Dissertation abstract

Neural mechanisms for fast recognition of auditory emotion

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The perception of auditory stimuli as expressing a specific emotion correlates with certain acoustical feature patterns of the stimuli. It is assumed that the sender of an emotional expression makes use of prototypical acoustical cues to encode the emotional meaning. Based on a mutual knowledge of the code, the meaning can be decoded by the listeners. For basic brief forms of emotional expression, it has been suggested that schematic representations of prototypical cue patterns in the brain allow for a fast and possibly automatic appraisal of the auditory input. In this thesis, event-related brain potentials (ERPs) were recorded in four different experiments to survey the neurophysiological mechanisms underlying the quick categorization of non-verbal auditory input as happy or sad.

In part I, Experiment 1, 12 non-musicians listened to tone series comprising a frequent (standard) single musical tone played by a violin with a certain emotional connotation (happy or sad). Among these standard tones, deviant tones differing in emotional valence, instrumental timbre, or pitch were presented. In one session, subjects actively detected the deviant tones by button press. All detected deviants generated P3b waves at parietal leads. In another session, participants listened passively to the tones while watching a silent movie. All deviants generated Mismatch Negativity (MMN) responses. These results indicate that the brain is not only able to use simple physical differences such as pitch for rapid pre-attentive categorization but can also perform similar operations on the basis of more complex differences between tones of the same pitch such as the subtle timbre differences associated with different emotional expressions. However, it is commonly agreed upon that a great variance of feature combinations may be found to code the same emotion. To examine whether the brain automatically builds up categories of basic emotions across tones of different (psycho)acoustical structure, a second MMN-experiment was run.

In Experiment 2, sixteen participants passively listened to tones. Three different tones of the same emotional category were presented as standards. Tones of one category, either sad (condition A) or happy (condition B), differed with respect to their acoustical structure. One tone of each set respectively served as the emotional deviant in the other condition. A MMN with a relatively long latency (380 ms) was found, though only in condition A (sad standards/happy deviant). An ex post Multidimensional Fechnerian Scaling experiment revealed that the emotional expression of the sad tones was perceived as less ambiguous than that of the happy tones. The pattern of results indicates that auditory stimuli are pre-attentively grouped into one emotional category irrespective of differences in acoustical structure, as long as enough stimulus features meet with certain criteria of a prototypical emotional representation in the brain.

The experiments presented in part II of the thesis addressed processing of emotional information conveyed by the voice. Experiment II-01 provided evidence that emotional information can be extracted from the voice within the first 200 ms of listening. If the emotional valence was happy, emotion recognition preceded identity recognition. The result supports recent models of voice perception suggesting separate processing pathways for emotion and identity recognition.

It was shown in experiment II-02 that emotional information from voices and pictures are integrated early in the processing stream. Again, emotion-specific timing differences were found. While congruent happy voice-picture pairs increased the amplitude of the ERP-component P2, congruent sad voice-picture pairs modulated the late positive potential (LPP) from 500 ms onwards.

Together, the results of part I and II demonstrate that the recognition of auditory emotion happens fast and automatically. They support theoretical considerations that the evaluation of prototypical auditory emotions is based on pre-wired templates in the brain which allow the organism to quickly react, even if the sound source is not attended to.