

Contextual constraint and key membership influence neural correlates of melodic prediction violations

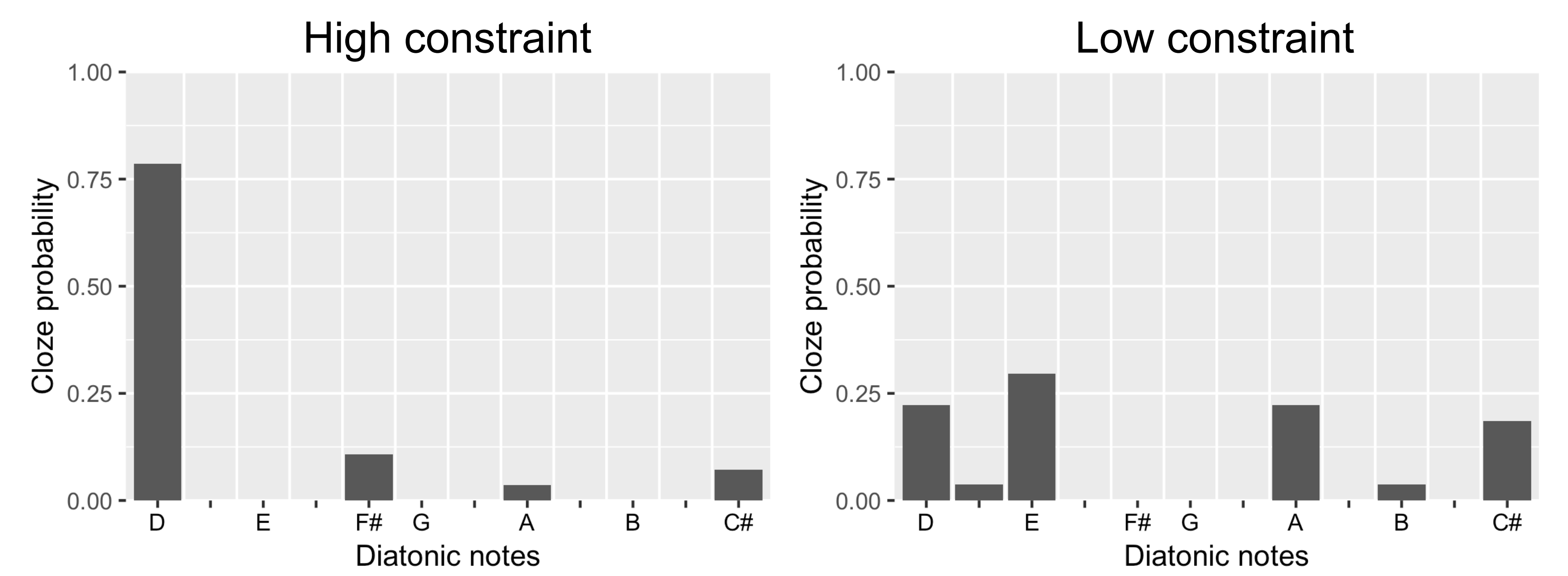
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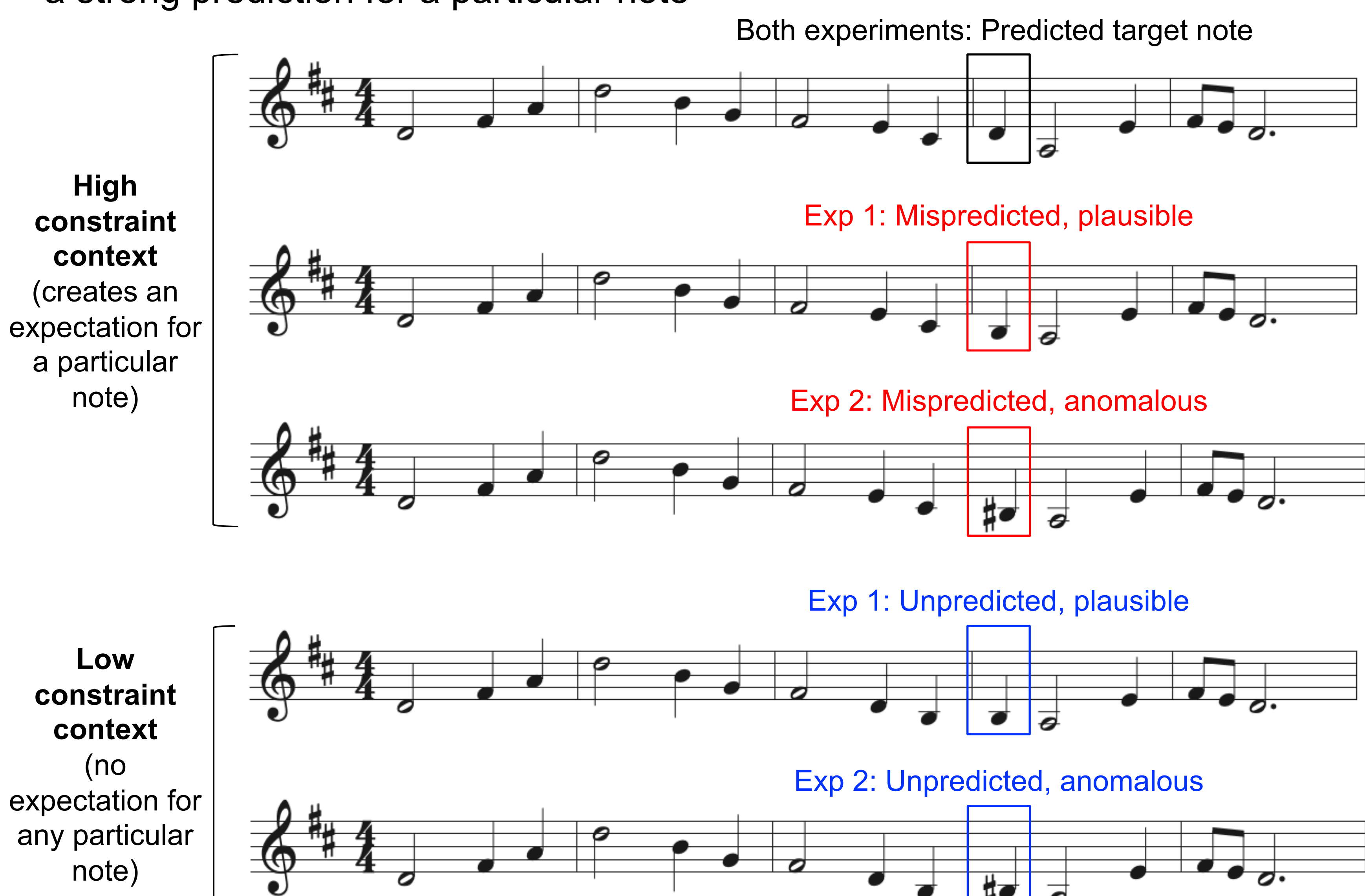
Introduction

- Melodic expectation has been extensively studied using behavioral and neural (ERP) methods.
- In current ERP studies of language, predictions are often examined by manipulating sentence contexts.
- In contrast, neural studies of melodic prediction violations have mainly used incongruent events (e.g., out-of-key notes) in fixed melodic contexts.
- We have developed a new approach based on manipulating melodic context in terms of the degree to which it constrains expectations for one particular note.¹
- Using this method to study ERP responses to unexpected notes, we can disentangle the effect of a note being low probability (unexpected) from the effect of it also violating a strong expectation for another specific note.
 - When a context leads to an expectation for one particular note, a different note can violate this prediction while still being in-key and congruous.

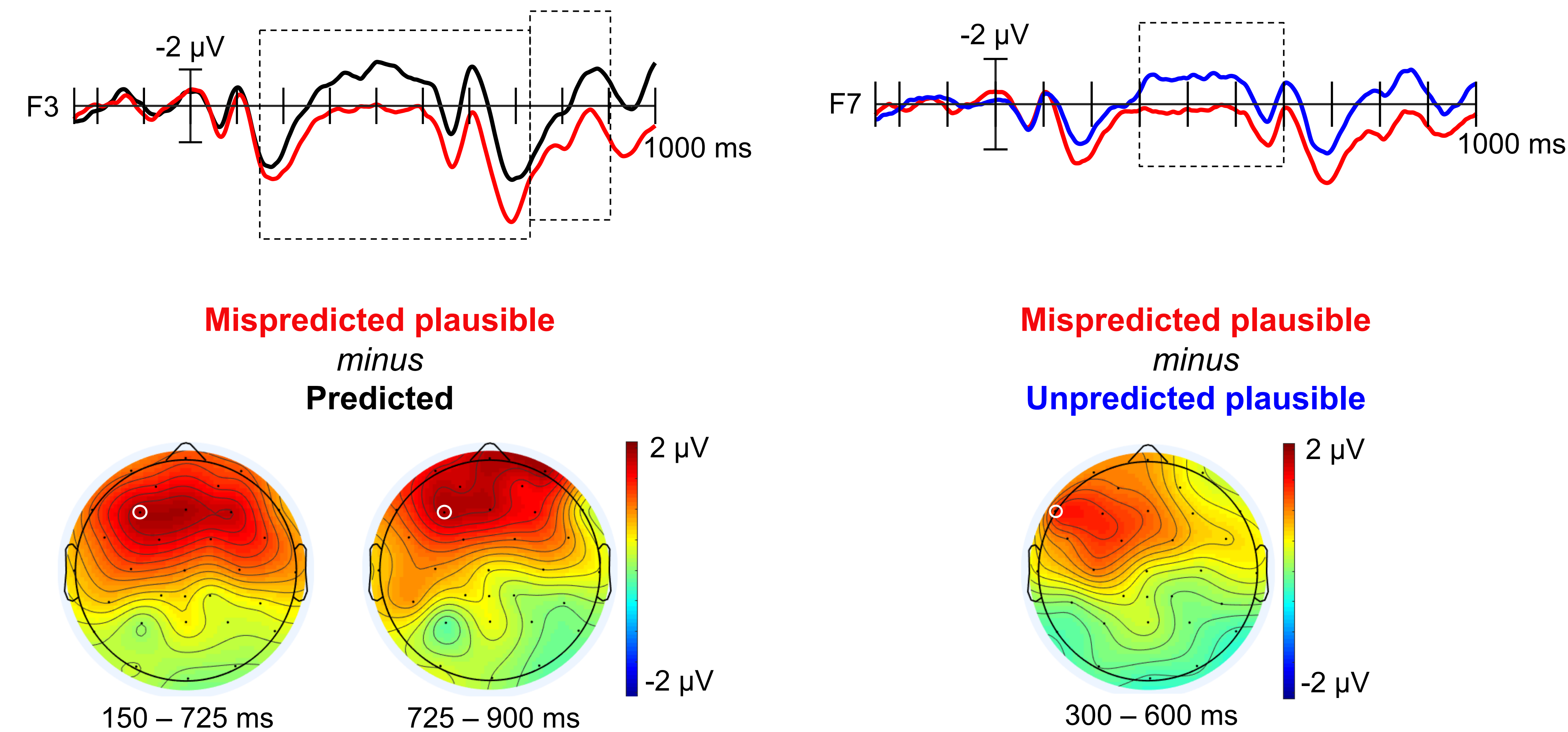


Methods

- Participants: at least 5 years of musical experience within the past 10 years
- Task: listen attentively and answer occasional memory probes
 - No acceptability judgments
- Stimuli: 60 pairs of 10-15 note novel melodies that either did or did not lead to a strong prediction for a particular note

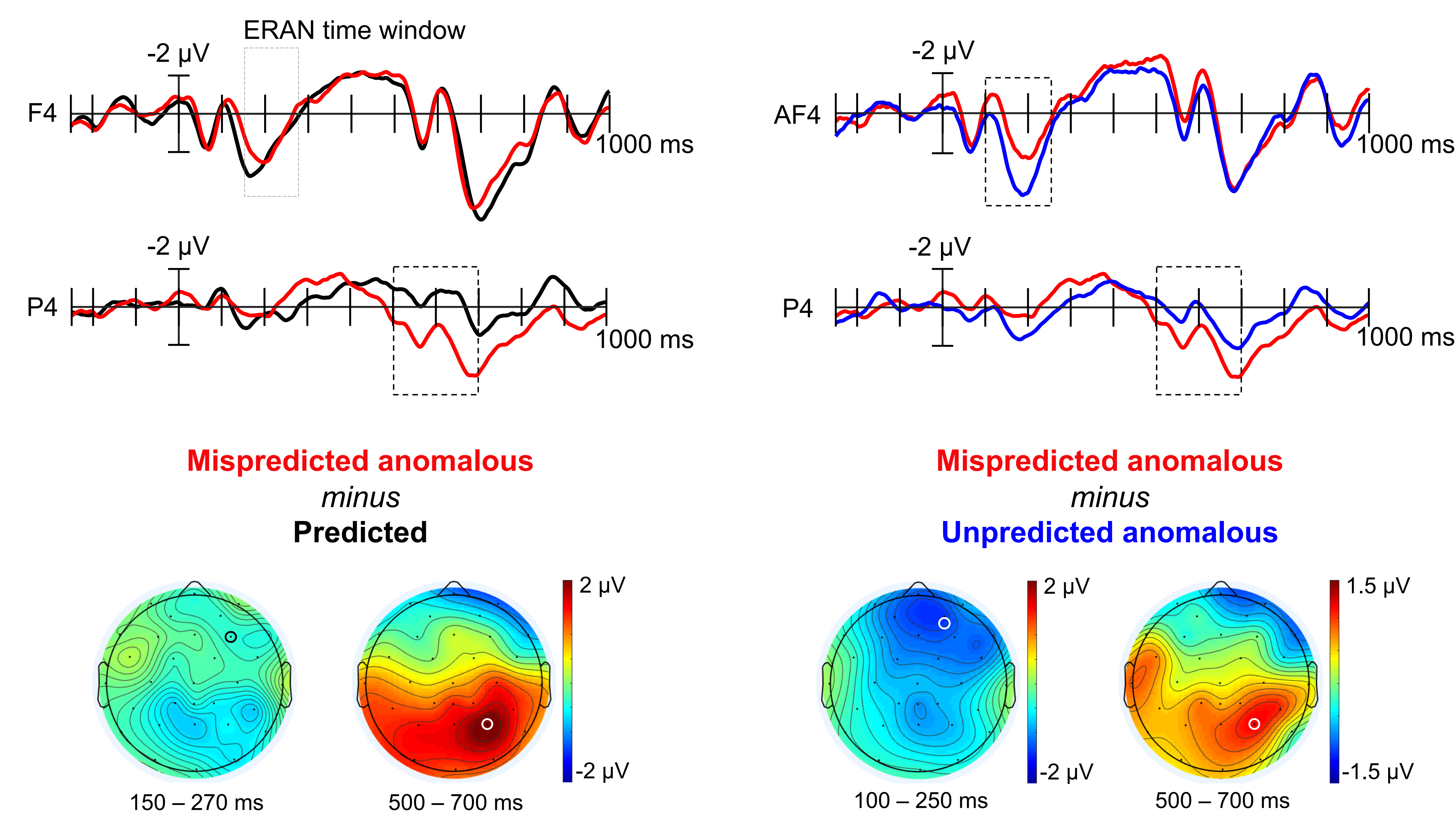


Experiment 1: in-key target notes



- In constraining melodies, **unexpected notes** elicit a bilateral frontal positivity relative to **expected notes**
- No sign of the early anterior *negativity* (150-300 ms) often associated with musical expectancy violations²
- Observed a previously reported early anterior positivity: 280-600 ms³
- Unexpected notes in constraining melodies** elicit a left-lateralized anterior positivity compared to **unexpected notes in non-constraining melodies**
 - Significant in time window of late anterior positivity in language studies (600-900 ms)^{4,5}
 - Begins earlier (significant at 300-600 ms)

Experiment 2: out-of-key target notes



- Out-of-key notes** vs. **expected notes** in constraining melodies elicit:
 - No significant early effects (i.e., no ERAN)
 - Late posterior positivity (P600)
- Out-of-key notes in constraining melodies** vs. **out-of-key notes in non-constraining melodies**:
 - More negative early frontal ERPs⁶
 - Late posterior positivity (P600) resembles same contrast in language⁴

Conclusion

- In **Experiment 1**, in-key target notes that violated a strong prediction (i.e., unexpected notes in a constraining melody) elicited a late anterior positivity compared to the same unexpected target notes in non-constraining melodies.
 - This result differs notably from the early right anterior negativity that has previously been associated with musical expectancy violations.²
- In **Experiment 2**, out-of-key target notes elicited a late posterior positivity (P600) compared to expected notes in constraining melodies.
 - Again, no early anterior negativity was observed.
- Across these experiments, we found brain responses to unexpected notes that differ from the responses reported by many music studies.
- However, these results bear a striking resemblance to the neural responses found in language studies using comparable manipulations of word expectedness and sentential constraint.

References

- Fogel et al., 2015 *Frontiers in Psychology*
- Miranda & Ullman, 2007
- Pearce et al., 2010
- Kuperberg et al., 2019
- Federmeier et al. 2007
- Hsu. et al., 2015

Audio examples: bit.ly/Fogel-CNS