MEG correlates of periodicity relevant to pitch perception in human auditory cortex

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Introduction

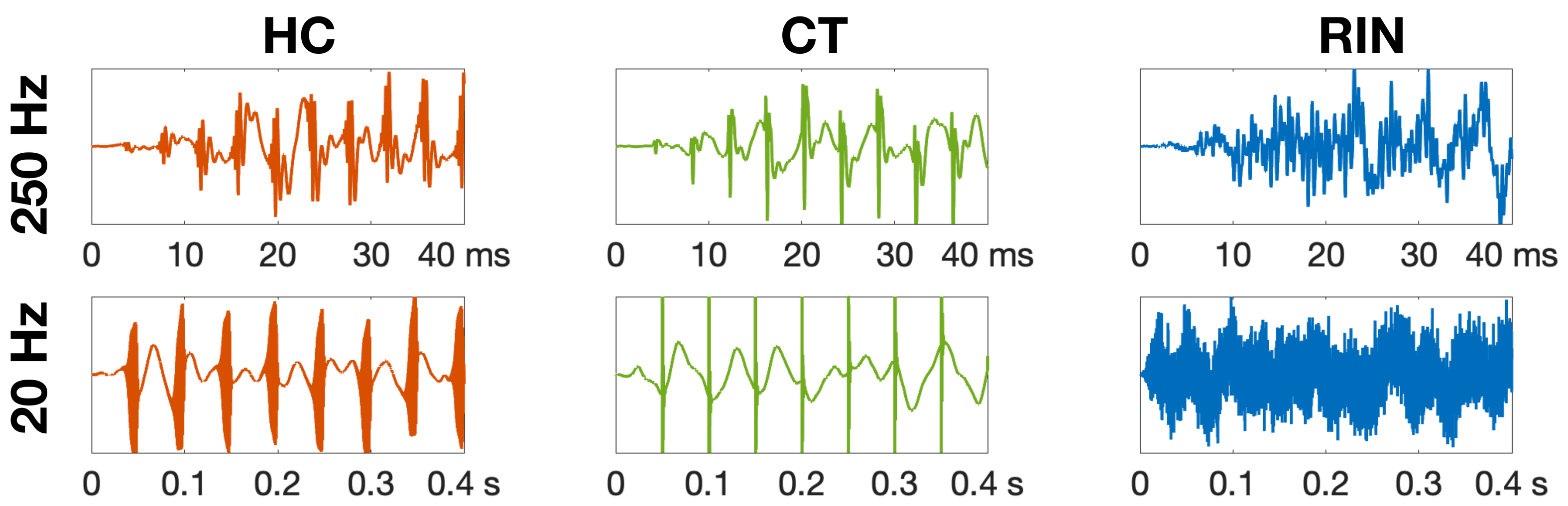
Motivation

- Cortical substrate of pitch is still debated [1]
  - Pitch center [2] vs. distributed pitch system [3]
  - Among many other factors, different types of stimuli might have resulted in different results.
- Pitch equivalence across different types of periodic stimuli was investigated.

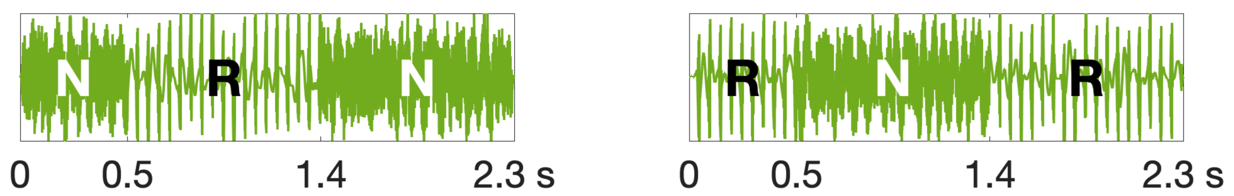
Methods

Stimuli

- Regular segments
  - Types: harmonic complex (HC), click train (CT), regular interval noise (RIN) [4]
  - F0: 250 Hz or 20 Hz (c.f., low limit of pitch = ~30 Hz [5])



- Noise segments: Gaussian noise
- Sequences of regular/noise segments
  - To disentangle sound-onset/offset from regularity (periodicity)-onset/offset



- Filtering and masking
  - Missing F0: bandpass filtering between 1–4 kHz
  - Masking F0: additive gaussian noise filtered between 0.5xF0–1.5xF0 Hz
  - Pink filtering: to render 1/f power spectra

Participants

- Ten right-handed healthy participants (mean age = 26 ± 7 years; 5 females)

MEG data

- 274-channel whole-head MEG system (CTF, Canada), sampled at 1200 Hz
- 720 trials in total = 3 stimuli types x 2 F0s x 2 sequence types x 60 repetitions
- Task: to press button at the end of each trial during ISI (0.9–1.1 s)

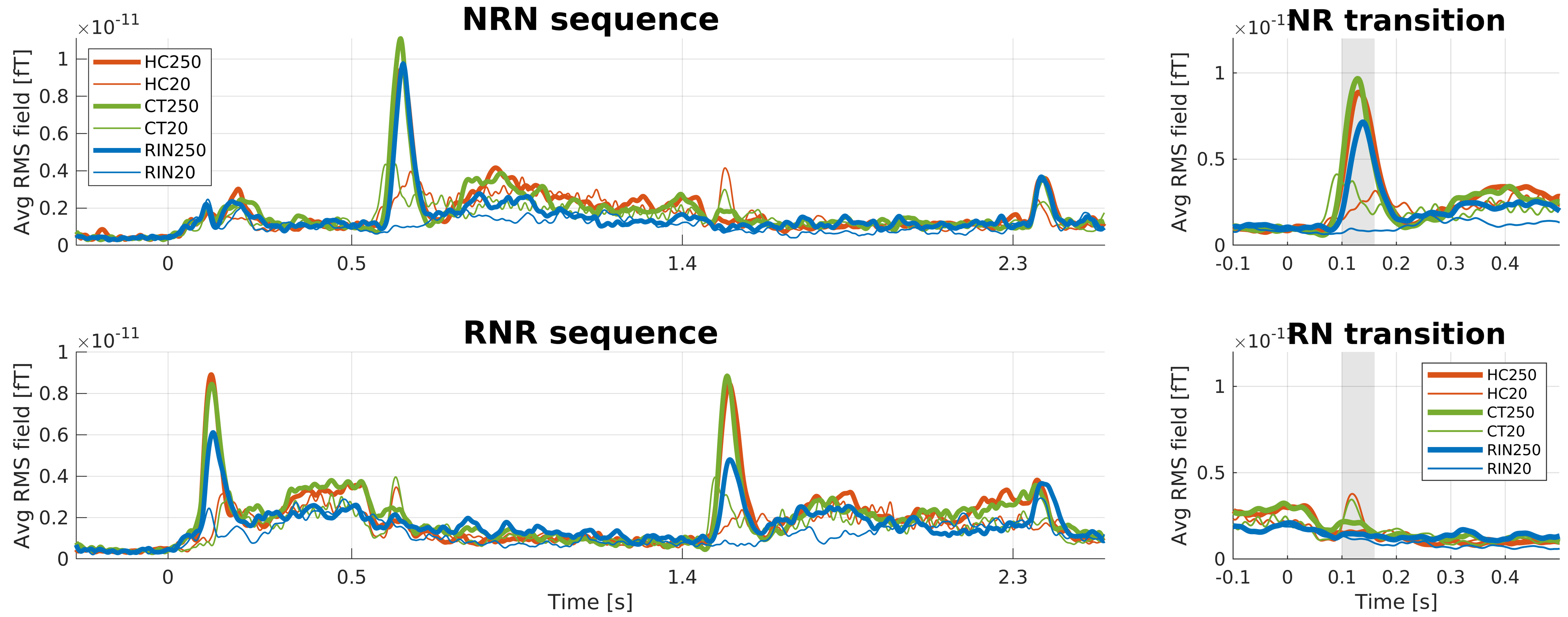
MRI data

- MPRAGE T1-weighted anatomical scans

Data analysis

- Software: MNE-Python, NoiseTools, and custom codes
- Preprocessing: Maxwell tSSS filter, band-pass (0.5–40 Hz) filtering (win-FIR), ICA artifacts correction
- Sensor-level analysis: root-mean-squared (RMS) averaged over all channels
- Source-level analysis: noise-corrected neural current estimates (dynamic statistical parametric mapping; dSPM)
- Statistical inference: repeated measures (rm) ANOVA for a time-window between 100–160 ms after transition

Sensor-level analysis



NR transition

- Pitch-associated periodicity (250 Hz)
  - Strong evoked responses at ~130 ms after transition for HC and CT (weaker for RIN)
- Non-pitch-associated periodicity (20 Hz)
  - Weaker responses for HC and CT (absent for RIN)

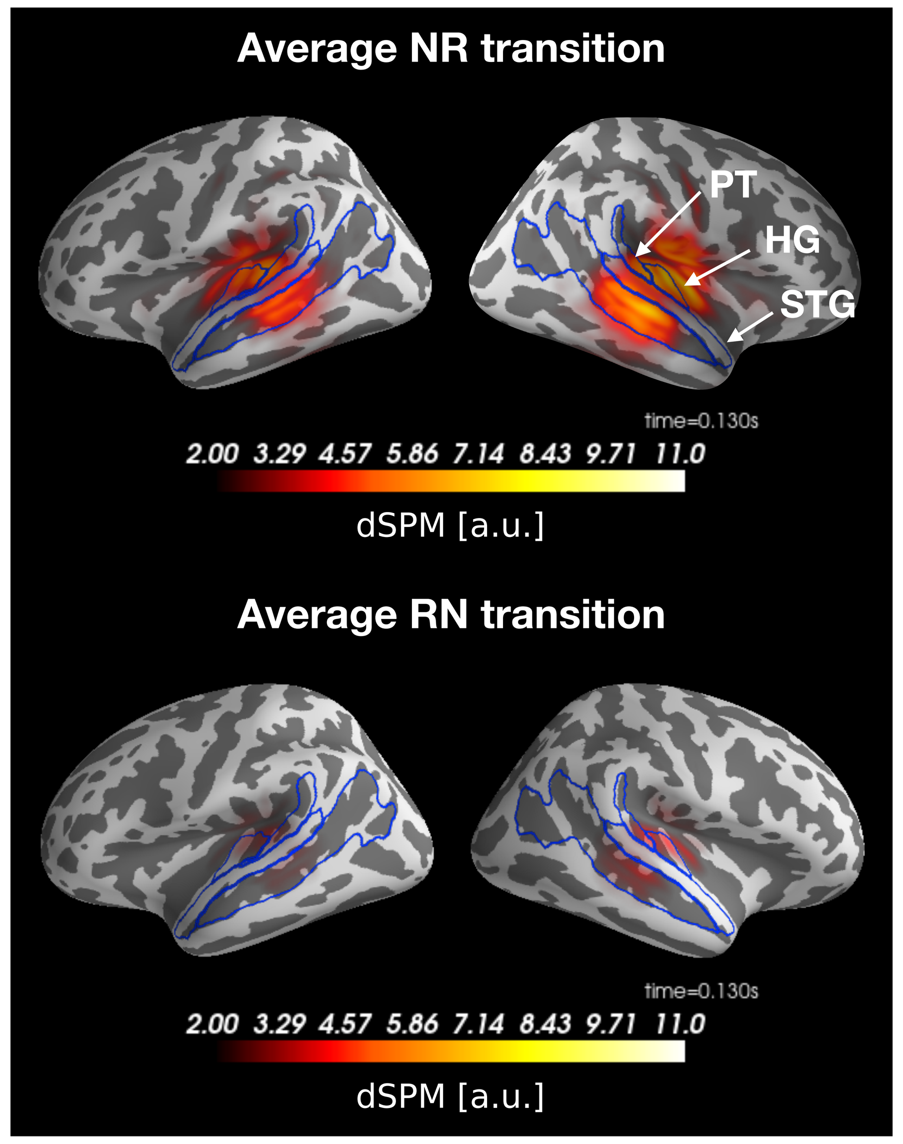
RN transition

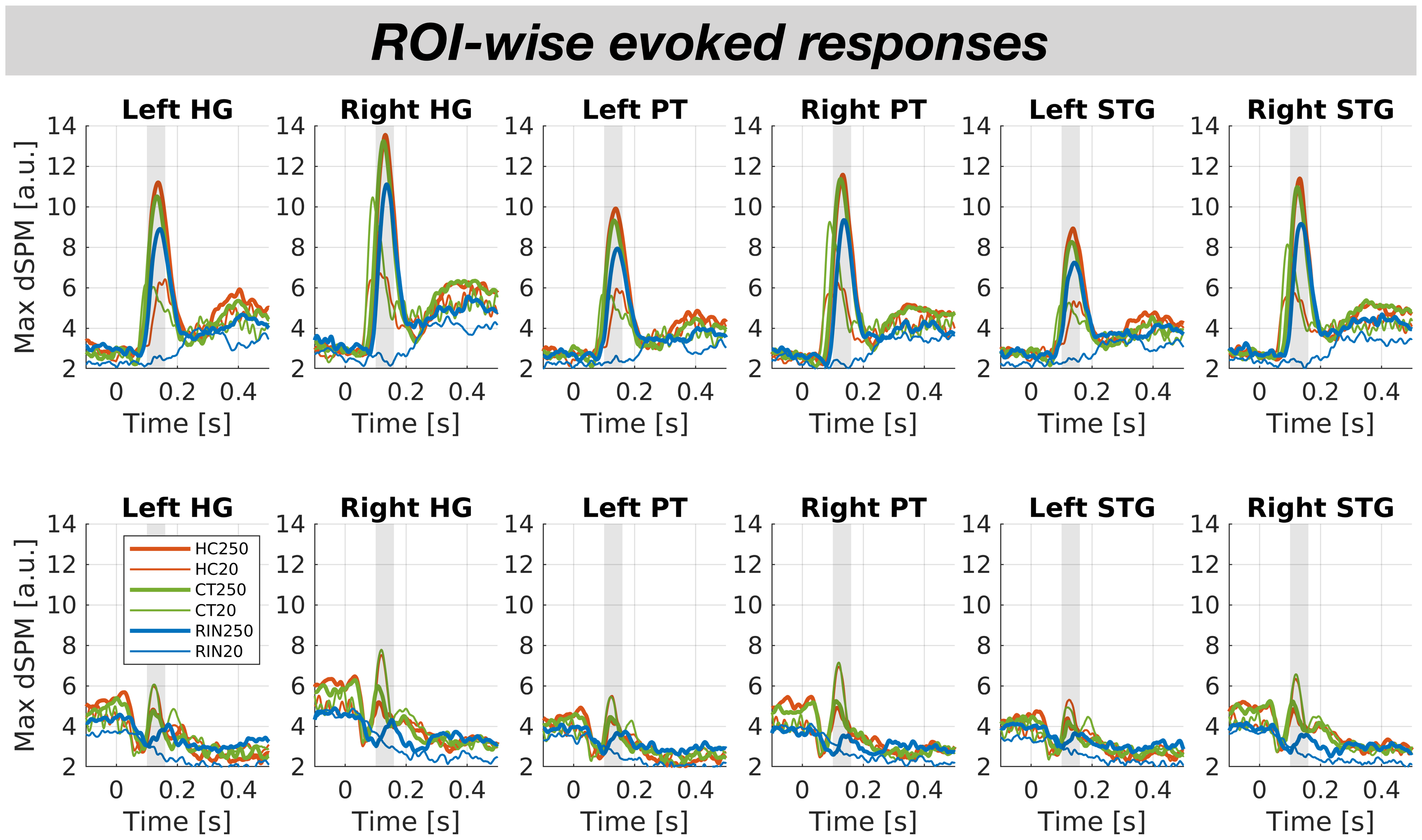
- Pitch-associated periodicity (250 Hz)
  - Weak deflection at ~60 ms for HC and CT
- Non-pitch-associated periodicity (20 Hz)
  - Weak responses at ~60 and ~130 ms for HC and CT

RM-ANOVA

- Main effects of regularity-type, F0, and transition-type were all significant (all $p < 0.02$)

Source-level analysis





HG: Heschl's gyrus, PT: planum temporale, STG: superior temporal gyrus

NR transition

- 250 Hz: strong responses for HC and CT; weaker for RIN
- 20 Hz: weak response for HC and CT; late (~300 ms) response for RIN

RN transition

- 250 Hz: more pronounced even for RIN
- 20 Hz: more pronounced responses at ~120 ms for HC and CT but absent for RIN

Functional anatomy

- Strongest in the HG

RM-ANOVA

- Main effects of regularity-type, F0, transition-type, and ROI were all significant (all $p < 0.006$) but not hemisphere ($p = 0.49$).

Conclusions

- Regular-noise transitions evoked strong responses at sensor and source levels.
- Noise-regular transitions evoked weak or absent (for RIN) responses at sensor-level while weak but consistent responses were found at source-level.
- Various pitch-associated periodic stimuli evoked strong responses in the HG.

References

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