Neural correlates of pitch salience using fMRI

Bianchi, Federica; Santurette, Sébastien; Dau, Torsten; Hjortkjær, Jens; Siebner, Hartwig

Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

Neural correlates of pitch salience using fMRI

Federica Bianchi[1], Sébastien Santurette[1], Torsten Dau[1], Jens Hjortkjær[1], Hartwig Siebner[2]

[1] Oticon Center of Excellence for Hearing and Speech Sciences, Technical University of Denmark, Ørsteds Plads Building 352, 2800 Kongens Lyngby, Denmark

[2] Danish Research Center for Magnetic Resonance, Copenhagen University Hospital, Hvidovre, Denmark

Neuroimaging studies have investigated the existence of a pitch center in the human brain. While some early studies using iterated-ripple noise (Griffiths et al., 1998) and complex tones (Penagos et al., 2004) reported a consistent activation to pitch in lateral Heschl's gyrus (HG), more recent studies (Hall and Plack, 2009; Barker et al., 2011) did not find significant activation in HG in response to different pitch-evoking stimuli. A general pitch center should not only respond to all pitch-evoking stimuli (pitch constancy), but also covary with pitch salience. Covariation of neural activity with pitch salience was investigated by Penagos et al. (2004), who found that resolved complex tones (strong pitch) elicited higher neural activation than unresolved complex tones (weak pitch) in normal-hearing subjects (NH). However, further investigations did not find such neural correlates of pitch salience (Hall and Plack, 2009; Barker et al., 2011).

In the present study, two imaging paradigms were designed and tested to estimate functional-magnetic-resonance-imaging (fMRI) activation in response to complex tones with varying salience. The pitch salience of complex tones is known to increase as a function of fundamental frequency (F_0): small F_0s (unresolved complex tones) give rise to a weak pitch, whereas large F_0s (resolved complex tones) elicit a salient pitch. The hypothesis is that, if fMRI techniques are able to detect changes in pitch salience, the results should show a difference in activation in response to resolved *vs* unresolved complex tones.

The first imaging paradigm was similar to that used by Penagos et al. (2004). Resolved and unresolved complex tones with F_0s of 100, 200 and 500 Hz, filtered into low- and high-frequency regions, were presented according to a block design consisting of 24 s of stimulation and 24 s of scanning. A repetition-time (TR) of 8 s minimized the interference of scanning noise with stimulation. Preliminary data from two NH listeners suggested that this paradigm might not be sensitive enough to observe differences in individual subjects. In order to increase statistical power, a novel event-related imaging paradigm was thus designed. Complex tones with parametrically-varying F_0 were presented in short silent gaps between long scanning blocks. This paradigm might allow to investigate individual differences across NH and HI subjects, as scanning occurs over a

longer period and F_0 is parametrically varied, while a pitch-discrimination task keeps the subject alert.

Variations in cortical activity measured with this second paradigm will be compared to behavioral estimates of pitch salience (difference limens for F_0, F_0DLs) in the same listeners. As the difference in F_0DLs between resolved and unresolved complex tones is typically large for NH subjects, but may be smaller or negligible in individual HI listeners (Bernstein and Oxenham, 2006), the relationship between objective and behavioral data may help clarify whether the observed cortical activation is correlated to pitch salience, and how it is affected by hearing impairment.