Activation of auditory cortex by anticipating and hearing emotional sounds: an MEG study

Poster No: 997 WTh-AM

Authors: Koichi Yokosawa¹, Siina Pamilo², Lotta Hirvenkari², Pavan Ramkumar², Elina Pihko², Riitta Hari³

Institutions:
¹Faculty of Health Sciences, Hokkaido University, Sapporo, Japan, ²Low Temperature Laboratory, Aalto University School of Science and Technology, Espoo, Finland, ³Brain Research Unit, Low Temperature Laboratory, Aalto University School of Science and Technology, Espoo, Finland

Introduction:
Several studies have shown that electroencephalographic (EEG) slow waves are modulated in response to emotionally salient visual stimuli. Pastor et al. (2008) reported that emotional pictures elicited large positive EEG slow waves over the centroparietal area. Accordingly, Shestyuk et al. (2005) found decreased slow potentials to pleasant stimuli in depressive subjects when the subjects were memorizing visually-presented emotional words. To continue along similar lines, we recorded DC-range magnetoencephalographic (MEG) responses to long emotional sounds. The benefit of such responses—although they are difficult to record in a reliable manner—is that they do not contain onset transients and that they likely reflect long-term cortical processing.

Methods:
Each participant was presented with emotional sounds of 6-s duration, selected among 8 pleasant & low arousal (P), 8 unpleasant & high arousal (U), and 8 neutral (N) sounds obtained from the International Affective Digitized Sounds library (IADS-2). A 100-ms cue sound was given 2 s before each emotional sound. The frequency of the cue (500 Hz, 1 kHz, or 2 kHz; order randomized across subjects) was related to the category of the emotional sounds (P, U, or N), so each participant was able to anticipate the category of the coming sound. Consequently, each analysis epoch consisted of an anticipation period (0–2 s; cue at time 0), a hearing period (2–8 s), and an afterglow period (later than 8 s) (Fig. 1). Experiments consisted of two sessions of about 20 min, each with 60 stimuli. Altogether, 120 epochs, comprising about 40 epochs of each category, were presented in a random order. MEG signals were recorded from 10 healthy adults (5 men and 5 women; ages, 21–47 years, mean age 25.4 years; all right-handed) with a 306-channel whole-scalp device (VectorVView, Elekta–Neuromag). The signals were collected from DC to 200 Hz and averaged according to stimulus category. Dipole moments for the infra-slow signals were calculated separately for each individual assuming that the source location and orientation were roughly the same as those for the 100-ms auditory response N100m estimated as responses to cue sounds.

Results:
Figures 2 and 3 show the group-level results. In the left hemisphere (Fig. 2), the dipole moments were strongest to unpleasant (U) sounds (difference statistically significant at p < 0.05 or < 0.005 compared with neutral sounds; ANOVA and Tukey's test) during all 3 analysis windows (anticipation period at 1.8–2.0 s, hearing period at 4.9–5.1 s, and afterglow period at 8.6–8.8 s). In the right hemisphere (Fig. 3), the only statistically significant difference was the stronger (p < 0.005) response to pleasant (P) than neutral sounds during the hearing period. The interaction between categories and hemispheres was statistically significant at p < 0.016 in the hearing period.

Conclusions:
Our results point towards hemispheric laterality in the processing of emotional sounds: The left hemisphere reacted strongly to unpleasant & high arousal sounds and the right hemisphere reacted strongly to pleasant & low arousal sounds. In the left hemisphere, the effect was seen already during the anticipation period. The larger response of the auditory cortex could be related to attentional modulation. Our results suggest that anticipation of unpleasant stimuli enhances attention and that the hemispheres have different roles in reacting to stimuli carrying positive and negative emotional information.
Figure 1. Time course of auditory stimulus of each analysis epoch.

Figure 2. Mean ± CI (95% confidence interval across all 10 participants) dipole moments of sustained fields during the 3 analysis periods in the left hemisphere. Abbreviations for emotional sounds: N—neutral, P—pleasant & low arousal, U—unpleasant & high arousal.
Figure 3. Mean ± CI dipole moments in the right hemisphere.

References:
Shestyuk, AY. (2005), 'Reduced sustained brain activity during processing of positive emotional stimuli in major depression', *Biological Psychiatry*, vol. 57, pp. 1089-1096.

**Emotion and Motivation**

**Emotional Perception**

**Imaging Techniques and Contrast Mechanism**

MEG