

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

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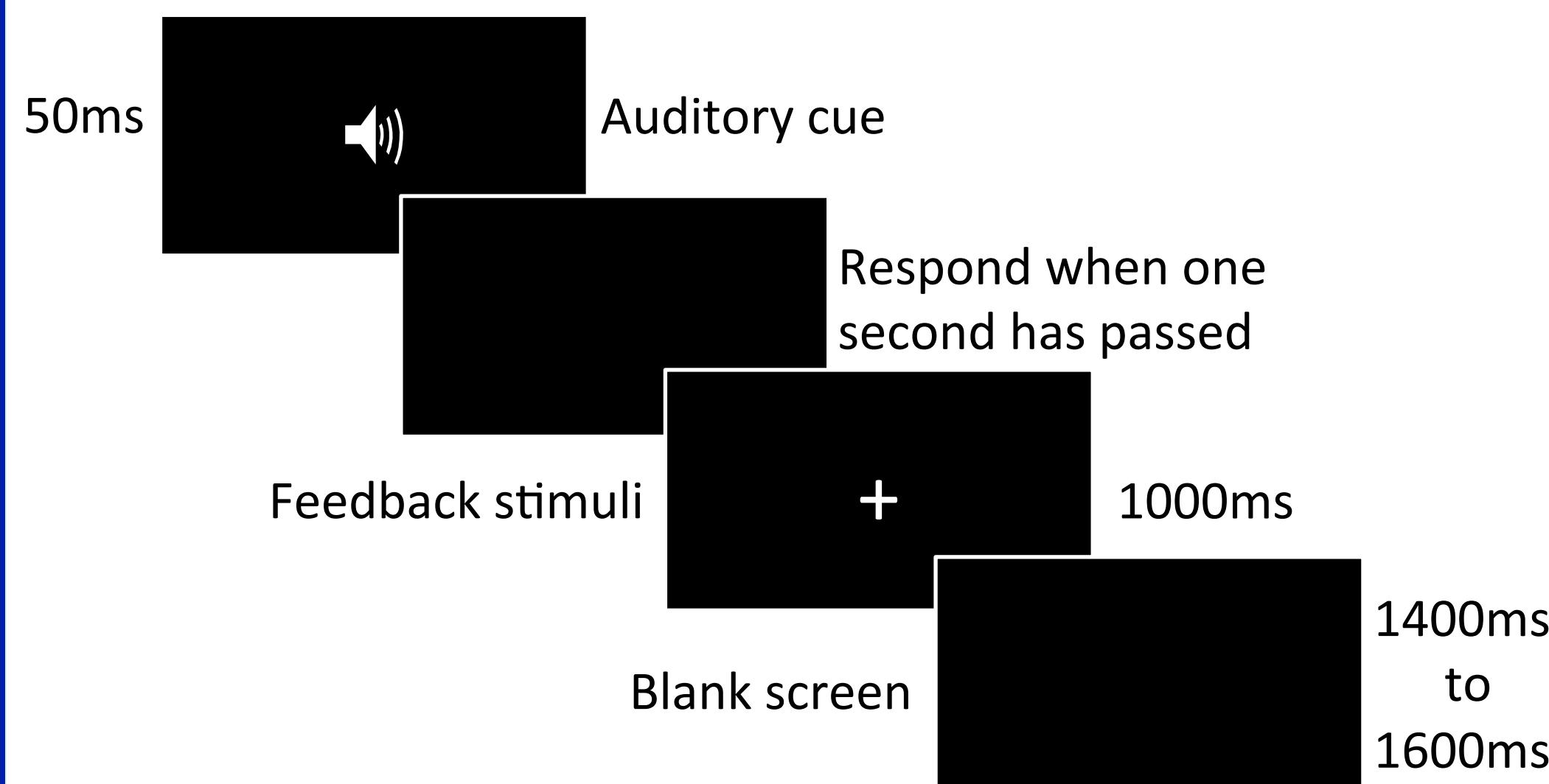
The Neuroeconomics Laboratory, University of Victoria

Poster Session 1  
Poster Number 3

## 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 of reward positivity amplitude and expectancies of outcomes to determine whether this relationship was linear as suggested by theoretical accounts (*e.g.* Sutton and Barto, 1998).

## METHOD



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)

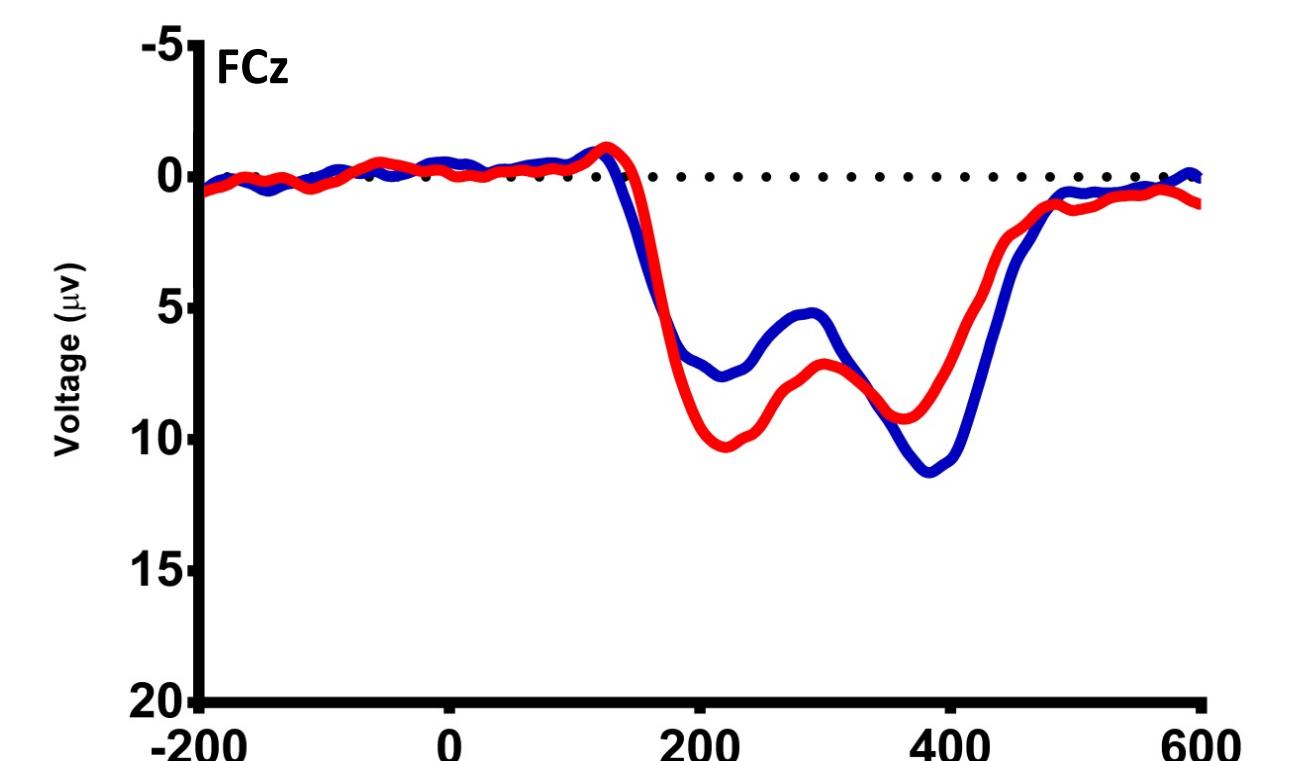
The response window decreased after correct responses and increased after incorrect responses

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

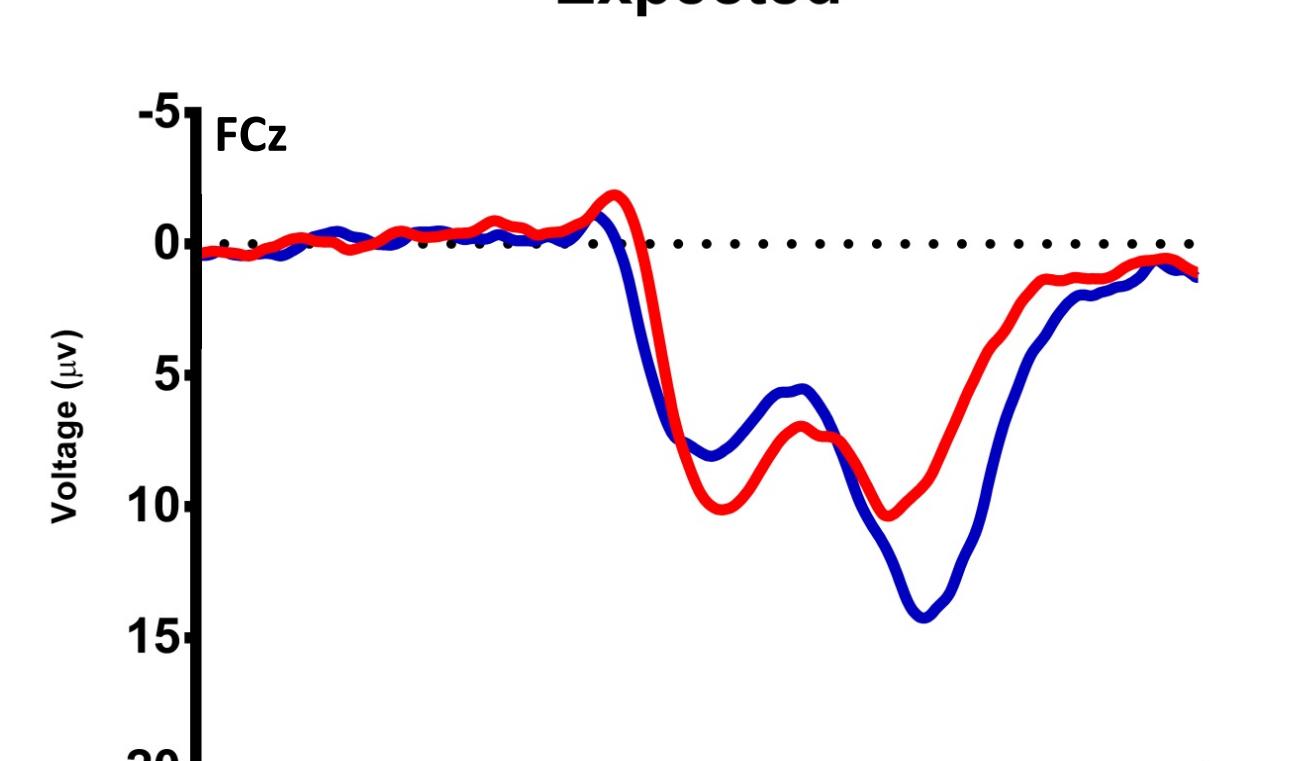
Very unexpected prediction errors (*e.g.* errors in the very easy condition), as well as unexpected, control, expected, and very expected prediction errors were analyzed

## RESULTS

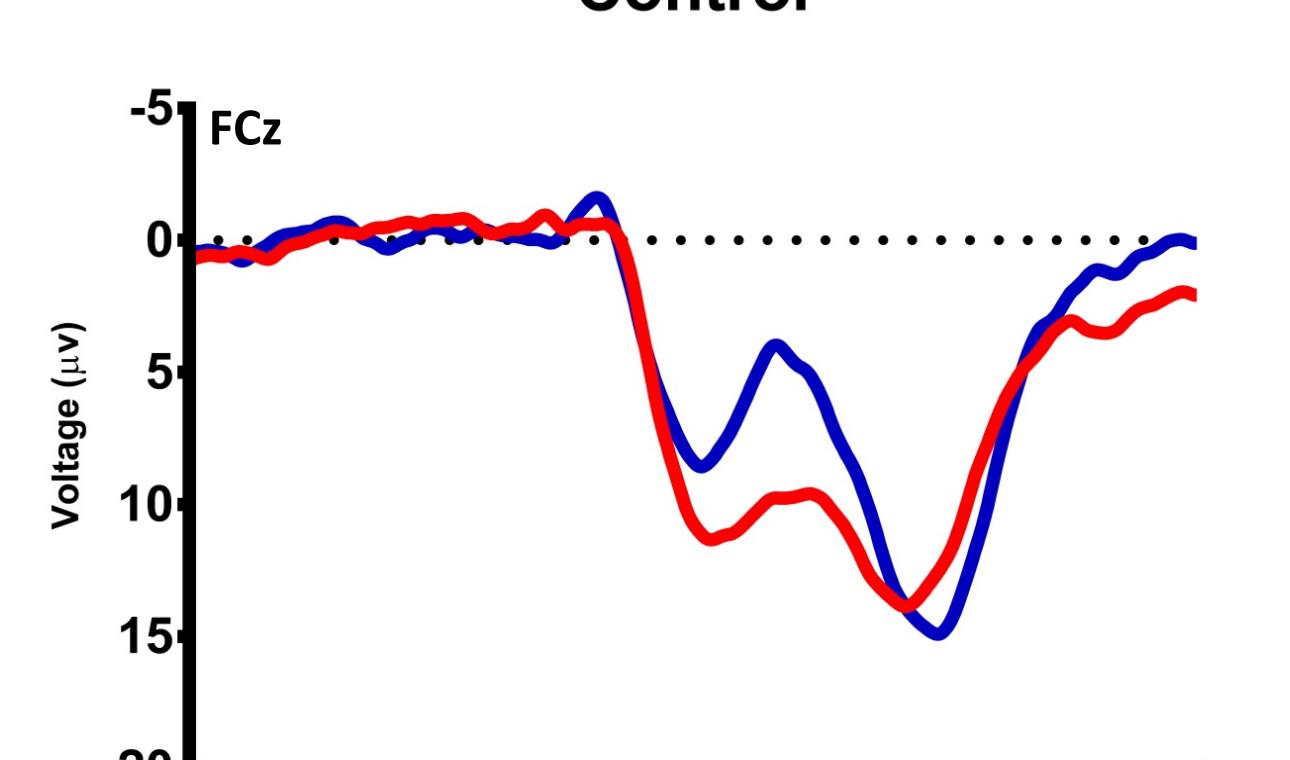
Very Expected



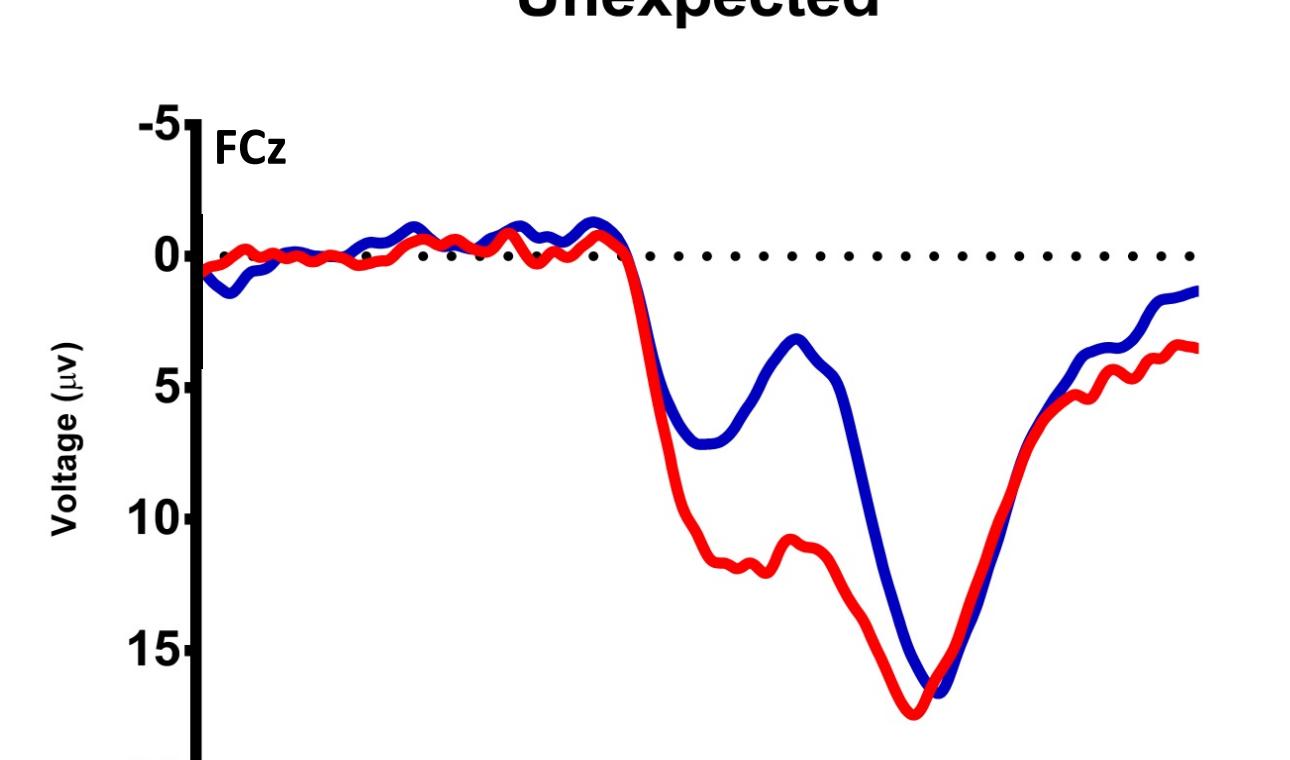
Expected



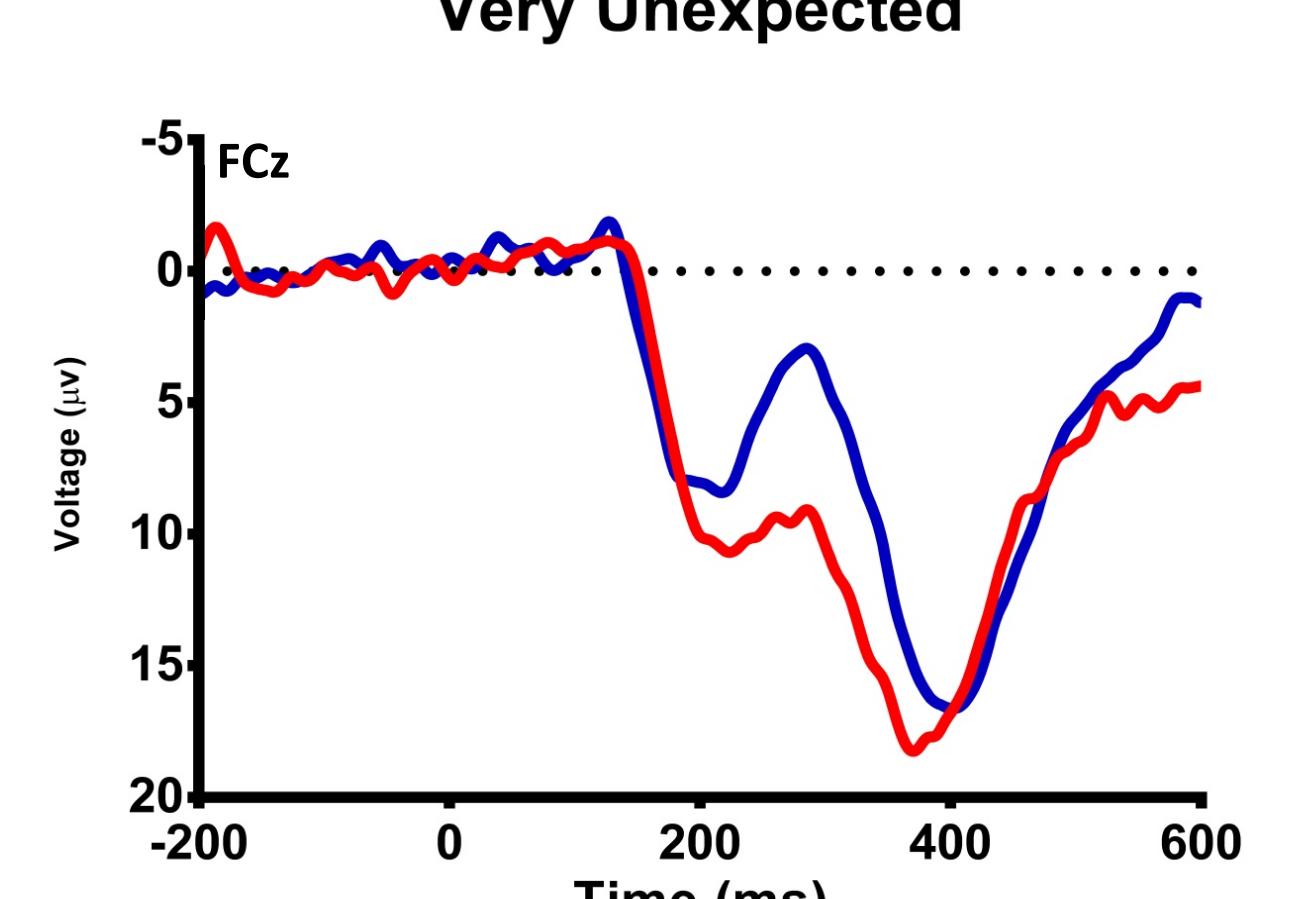
Control



Unexpected



Very Unexpected



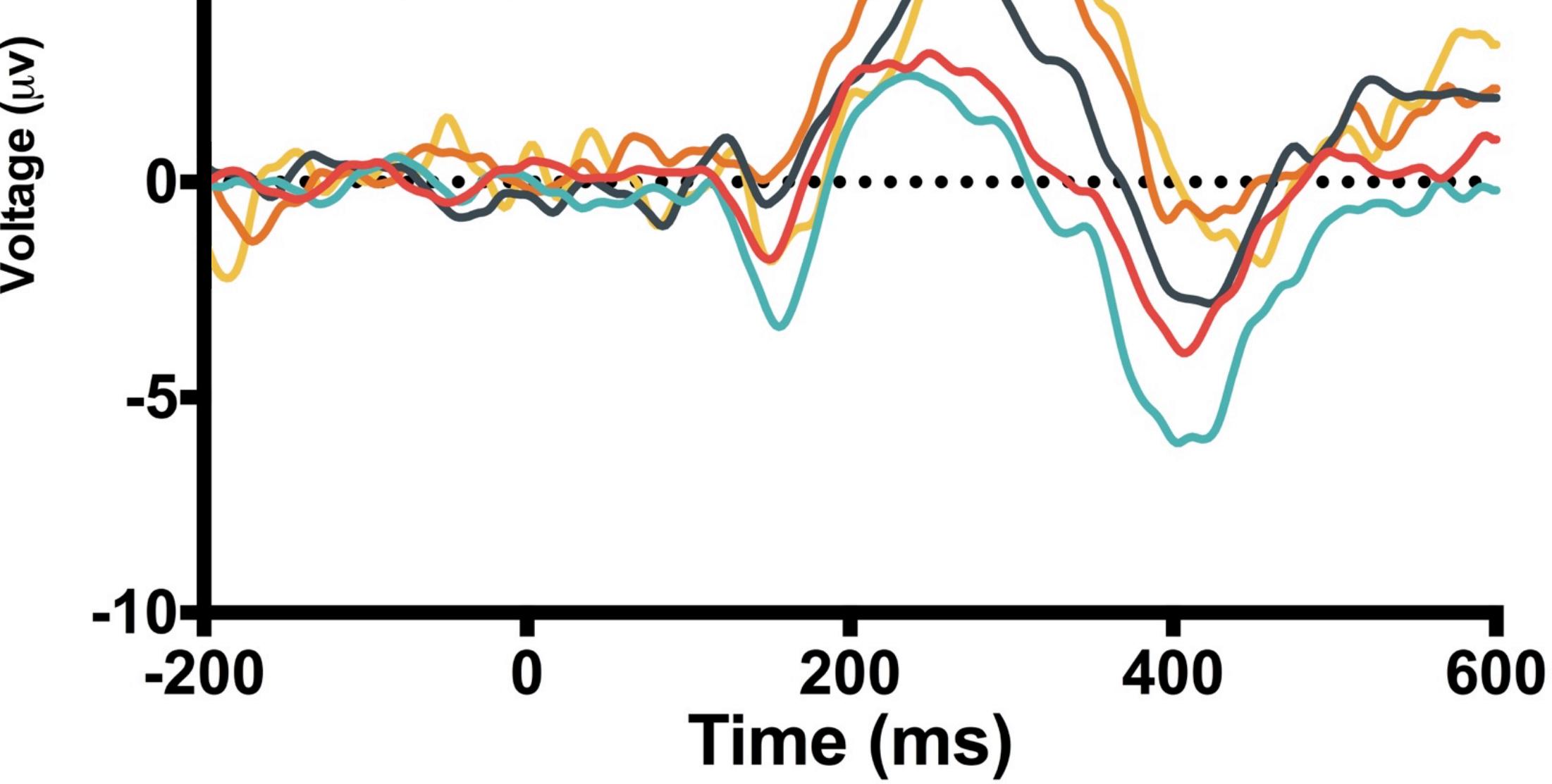
Very Unexpected

Unexpected

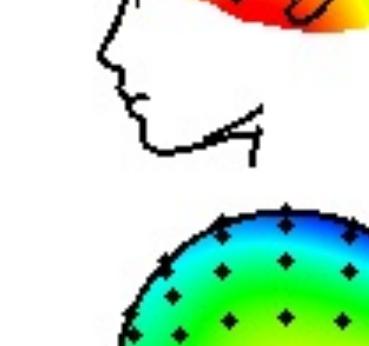
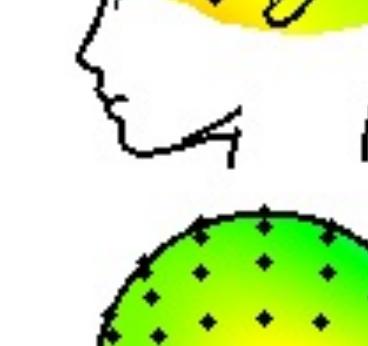
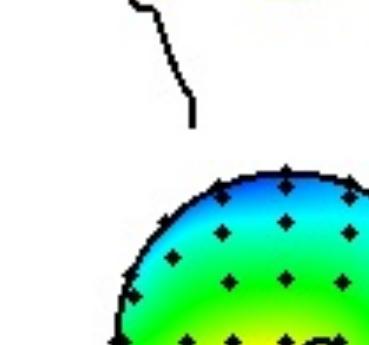
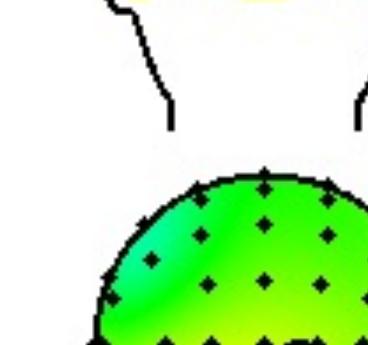
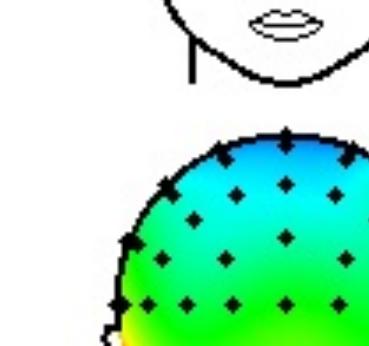
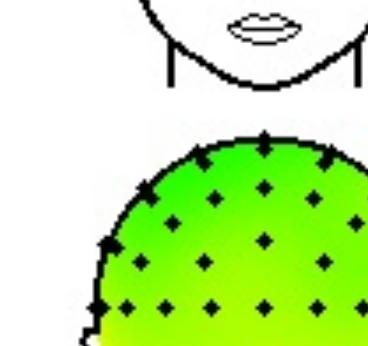
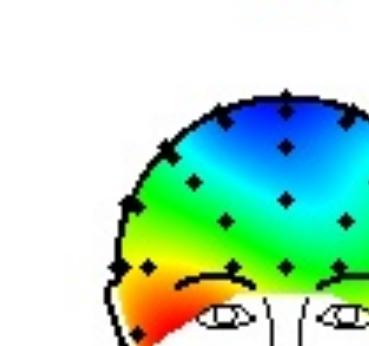
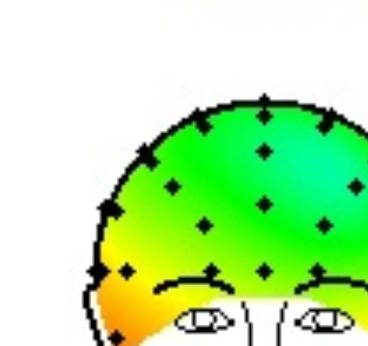
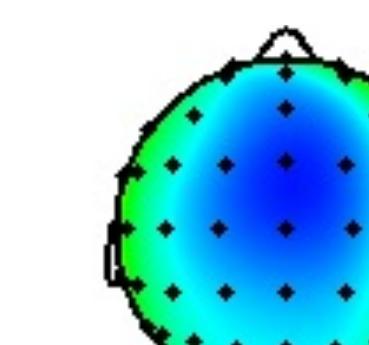
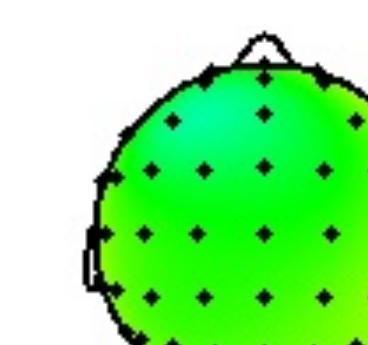
Control

Expected

Very Expected



## Difference Waves (Correct - Incorrect)



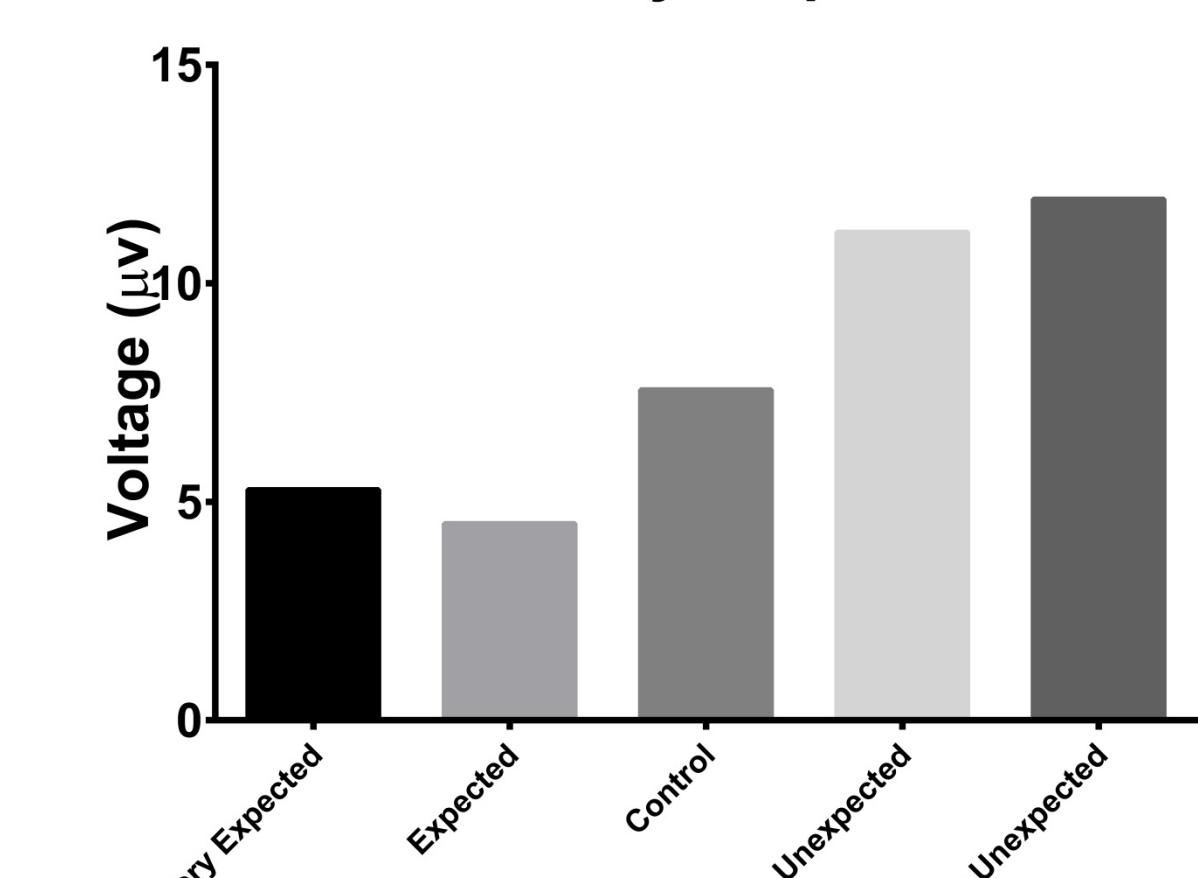
Very Expected Difference Waves

Very Unexpected Difference Waves

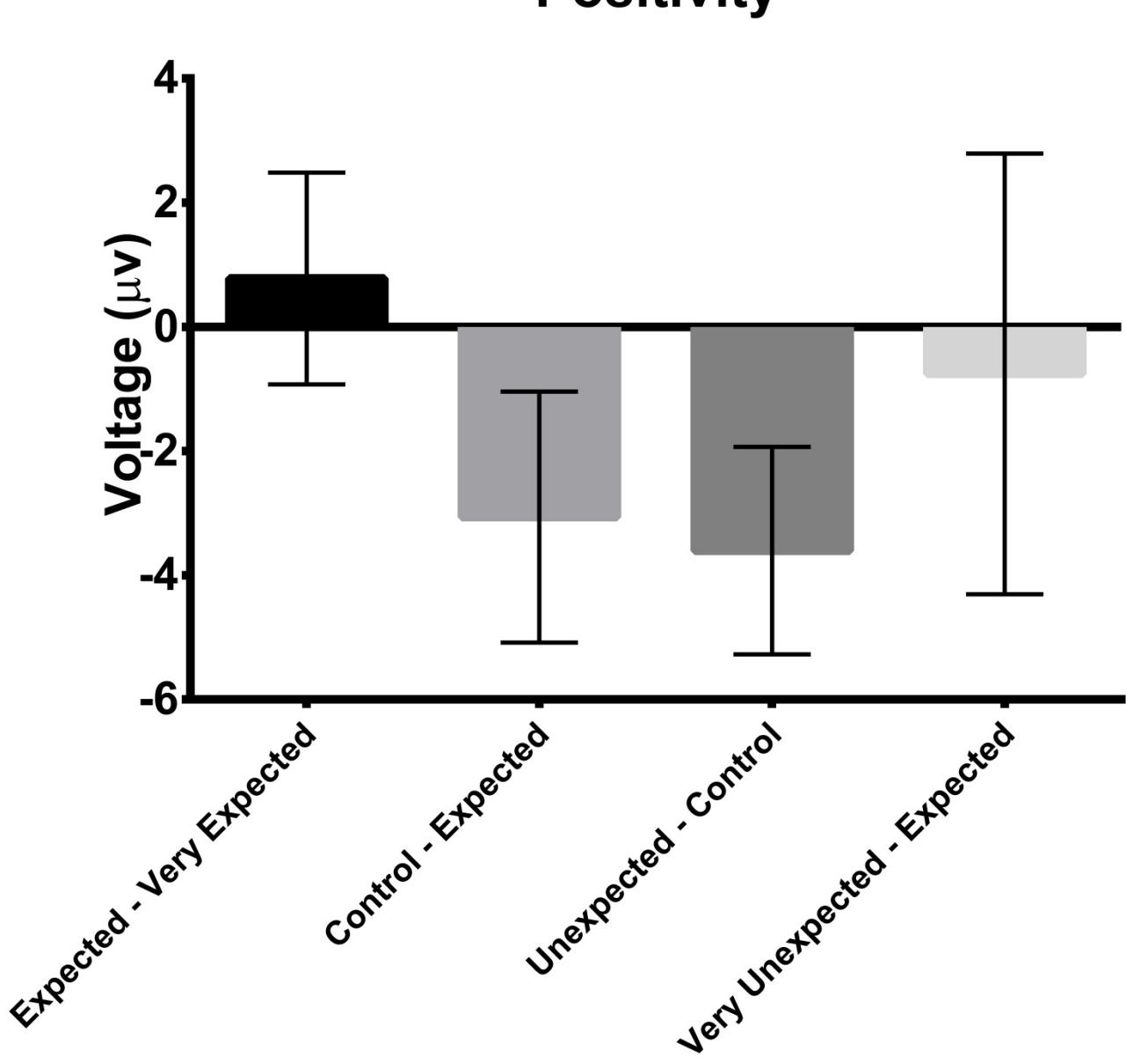
## CONCLUSIONS

As reinforcement learning theory would predict, the reward positivity amplitude increased linearly between the easy, control, and hard conditions. The same effect was seen 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 sigmoid relationship between reward expectancy and reward positivity amplitude.

Reward Expectancy and the Reward Positivity Amplitude



Confidence Intervals of Reward Expectancy and the Reward Positivity



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