The Timing and Neural Correlates of Emotion Effects on Auditory Processing

Selinger L [a], *Domínguez-Borràs J* [a,b], *Escera C* [a,b]
[a] Cognitive Neuroscience Research Group, University of Barcelona, Barcelona Spain.
[b] Institute for Brain, Cognition and Behavior (IR3C)

Introduction

Previous studies have shown a major access of novel sounds to the attentional set in a threatening context, than in an emotionally neutral one (Dominguez-Borras, Garcia-Garcia, & Escera, 2008). An enhanced brain response and distraction effect to novel sounds has been observed if something in the environment indicates potential danger. The time course and subjacent neural circuit of this modulation however, remain unknown. This is the first study aiming at investigating a possible phasic mechanism of emotional processing on auditory perception in humans at the behavioral and electrophysiological level. We performed different source localization algorithms in order to localize the brain sources of the differential perceptual processing in either emotional context.

Methods

The EEG of 21 young women was registered (64 channels, 512 Hz) while responding to a discrimination task of faces with neutral (NEU) or frightened (NEG) facial expressions (400 ms on screen). A complex tone (75 ms duration), which the subjects were instructed to ignore, was displayed either simultaneously with the face images onset or in different time intervals after image onset (0ms, 50ms, 100ms, 150ms or 200ms). Effects of emotion, timing condition or electrode site on the auditory N1 component were analyzed by means of repeated measures ANOVAS (EMO x timing x frontal electrode sites x lateral electrode sites). Brain sources of the modulatory effect of emotion were localized implementing different localization algorithms (VARETA, sLORETA, current dipoles) and comparing the results.

Results

Event related potential (ERP) analyses of early auditory components revealed an increased brain response during the visualization of emotional pictures. We found a significantly enhanced mean amplitude of the N1 component for the emotionally negative compared to the neutral condition. Importantly, this effect occurred when the tone followed the picture by 50ms (EMO:$F_{(1,20)}$= 4.508; p= 0.046), 100ms (EMO x lat: $F_{(2,40)}$= 4.508; p= 0.043), 150ms (EMO x front: $F_{(2,40)=}$ 7.893; p= 0.006) (Figure 1A) and 200ms (EMO x front: $F_{(2,40)}$=4.779, p=0.032) but not when both stimuli were displayed simultaneously. When subtracting the brain activation in the emotionally neutral condition from that in the negative one, differential activation is localized principally in the temporal lobe, including the superior and middle temporal gyrus, as well as in superior parietal areas (Figure 1B).

Conclusions

The results provide evidence for a top-down effect of emotion on the brain response to concomitantly presented stimuli, varying with the time course of affective processing. This suggests the presence of a phasic and fast operating effect of emotion on attentional systems. The fact that in the negative condition we find an increased activity in the superior and middle temporal gyrus even at the very onset of the sound might be due to a gating effect, an anticipation of the sound, probably attributable to an enhanced general alertness elicited by the fearful faces. This idea is supported by the superior parietal activity hinting at amplified attentional resources in the negative condition (Vuilleumier, 2009). The localization of the differential brain response in the negative emotional context in the superior temporal gyrus corroborates our hypothesis of a crossmodal sensory modulation of auditory processing elicited by visual emotion. In a nutshell, there seems to be a short window in which people hear better following the presence of negative emotional stimuli. Importantly, neither the sounds nor the emotional valence were task-relevant.

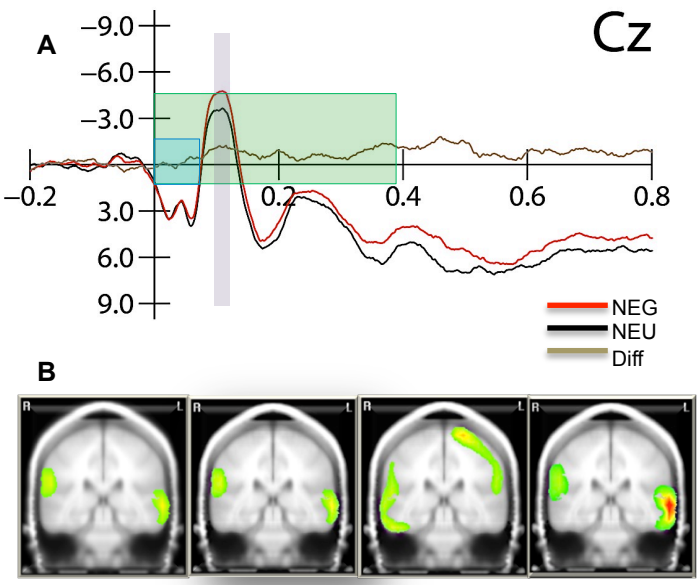

Figure 1: Timing condition 150ms: the image onset preceeds the sound by 150ms (green and blue square respectively). **A**: Auditory ERP at Cz; **B**: Localization of brain activity by means of VARETA (110-125ms, auditory N1) the differential activiation resting NEU from NEG for the timing conditions SOA=50ms, 100ms, 150ms and 200ms (from left to right).

References

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