# Neural correlates of melodic prediction violations: similarities to language processing

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## Introduction

- The concept of "prediction" is frequently evoked in studies of both music and language processing
- It has been suggested that predictive mechanisms may be shared between the two domains[1]
- However, very different paradigms have been used to examine the neural correlates of prediction in music and in language

- In ERP studies of language, the effects of violating certain predictions have been examined by manipulating sentence contexts
  - Predictions for a specific word occur when a context constrains strongly for a certain continuation; these predictions can be violated even when a sentence is continued with a different **plausible** word
  - These violations have been observed to elicit a late anterior positive ERP component[2,3]

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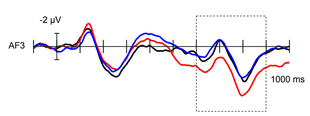
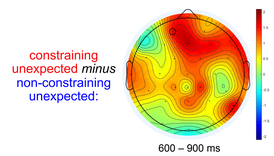
|---|---|---|---|
| **Lexically constraining contexts** mean constraint = 79% | The lifeguards received a report of sharks right near the beach. Their immediate concern was to prevent any incidents in the sea. Hence, they cautioned the… | ***swimmers*** | lexically predictable |
| | | ***trainees*** | lexically unexpected (prediction violation) |
| **Lexically non-constraining contexts** mean constraint = 26% | Eric and Grant received the news late in the day. They decided it was better to act sooner than later. Hence, they cautioned the… | ***trainees*** | lexically unexpected (no prediction violation) |




- In contrast, studies of prediction violations in music have mainly used **incongruent** events (e.g., out-of-key notes; usually eliciting an early right anterior negativity) and have not manipulated the contextual constraint of sequences[4]
- Here, we created a musical paradigm that more closely resembles those used in language studies

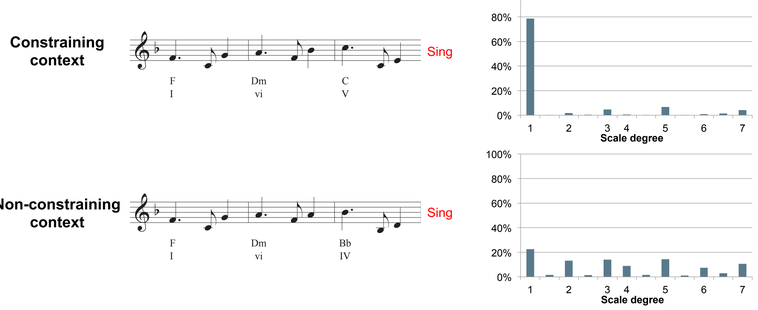
## Stimuli Development

**Melodic cloze probability task**[5]

- Listeners were presented with the openings of novel tonal melodies and asked to "sing the note you think comes next" to continue (not necessarily complete) the melody
- Participants: 50 musicians (at least 5 years of experience within the past 10 years)

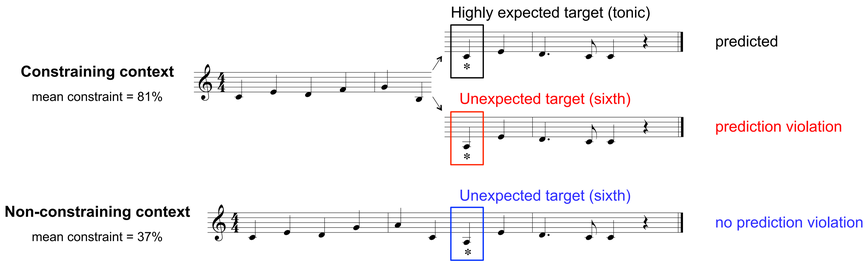
- Stimuli: 60 pairs of novel 5-9 note "melodic stems"
  - Presented with piano timbre at 120 BPM
  - **Constraining** melodic stems: designed to constrain expectations to a single continuation; underlying harmonic structure ends with an implied authentic cadence
  - **Non-constraining** melodic stems: not designed to constrain expectations; end with an implied IV, vi, or ii harmony

- Results used to define conditions for ERP study



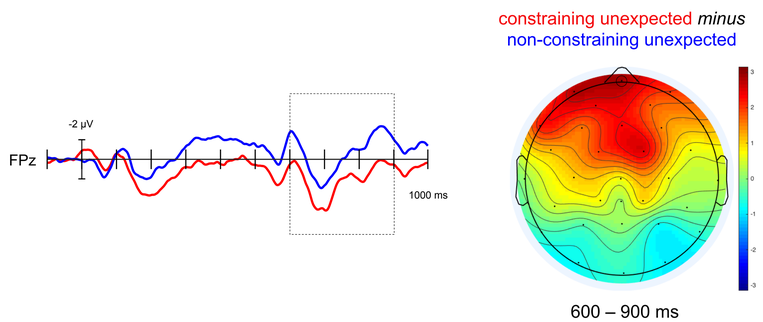

## Methods

- **Participants:** 25 musicians (at least 5 years of experience within the past 10 years)
- **Stimuli:** 60 pairs of novel 10-15 note melodies (cloze stems + continuations created by the composer)
  - All in major keys; contained **no out-of-key notes or any other incongruities**
    - "Unexpected" sixth scale degree sounds entirely natural
  - Presented with piano timbre at 120 BPM
  - Each participant heard a given melody pair in only one condition, plus 30 filler melodies
- **Task:** listen attentively and answer occasional memory probes

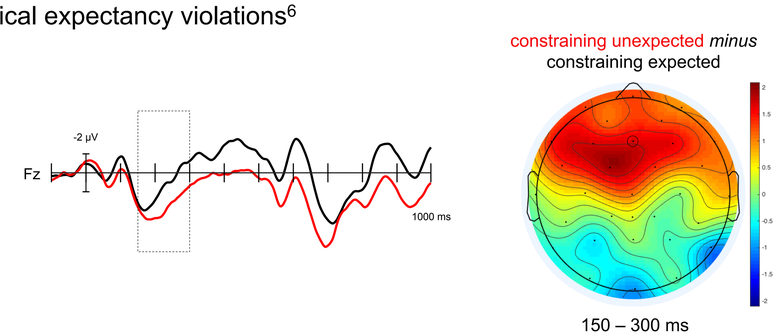



## Results

- Unexpected target notes in constraining melodies elicited a frontal positivity relative to the same unexpected target notes in non-constraining melodies, $t(24) = 2.82$, $p = .005$




- Unexpected target notes in constraining melodies elicited a frontal positivity relative to highly expected target notes, $t(24) = 2.18$, $p = .020$
- No sign of the early right anterior *negativity* that has previously been associated with musical expectancy violations[6]




## Conclusion

- When presented in melodies that constrain expectations for a different continuation, plausible (in-key) but non-expected target notes elicit a frontal positivity relative to the same notes in non-constraining melodies
  - This effect of melodic prediction violation resembles the ERP effect seen in language studies of prediction violation

**Our results suggest that predictive processes may function similarly in language and music**

- In constraining melodies, unexpected target notes elicit a frontal positivity relative to expected target notes
  - No resemblance to the early right anterior negativity (ERAN) previously shown to be elicited by "irregular" notes or chords[7]
  - In contrast to most studies of melodic expectancy violations, the melodies used here had in-key target notes and did not contain incongruities of any kind
  - We had no overt acceptability task

**Manipulating the predictive constraint of sequences provides a new way to study the neural correlates of melodic expectation**

## References

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