Auditory salience: A study of the influence of timbre attributes using the additional singleton paradigm

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Abstract

Attention is a set of processes that allows a listener to select certain relevant information in a sound scene and to ignore others. However, some sounds that are not relevant to process sometimes manage to capture our attention. This effect is known as salience. In the present study, the influence of two timbre attributes, "brightness" and "roughness", on the salience of a sound is investigated. To address this issue, an additional singleton paradigm has been implemented. This paradigm gives access to an indirect measure of the influence of a sound feature on its salience. The participant's task is a target discrimination task according to its duration. In the reference condition, the target is embedded in sequences of successive distractors that are all identical. In the test condition, one of the distractors has a different timbre than the others and is then called the singleton. We examine how performance on the discrimination task is degraded when the singleton is present. All sounds are equalized in loudness and have a fundamental frequency at 440 Hz and the first 20 harmonics with an exponentially decreasing energy. The target can be longer (230 ms) or shorter (110 ms) than the distractors (170 ms).
In a first experiment (N = 15), the timbre attribute studied is brightness, characterized by the spectral centroid. The singleton is presented with a higher perceived brightness (SC = 836 Hz) than the target and the distractors (SC = 517 Hz). The error rates and response times increase significantly of 7.5% and 137 ms respectively when the sequence contains the singleton. This performance degradation reflects an effect of brightness on salience.

In two following experiments (N = 20 each), we analyze the influence of different values of brightness on one hand, and different values of roughness (characterized by the amplitude modulation depth) on the other hand. Variations of 1, 2, 5 and 10 just-noticeable differences of spectral centroid (i.e. 542, 568, 647 and 776 Hz) and of amplitude modulation depth (i.e. 10, 20, 50 and 100 %) are tested. The results confirm the effect of brightness on salience and show an effect of roughness as well. Moreover, the higher the spectral centroid or the amplitude modulation depth of the singleton, the higher the error rates and response times. This reveals that the attentional capture effect is not an on/off effect but modulates with the variation of timbre's attributes. Finally, and surprisingly, the same levels of variations

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give very similar effect sizes for these two attributes.

The interactions between these attributes are to be analyzed in the rest of this study. This work opens new perspectives for the study of auditory salience and the understanding of bottom-up mechanisms that underly it. The results obtained will be used to improve models of auditory salience.