Using multivariate analyses of electrophysiological data to disentangle preparatory mechanisms

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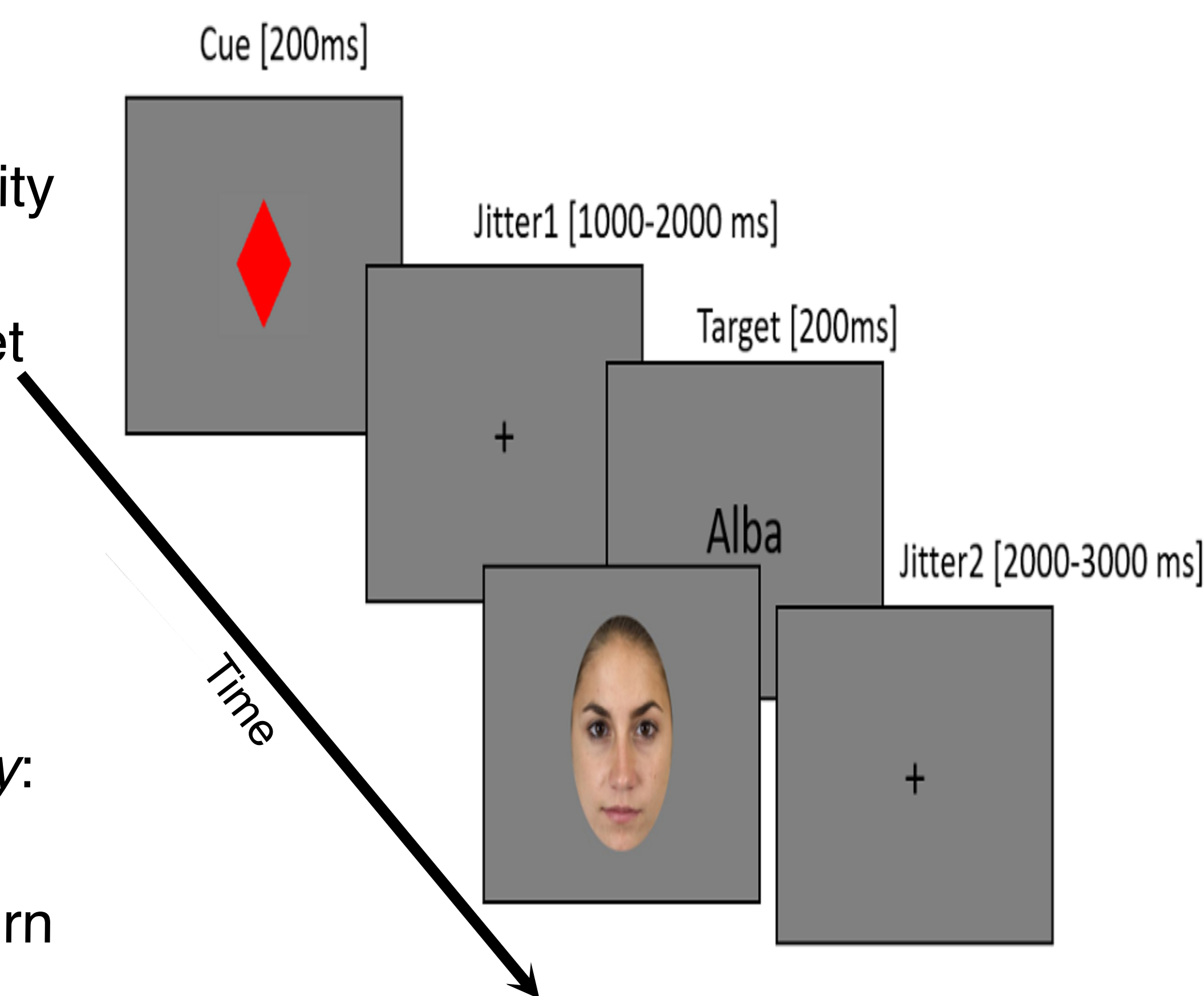
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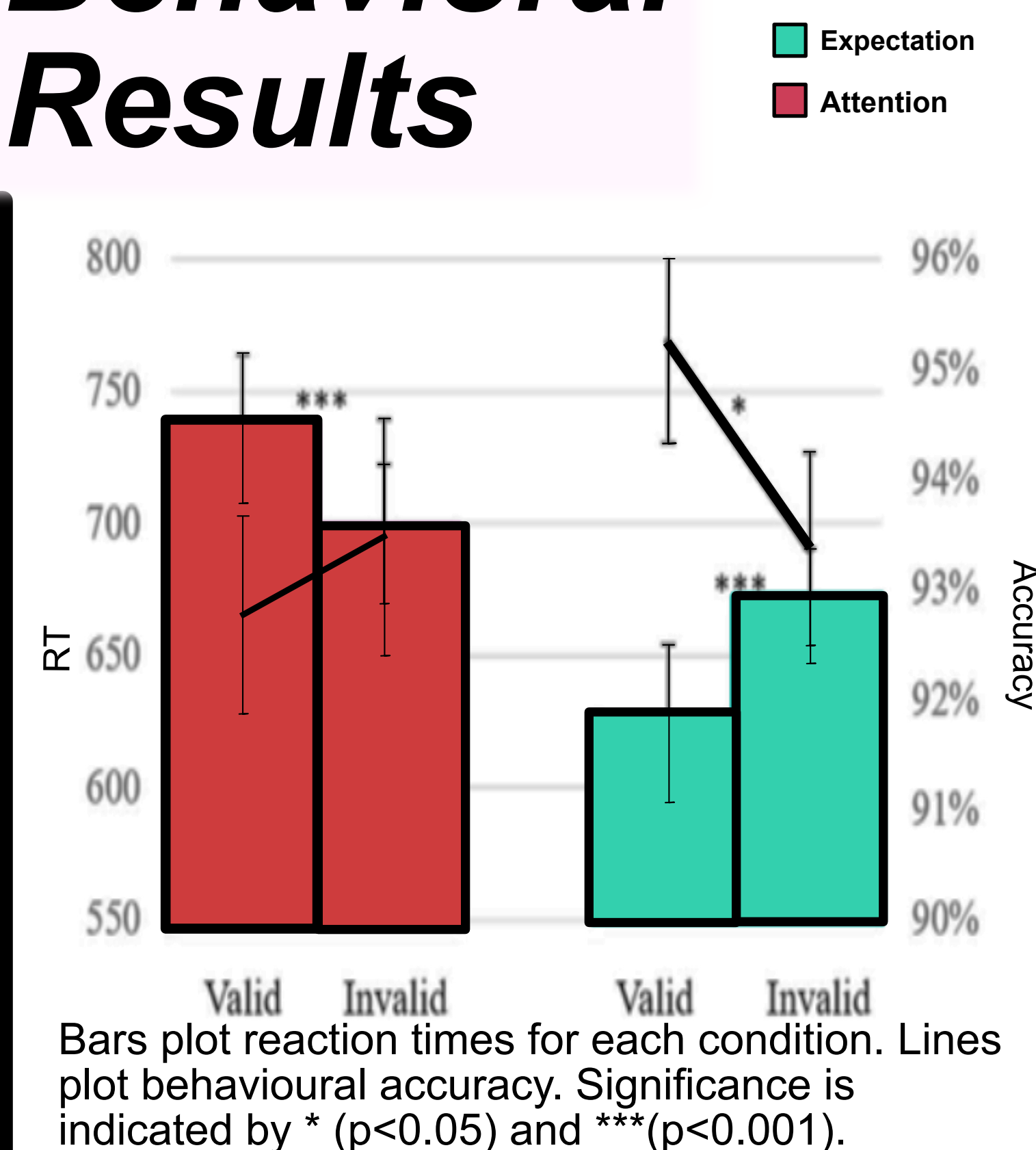
Introduction

- **Preparation** is an endogenous brain function that occurs during the anticipation of a stimulus and **improves** performance.

- **Neuroimaging** techniques have provided evidence of preparatory activity in different **cognitive domains**.

- Two of the most relevant processes in the field are content-based selective **attention** (*relevance*) and perceptual **expectation** (*probability*), but their underlying mechanisms remain unclear.

- We sought to **compare** preparation in both domains using **multivariate analyses of electrophysiological data**.

Methods

- **Participants**: 32 students from the University of Granada.

- **Task**: Gender discrimination on a cue-target paradigm.

- **DV**: Electroencephalography was recorded from 64 electrodes, together with Reaction Times (RT) and errors during task performance.

- **IV**: *Block*: Attention vs. Expectation || *Validity*: Valid vs. Invalid || *Target*: Names vs. Faces.

- **Analyses**: Time-resolved Multivariate Pattern Analysis (**MVPA/decoding**) on EEG data.

Cue [200ms] · Jitter1 [1000-2000 ms] · Target [200ms] · Alba · Jitter2 [2000-3000 ms] · Time

Behavioral Results

Bars plot reaction times for each condition. Lines plot behavioural accuracy. Significance is indicated by * (p<0.05) and ***(p<0.001).

Decoding

We trained a **classifier** algorithm to tell appart EEG data obtained during the presentation of the **cue**, and associated with **preparation** for either **names or faces**, separately for attention and expectation blocks

Classifier performance (auc)
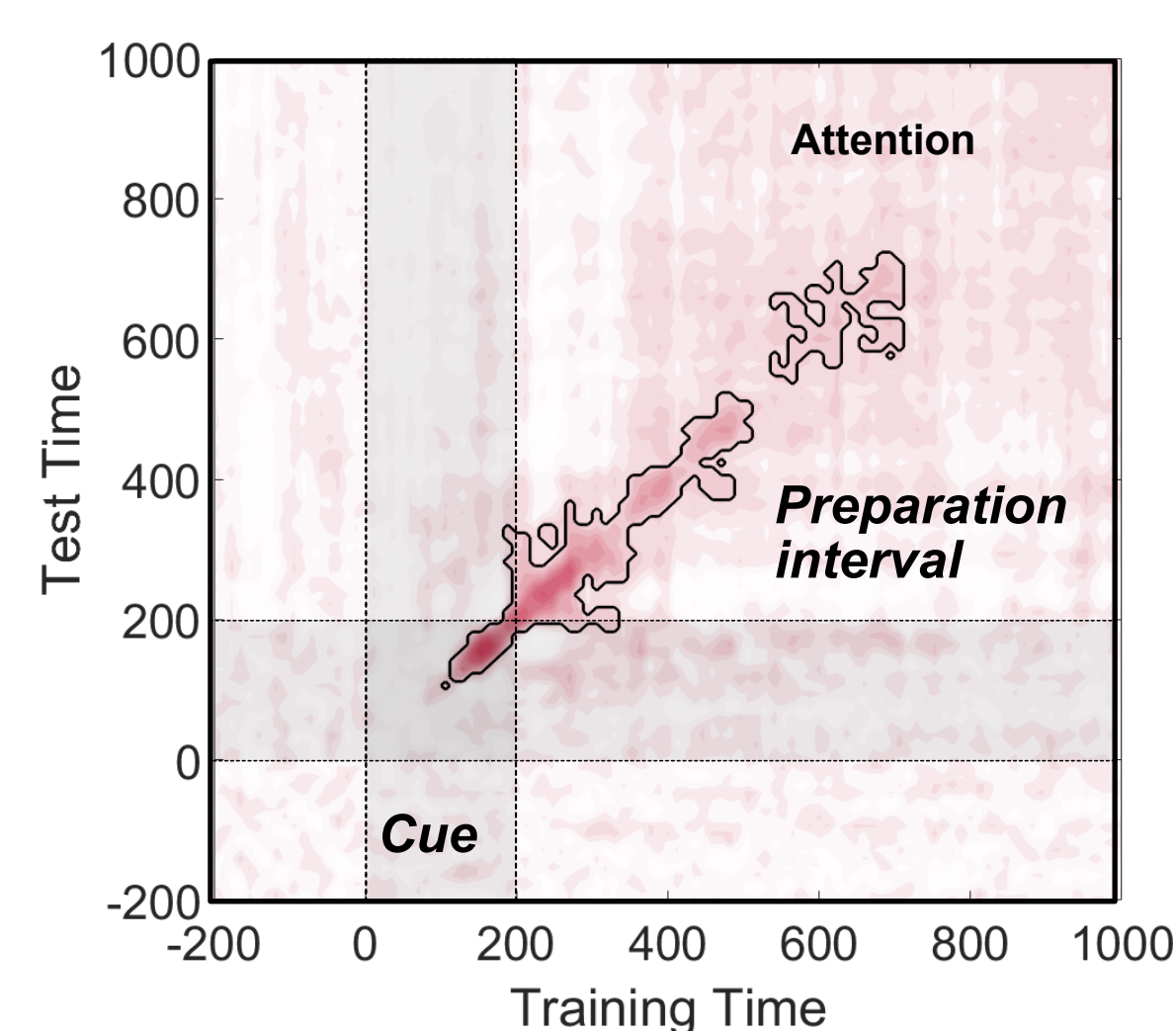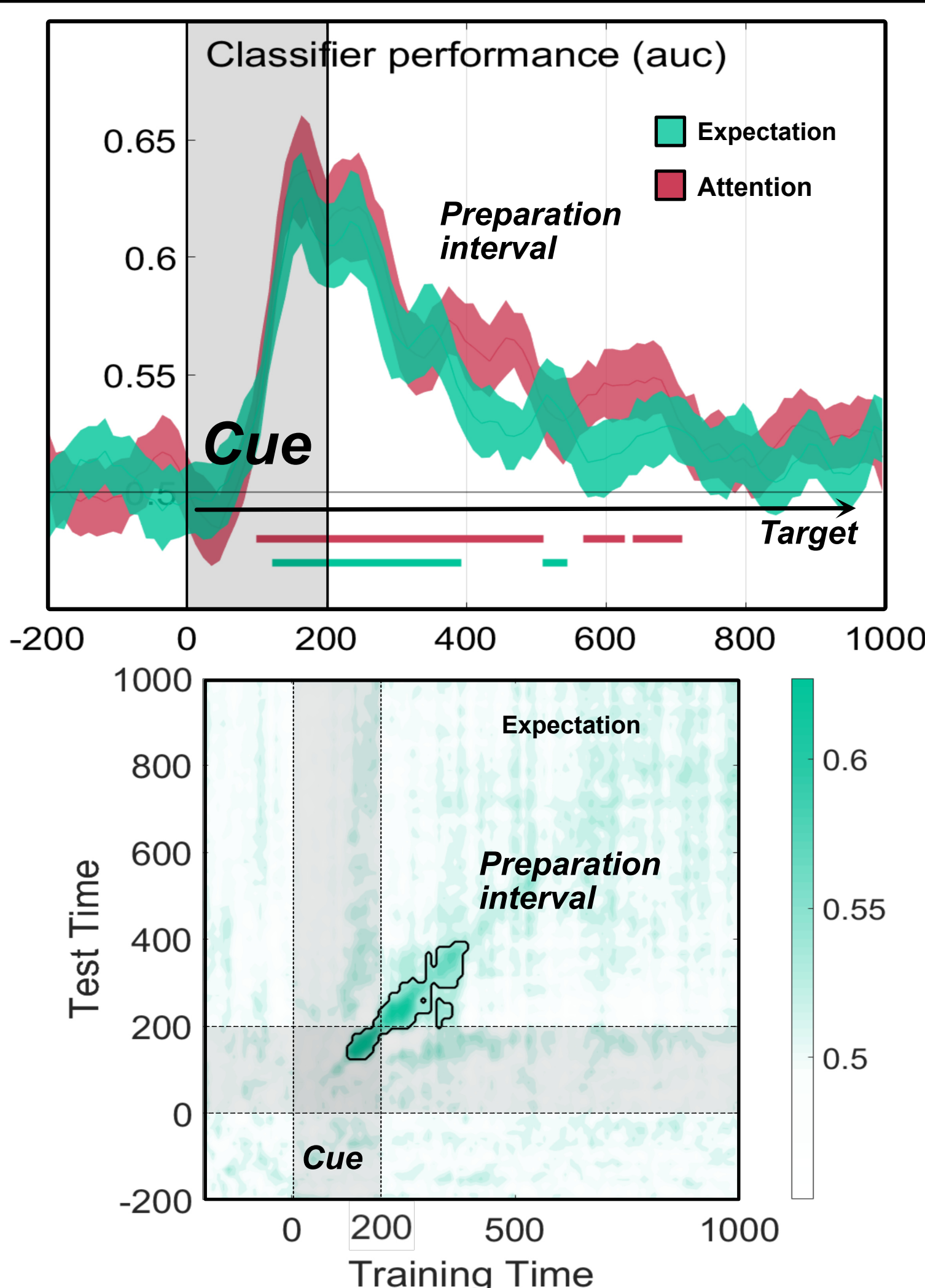
Temporal generalization analyses: The classifier was trained with data from one time point, and then tested on every other time point. Then, we repeated this for each data point.

Cross-decoding

For Multivariate **Cross-decoding**, we **trained** the classifier with **preparation** data from one block, and **tested** it on the other.

Results stay at **chance level**, pointing to the existence of **different** mechanisms for the **anticipaton** of relevance and probability of stimuli

Classifier performance (auc)
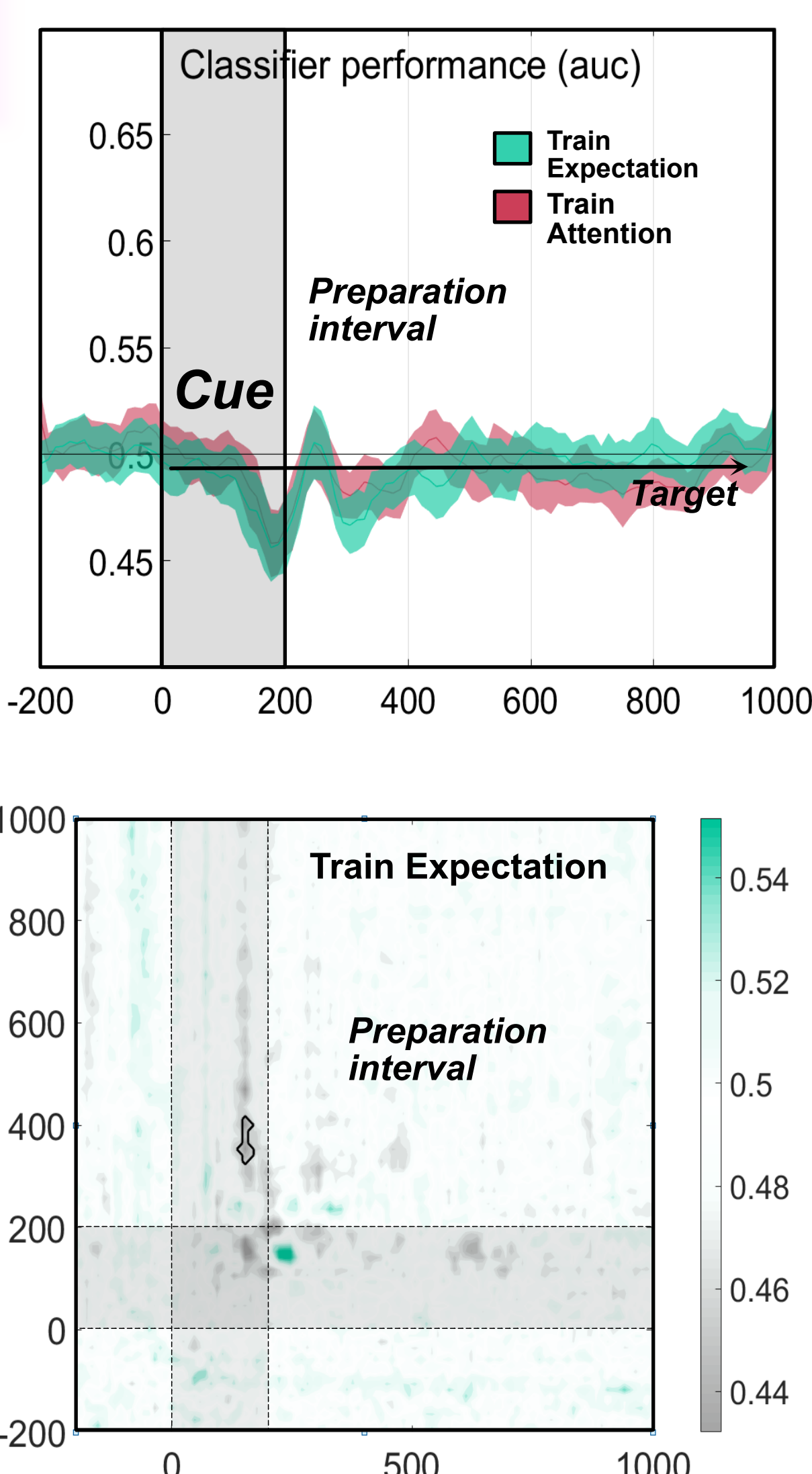
Temporal generalization matrices also point to the **absence of similar mechanisms** involved in both conditions. However, when training on expectation there is a small **significant cluster** of **underchance** classification in the expectation condition, which could be due to similar mechanisms operating at **different rhythms** on each block.

Decoding-Behaviour Correlations

We found the time point where classification accuracy was **higher** for both conditions (170ms).

Then we **correlated** the **decoding** results for each participant with their **behavioral** results.

Reaction times **negatively correlated** with decoding accuracy, suggesting that the fidelity with which content-related information is maintained during **preparation** has an effect on its **facilitatory effects** on behavior.
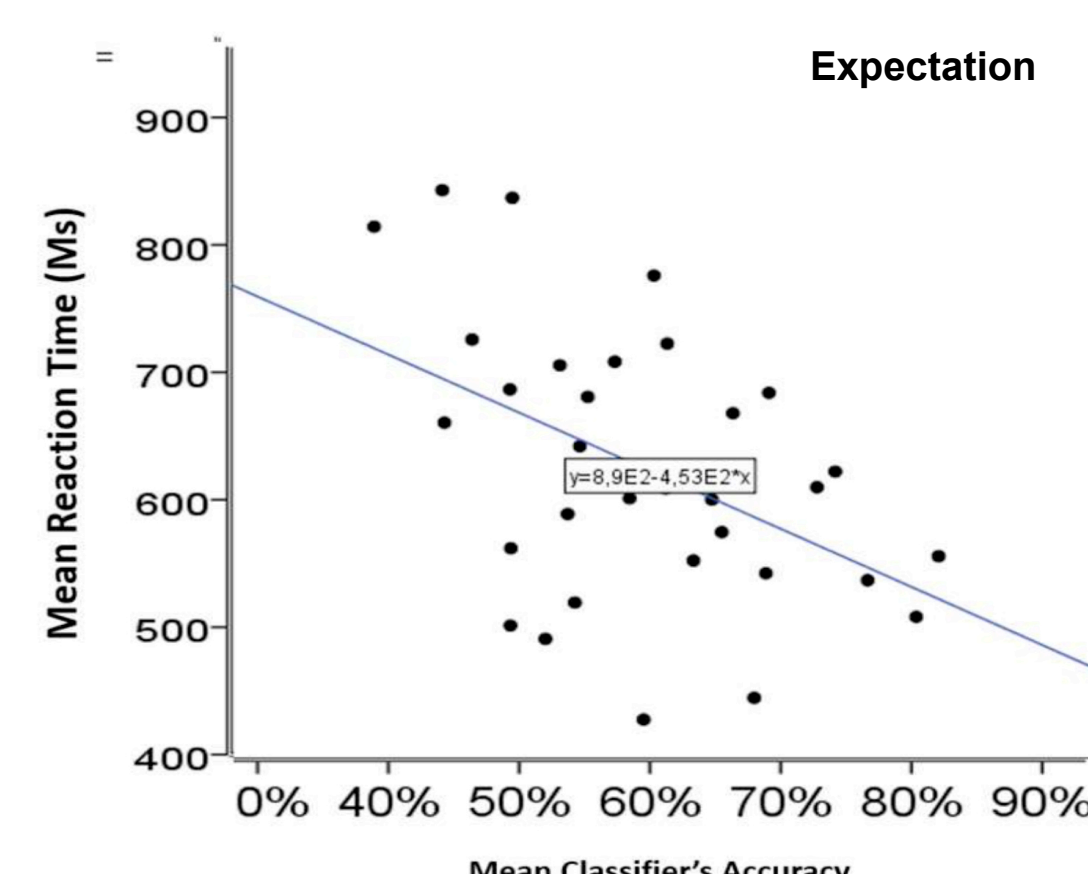
Conclusions

- Activity induced by cues, **prior** to target onset, **carries information** about the category of the relevant or expected incoming stimulus.

- The fidelity of this activity **correlates** with response efficiency, stressing its **relevance for behavior.**

- Cross-classification analyses across relevance and probability suggested that their representational format **differ.**

- This results show that **attention** and **expectation** likely rely on **different computational mechanisms**, and extend this dissociation to their **anticipatory** basis.

Bibliography

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