

# Reward Expectancy and the Reward Positivity: A Non-Linear Relationship

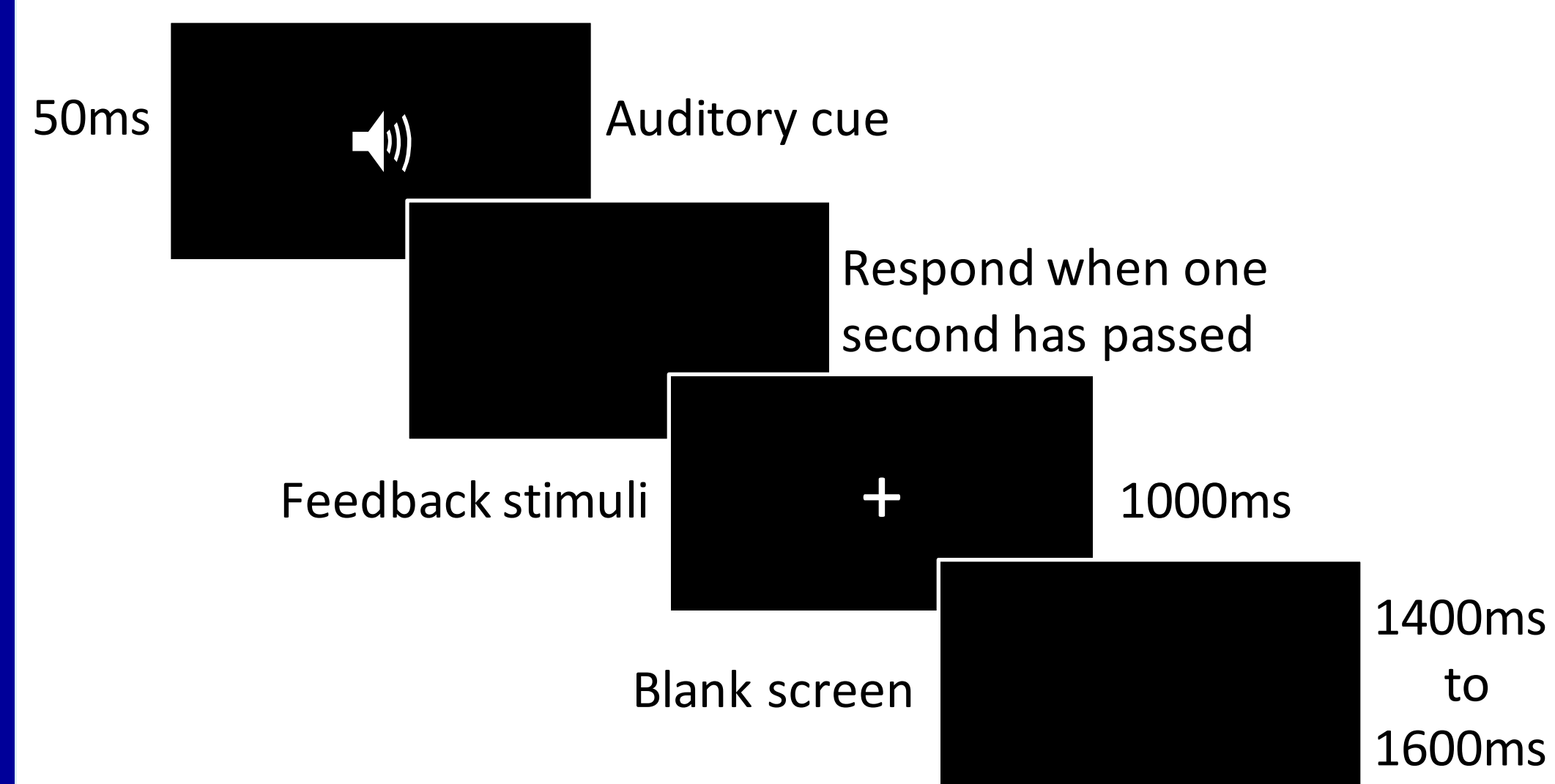
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## INTRODUCTION

We do not learn from our mistakes, we learn when our expectations of an outcome do not match the actual outcome. When there is a discrepancy between expected and actual outcomes a prediction error occurs. Reinforcement learning theory postulates that the reward positivity amplitude (Holroyd et al., 2008) scales in magnitude to the degree of discrepancy in prediction errors. In the present study we sought to extend electroencephalographic research by Holroyd and Krigolson (2007) examining the effect of reward expectancy on neural prediction error signals in a time estimation task. Specifically, we sought to examine the relationship between reward positivity amplitude and expectancies of outcomes to determine whether this relationship is linear as suggested by theoretical accounts (e.g. Sutton and Barto, 1998).



Participants performed a time estimation task

After an auditory cue, participants estimated the duration of one second

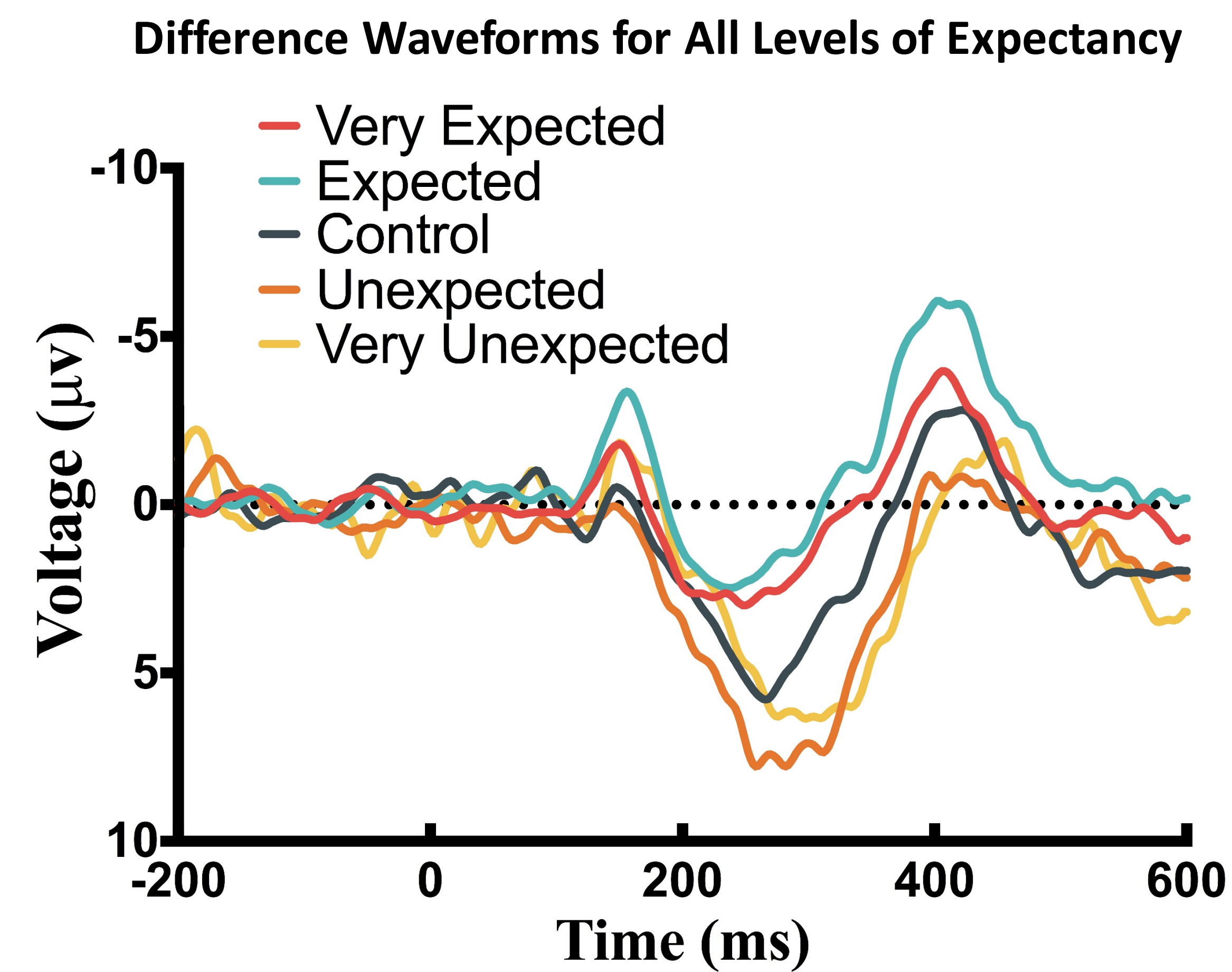
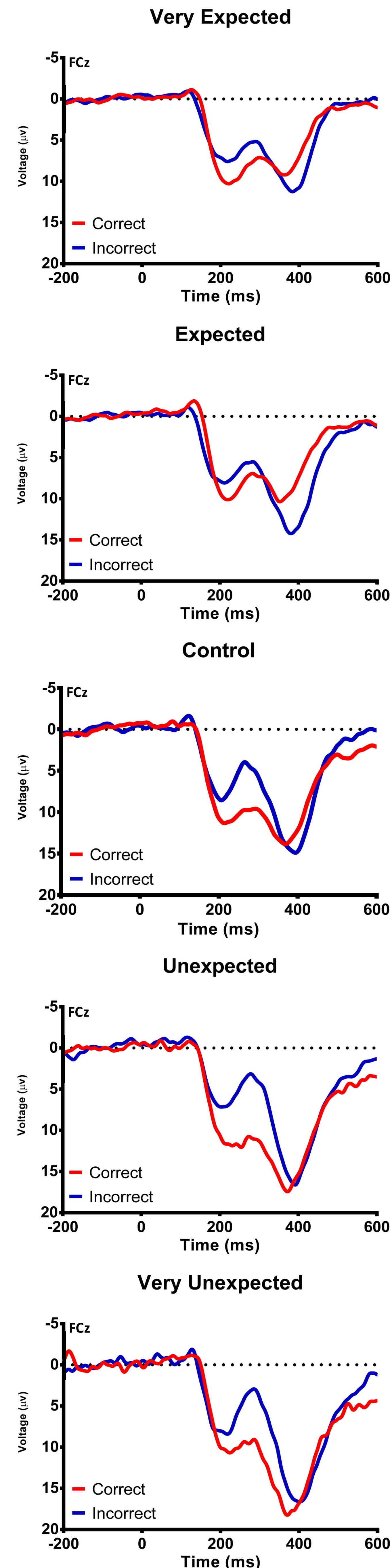
Responses were correct when participants responded within a response window (e.g. 900ms – 1100ms)

The response window decreased after correct responses and increased after incorrect responses

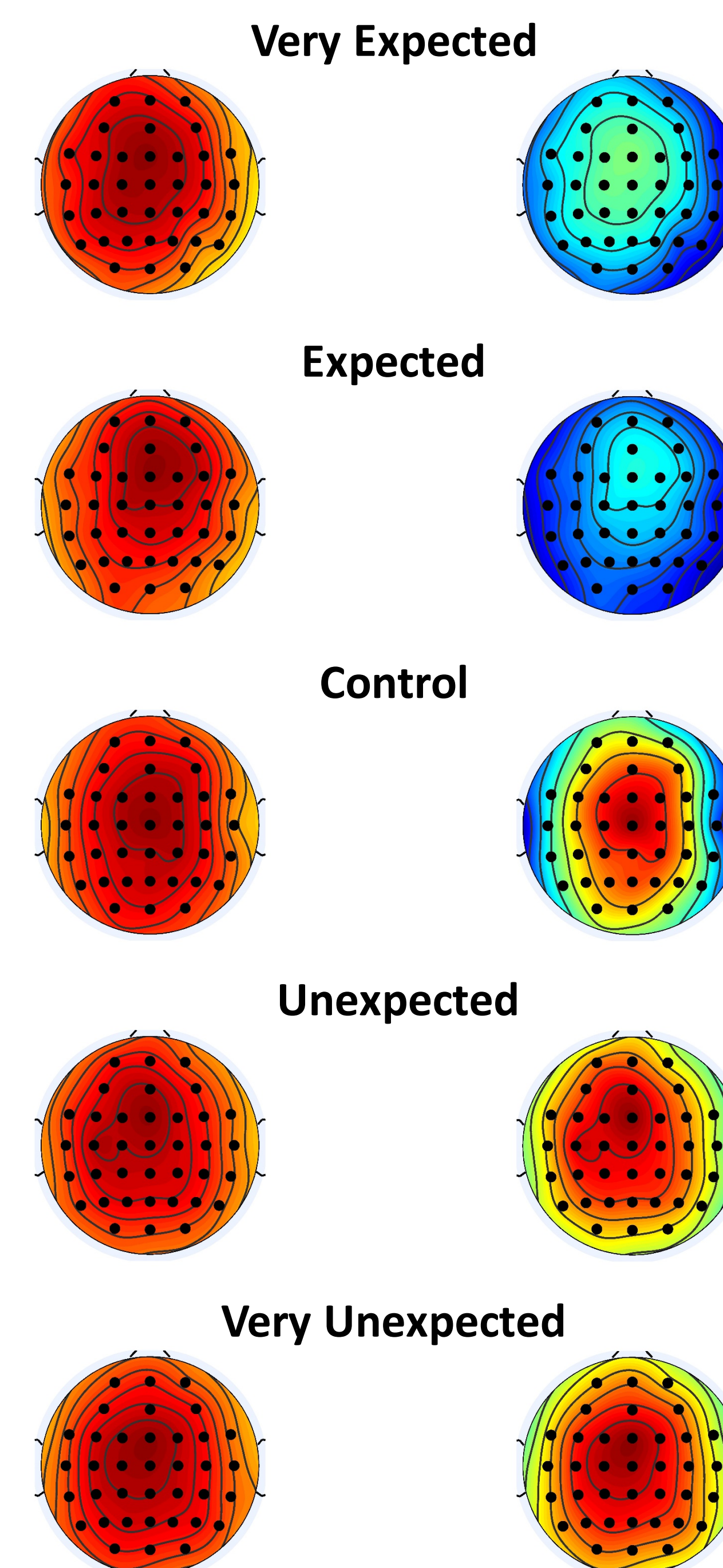
The response window of harder conditions decreased more after correct responses and increased less after incorrect responses than easier conditions

Very unexpected, unexpected, control, expected, and very expected prediction errors were analyzed

## RESULTS



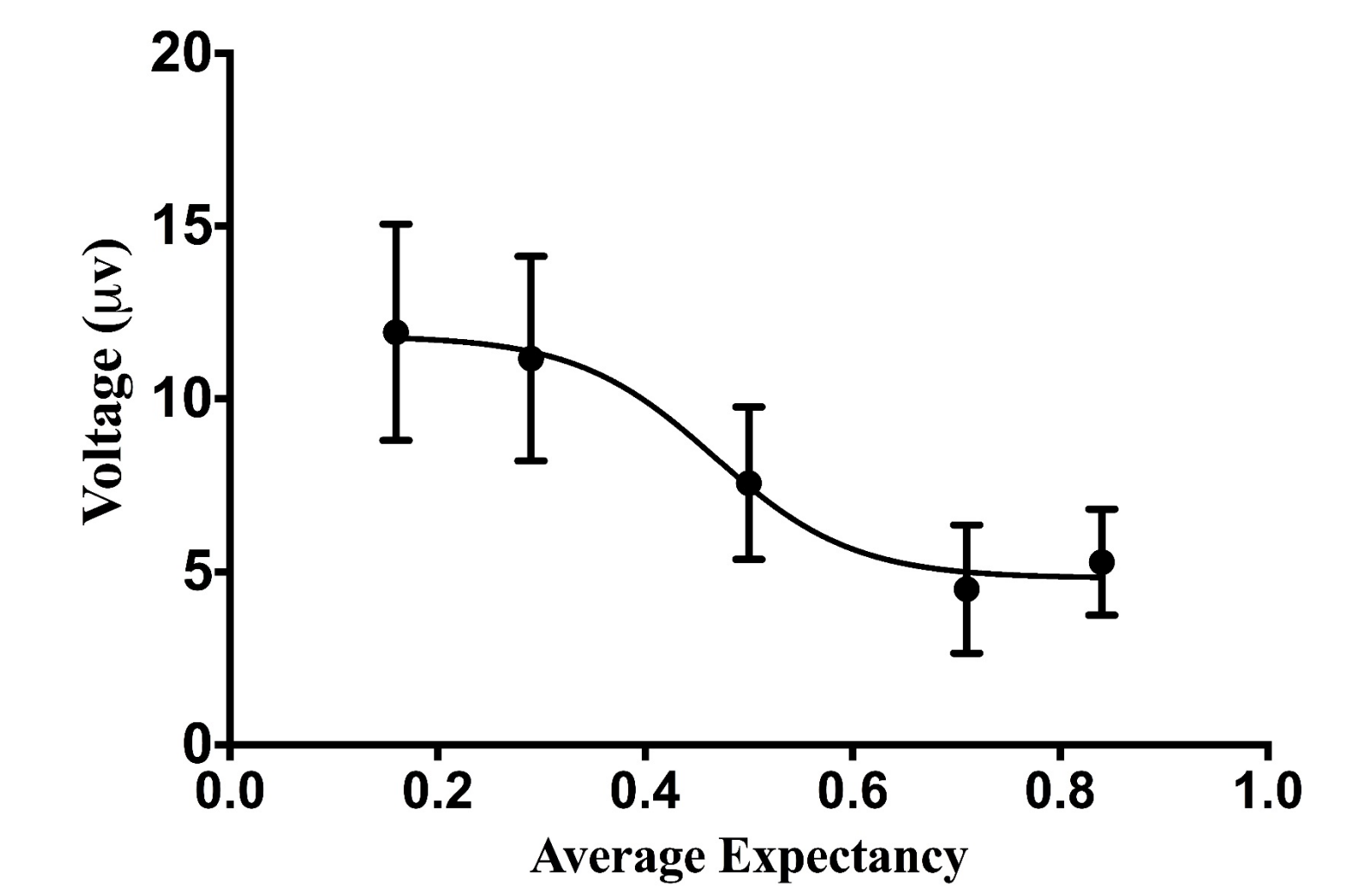
## Topographic Map with Individual and Standardized Scales of Voltage



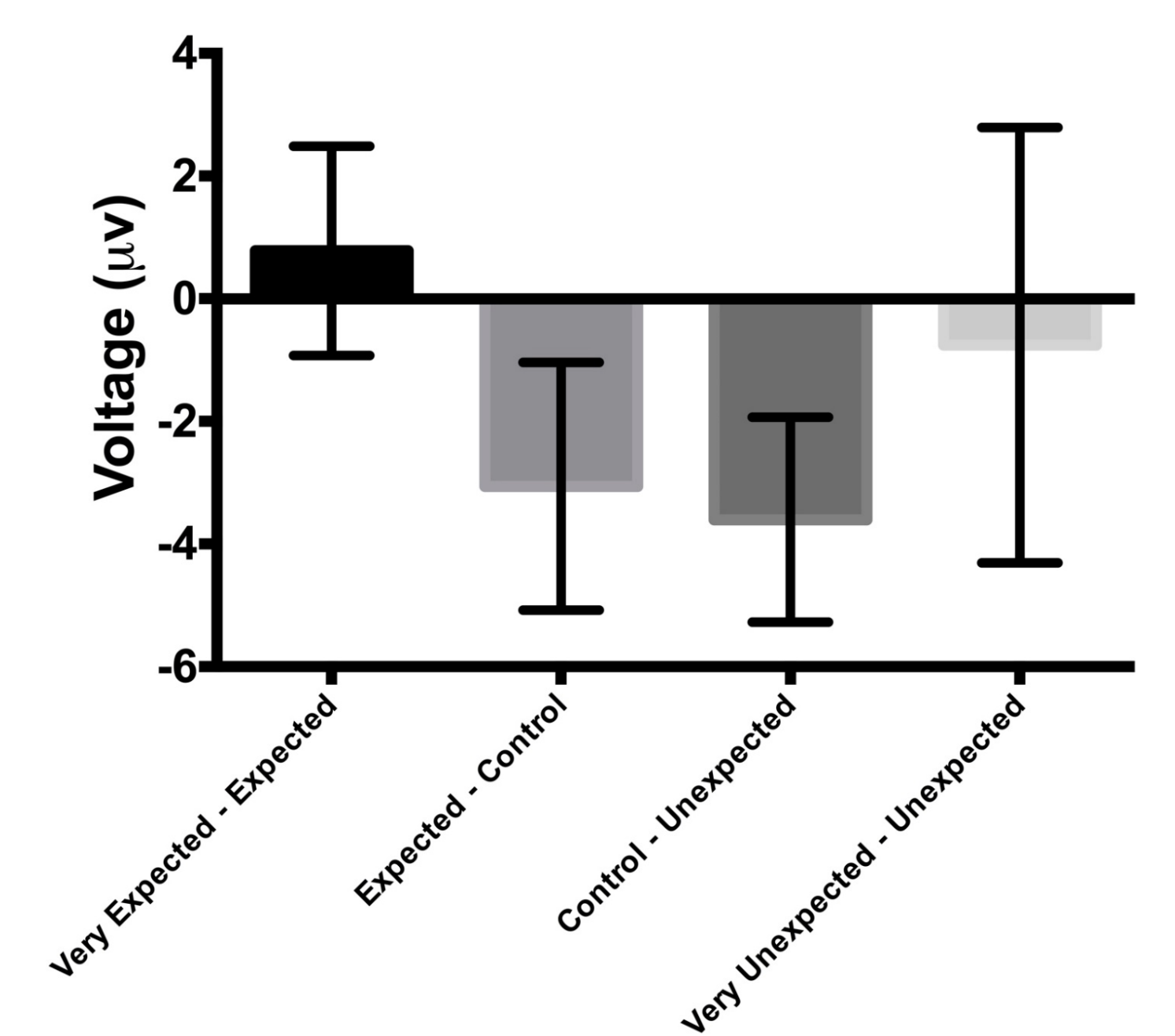
## CONCLUSIONS

As reinforcement learning theory would predict, the reward positivity amplitude increased between the expected, control, and unexpected conditions. Interestingly, there was no difference in reward positivity amplitudes between the very expected and expected conditions nor between the very unexpected and unexpected conditions. This result was not in line with the linear relationship as would be predicted by theoretical accounts (e.g. Sutton and Barto, 1998) but instead indicated a non-linear relationship between reward expectancy and reward positivity amplitude.

### Reward Positivity Amplitude with Confidence Intervals for All Levels of Expectancy



### Treatment Effect with Confidence Intervals



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