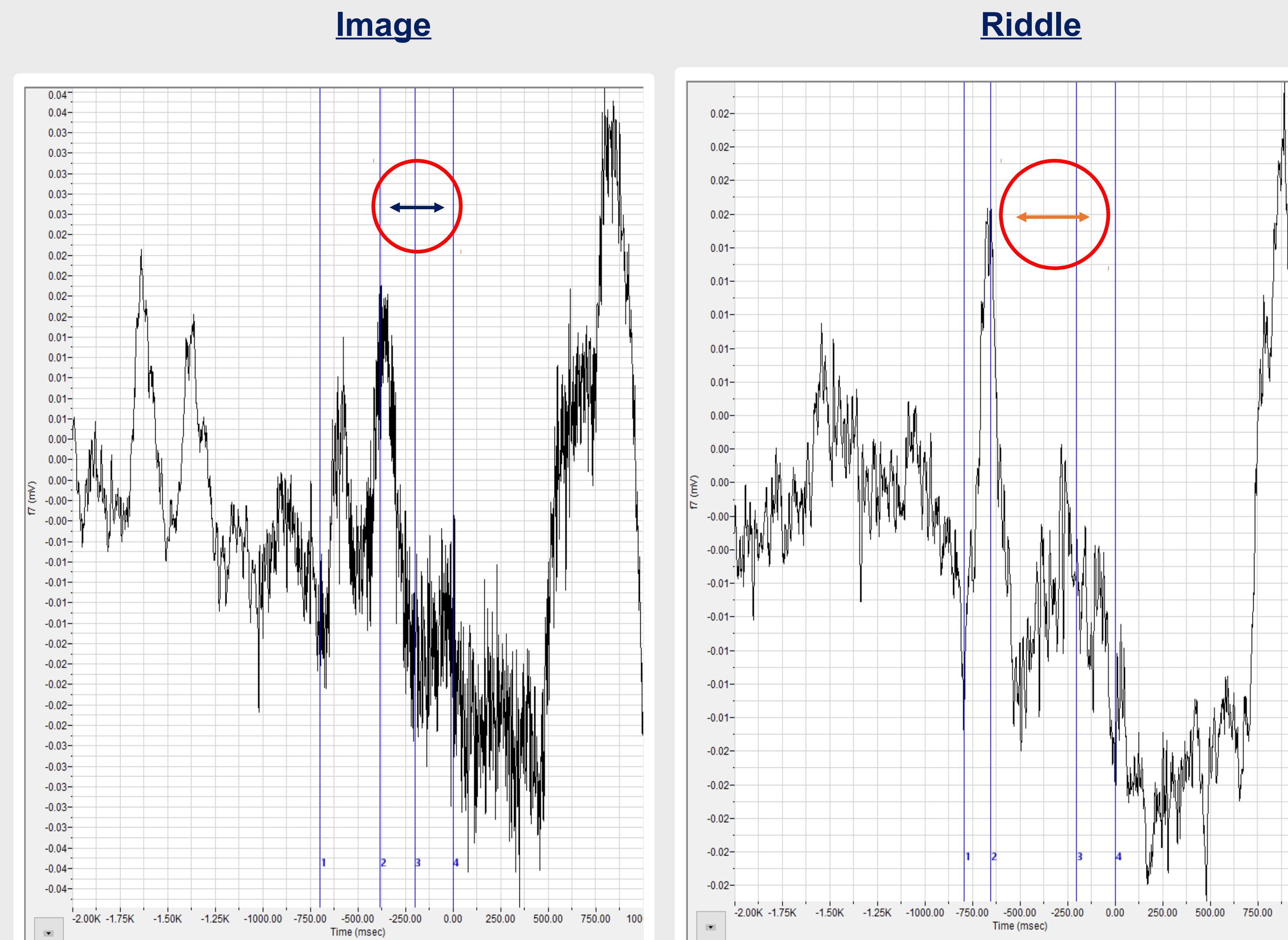
STATISTICS

Analysis of the averaged left-frontal electrodes latency data failed to indicate a significant overall effect for negative voltage $F(1, 17)$ = 1.75, p = 0.20. Latency of the positive voltage was also not significant in the model $F(1, 17)$ = 3.46, p = 0.08. However, a post-hoc LSD test indicated the average peak voltage occurring 100 msec closer to the stimulus relative to the riddle task was significant (p = 0.03).

Analysis of the Fz, Pz, and Cz electrodes indicated significant interactions between the locations and puzzles in both max voltage $F(1,17)$ = 7, p = 0.01 and minimum voltage $F(1,17)$ = 4.35, p = 0.05. While only a trend in puzzle type for latency was found on the minimum voltage measure $F(1,17)$ = 4.06, p = 0.06 (data not shown).

SUMMARY & LIMITATIONS

- Peak voltage was found to happen closer to the response in the MRT task than in the written riddle task. Indicating a different amount of time in the processing between the two tasks.

- The use of more puzzles and increasing our sample sizes in future studies should facilitate more reliable results.

References

Sprugnoli, et al. (2017). Neural correlates of Eureka moment. Intelligence.

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Fifel, Karim. "Readiness Potential and Neuronal Determinism: New Insights on Libet Experiment." *The Journal of Neuroscience*, vol. 38, no. 4, 2018, 784–786.

Hari, S. (2018). *Voluntary action, conscious will, and readiness potential*. Cosmos and History: The Journal of Natural and Social Philosophy, Vol 14, 1, 56–70