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Cortical pitch representations of complex tones in musicians and non-musicians

Federica Bianchi1,2, Jens Hjortkjaer1,2, Søbåt Santurte1, Hartwig Siebner2, Robert Zatorre3, Torsten Dau1
1 Hearing Systems, Technical University of Denmark, Orsted Plads Building 382, 2800 Kongens Lyngby, Denmark
2 Danish Research Centre for Magnetic Resonance (DRCMR), Hvidovre Hospital, Denmark
3 Montreal Neurological Institute, McGill University, and BRAMS, Montreal, Canada

Introduction

Musicians have been shown to have an enhanced pitch-discrimination ability compared to non-musicians for complex tones with either resolved or unresolved harmonics [1, 2, 3, 4, 5]. It is unclear whether this perceptual enhancement can be ascribed to an enhanced neural representation of pitch at central stages of the auditory system. The aim of this study was to clarify whether (i) cortical responses increase with harmonic resolvability, as suggested in previous studies [6, 7], and whether musicians show (ii) different neural activation in response to complex tones as compared to non-musicians and/or (iii) a finer fundamental frequency (F0) representation in the auditory cortex. Assuming that the right auditory cortex is specialized in processing fine spectral changes, we hypothesized that an enhanced F0 representation in musicians would be associated with a stronger right-lateralized response to complex tones compared to non-musicians.

Method - Experiment I: Behavioral pitch discrimination

- 31 listeners (15 non-musicians and 16 musicians with more than 5 years of formal musical training) participated in Experiment I and II.

**Stimuli**
- Low-frequency (LF): 0.31-1.5 kHz filtered complex tones
- High-frequency (HF): 1.5-3.5 kHz filtered complex tones

**Paradigm**
- "Which tone has the highest pitch?" paradigm

** Conditions**
- The smallest detectable ΔF0 was measured at two points on the psychometric function (difficult: 65%; easy: 90%) for the HF complexes and at 75% for the LF complexes.

**Results**
- A 2-factor ANOVA (3 levels of difficulty, 2 levels of resolvability) revealed: Larger benefit for musicians for resolved components (lower thresholds by a factor of 3) as compared to the benefit for unresolved complex tones (factor of 2) [4,5].
- ANOVA:
  - Significant effect of Group: F(1, 185) = 24.94, p < 0.001
  - Significant effect of Resolvability: F(1, 185) = 207.1, p < 0.001
  - Significant interaction Group × Resolvability: F(1, 185) = 7.94, p = 0.005

Method - Experiment II: fMRI (fMRI)

- Measure neural activation during a pitch-discrimination task
- 6 pitch conditions (same as in Experiment I, see Table 1) and 1 noise condition with TEN.
- ΔF0, between reference and deviant individually set at the listener’s threshold (from Experiment I)
- Event-related paradigm with sparse sequence (TR = 10 s, TA = 2.5 s-38 isoropic slices of 3 mm3, 37 Philips Achieva). Data acquired at DRCMR.

**Results**
- A full factorial ANOVA (3 levels of difficulty, 2 levels of resolvability) revealed
  - A significant effect of musical training (musicians > non-musicians) even if task difficulty was adjusted across participants [6, 7].
  - A significant effect of difficulty (65% > 90%) [Figure 6].
  - No effect of resolvability

Conclusions

Overall, these findings suggest an involvement of a posterolateral region in both auditory cortices during a pitch-discrimination task with conditions of varying task difficulty. When the harmonic level was fixed above the noise, no effect of harmonic resolvability was observed. Cortical responses in musicians were larger in the right than in the left auditory cortex as compared to non-musicians and were predictive of individual pitch-discrimination abilities. These outcomes are consistent with the right auditory cortex being specialized in processing fine spectral changes.

References