# INDIVIDUAL DIFFERENCES IN LEARNING RATE ARE REFLECTED IN INTEGRATION OF FEEDBACK MAGNITUDE INFORMATION

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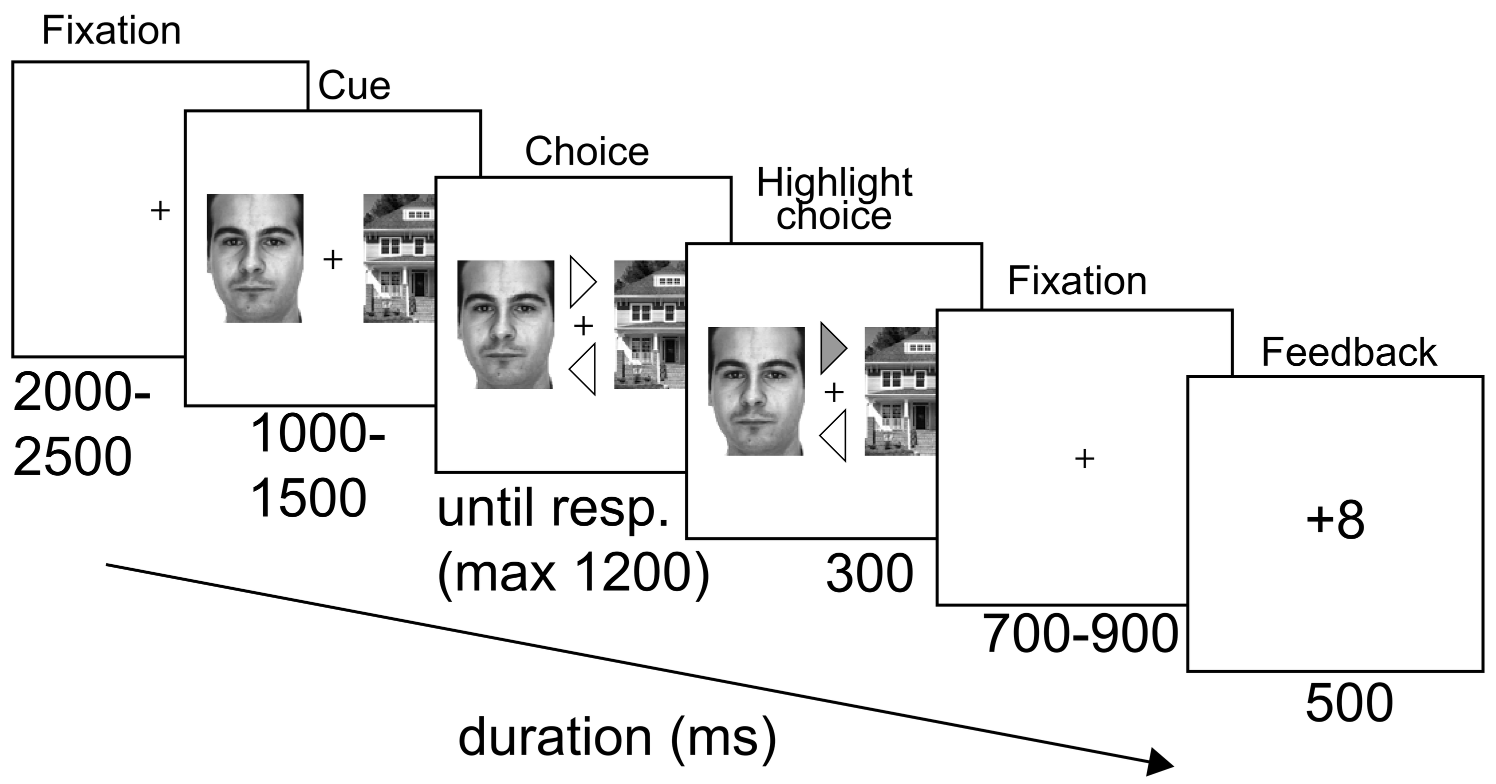
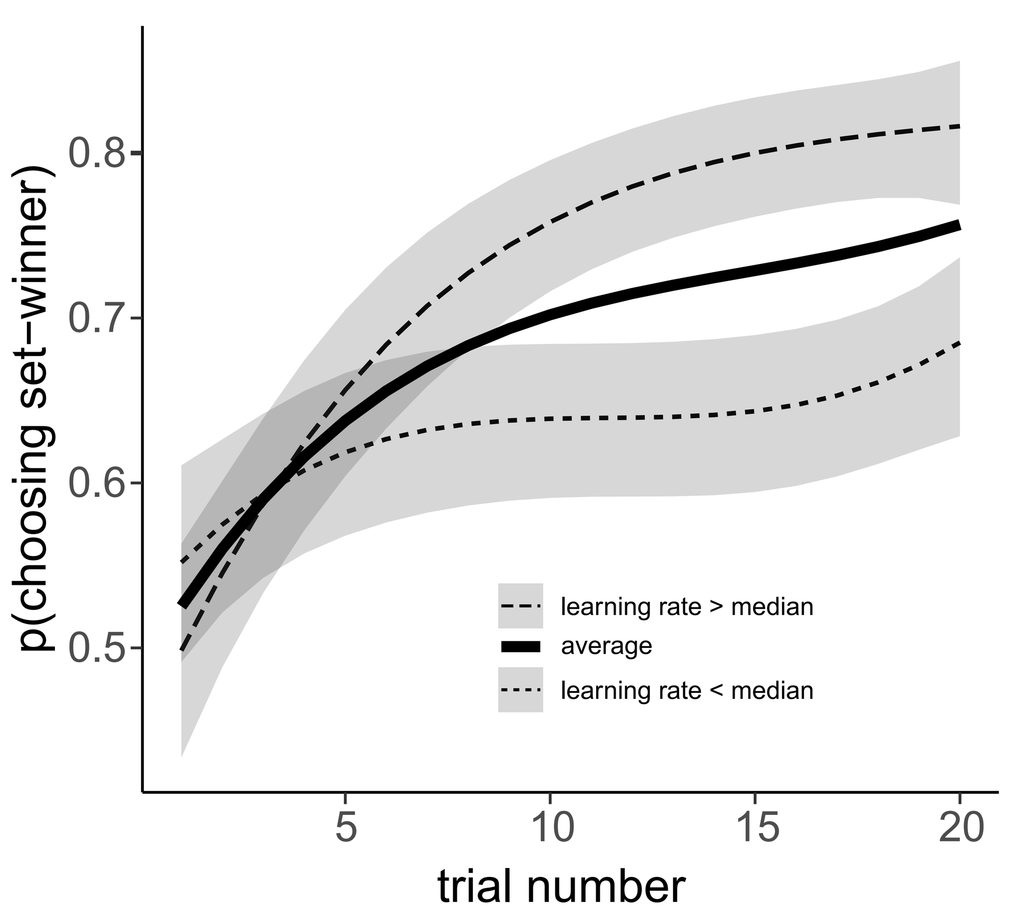
## HOW DO WE USE FEEDBACK?

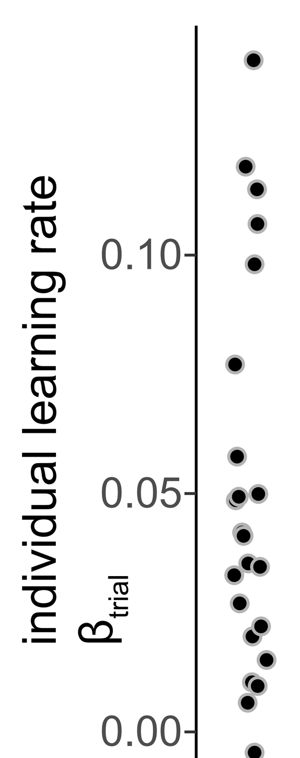
*The ability to use and integrate feedback information over time is key to our ability to learn and make decisions. Although it is fairly well established how the brain processes outcomes on a single trial, it is less well studied how these processes depend on encountered information on previous trials.*




*Here, participants chose on each trial either a face or a house, which was followed by receiving numerical feedback: neutral (**0**), or a gain (**+**), or a loss (**-**) with **different magnitudes (0:8)***

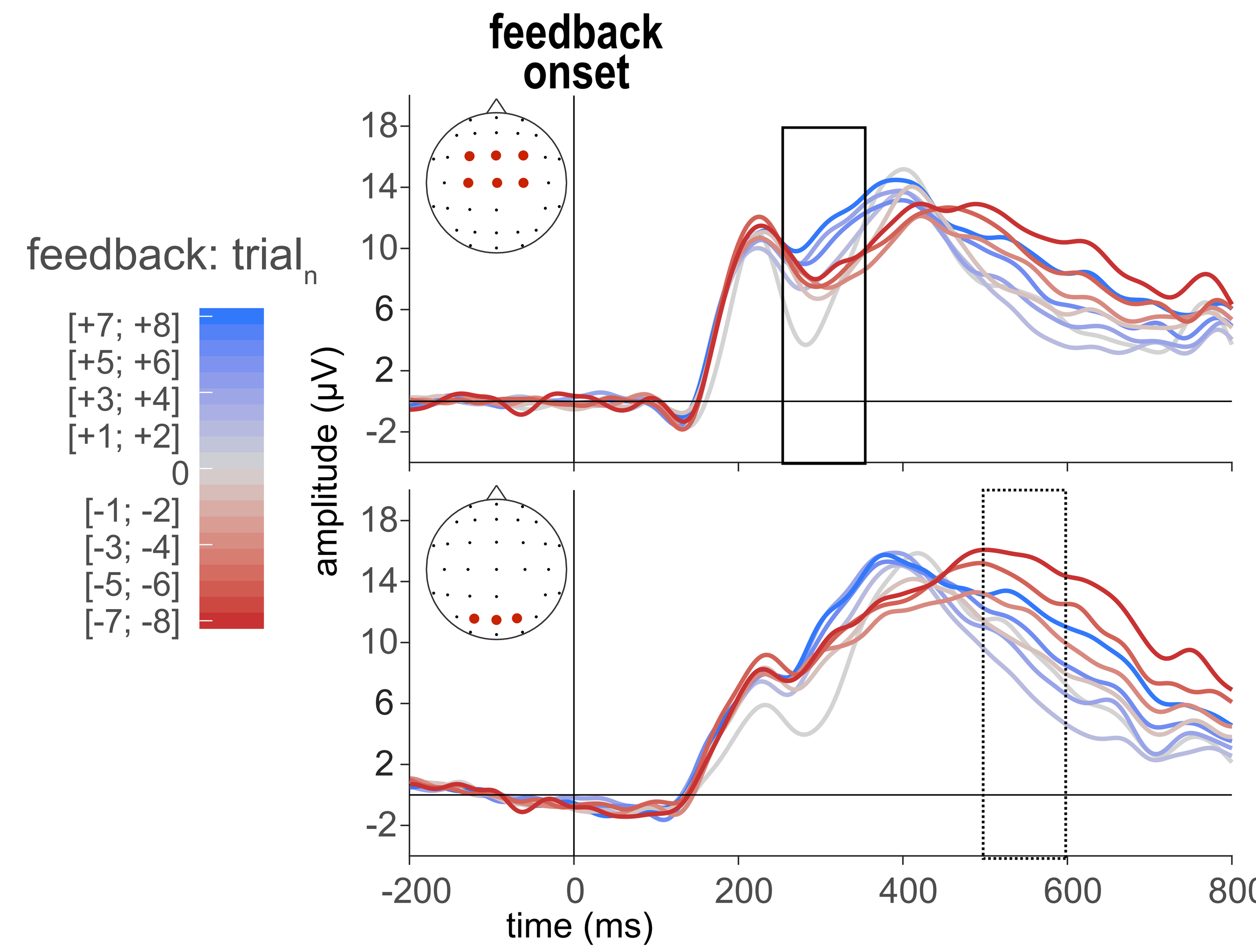
*On each set of 20 trials, either the face or house was the set-winner and was more likely to yield net gains.*



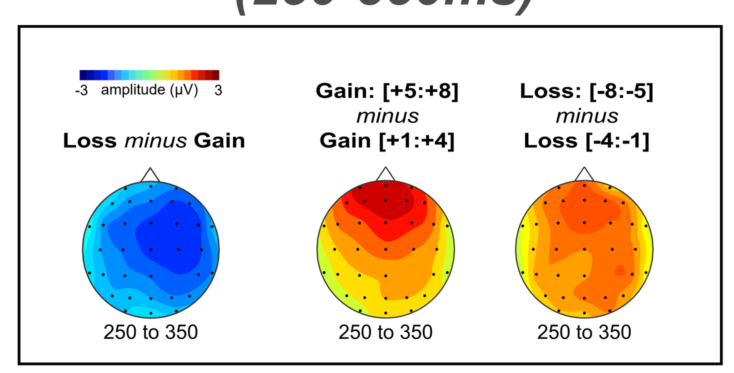




Participants learned over the course of 20 trials to choose the stimulus that yielded higher net gains. There was substantial variability in how well participants were able to do so.

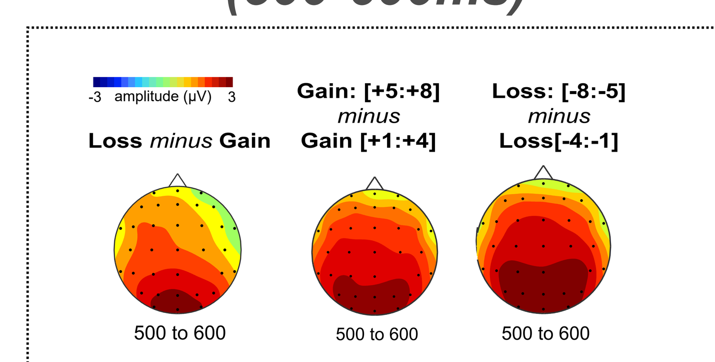
## PROCESSING OF CURRENT FEEDBACK




### *Early processing (250-350ms)*



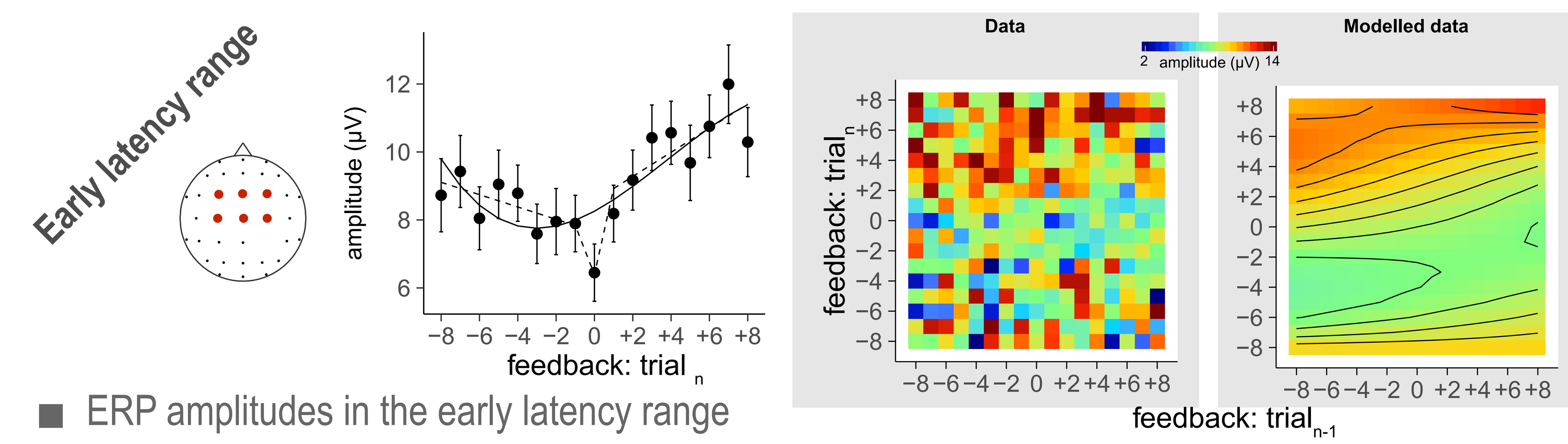

### *Late processing (500-600ms)*



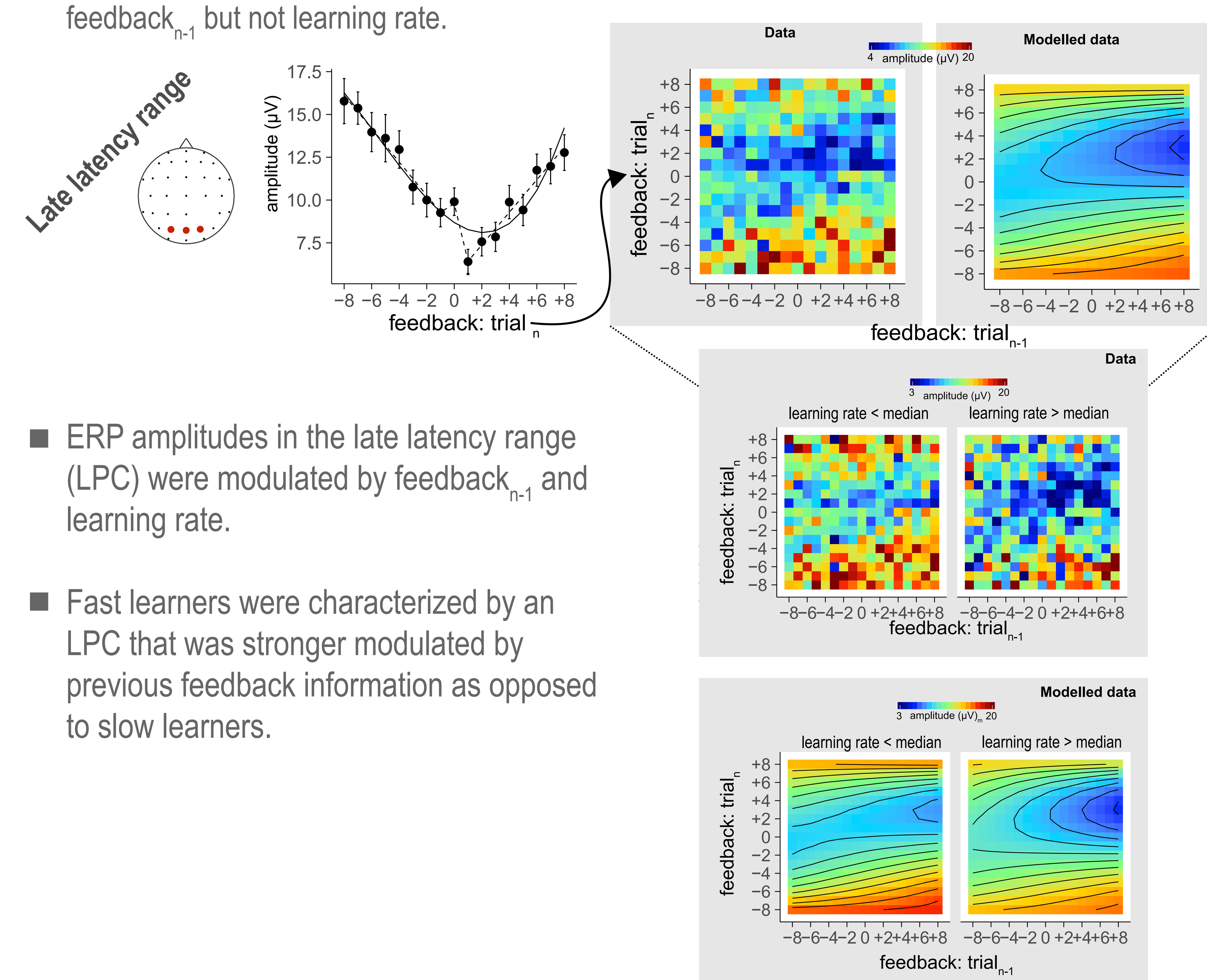

- Valence showed a classical negative polarity feedback-related negativity (FRN).
- For magnitude, we found a frontal positive deflection for large (vs small) feedback.
- Magnitude and valence modulated amplitudes in the later latency range (Late Positive Complex [LPC]).
- These modulations had similiar scalp topographies, suggesting a similiar neuro-cognitive process.

## INTEGRATION OF FEEDBACK

### *ACROSS TRIALS*




- ERP amplitudes in the early latency range (FRN) were slightly modulated by feedback$_{n-1}$ but not learning rate.




- ERP amplitudes in the late latency range (LPC) were modulated by feedback$_{n-1}$ and learning rate.
- Fast learners were characterized by an LPC that was stronger modulated by previous feedback information as opposed to slow learners.

## Summary

***Early (250-350ms)***

Processes were modulated by the magnitude and valence on the current trial.

In this latency range there was minimal influence of the feedback of the previous trial, suggesting a feedback ***registration*** mechanism, that is not modulated by prior information (i.e. expectation).

***Late (500-600ms)***

Processes were modulated by both current trial feedback contents, and also by the feedback on the previous trial.

This integration of feedback outcomes was even further modulated by the individual participants' learning rate. As such, the processes that are marked by the LPC subserve a dynamic ***updating*** role.

In sum, this study unpacks the neural and cogntive processes by which the brain dynamically integrates feedback information over multiple trials to guide decision making in an uncertain world.



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