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Emotions in sound design: exploring emotions in knocking sounds

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1 Abstract

Can knocking sounds play a role in our perception of emotions? And can the properties of these sounds have an impact on our emotions? The study aims to address these questions through a recording session and a perception test. We discuss our results showing that some recordings are significantly affecting emotional judgement, and that physical properties, such as loudness or knocking frequency, differ between emotions.

2 Introduction

Knocking sounds can act as a mode of communication between people on both sides of a door. Therefore, different knocking patterns are used in different types of situations. Emotions are an important element that can be conveyed through such everyday sounds, but it is not clear how well people can recognise them. Current research on this aspect of acoustical communication is scarce, despite having great potential for the development of digital applications and in the creation of entertainment content. We hope that our experiment can make a meaningful contribution to this field of research by providing a strong basis for future research.

3 Background

A great deal of research has been done in the field of emotions in music and vocal communication, as well as basic emotions in general [1][2]. In contrast, little research has explored environmental and everyday sounds [3][4]. However, acoustical features in walking sounds have been shown to convey information about the sex of the walker (Li, Logan, and Pastore, 1991)[5]. Additionally, Vitale and Bresin [6] found that knocking shares expressive cues with musical performances when they analysed visual and acoustic components in knocking sounds.

4 Goals

The present study focuses on the acoustic features of knocking sequences which correspond to five emotional states: anger; fear; happiness; sadness; and neutral. The goal is to identify correlations between the emotional content and the acoustic features of knocking sequences.

5 Method

In order to find such correlations the study was structured around four interconnected steps:
- record emotionally loaded knocking sequences;
- test whether the knocking sequences can successfully convey the intended emotion. The perception test was carried out via an online survey where five knocking sequences per emotion were randomly presented;
- analyse 7 acoustic features (such as knock frequency, loudness and IOI variation) for the 25 recordings included in the online survey using Adobe Audition. Means, standard deviations and 95th percentiles were computed for every feature and for every emotion;
- find correlations between acoustic features and perceptual ratings of knocking sounds.

6 Results

Perception test The online survey was completed by 98 respondents and a total of 2450 answers were recorded. The relation between knocking sounds and people's judgements was highly significant, $\chi^2(96, N = 2450) = 2277.58$, $p < 0.001$, indicating that people are able to infer the emotion of a knocking person from the acoustic properties of the knocking sounds.

Acoustic analysis Results show that sometimes specific emotions have very similar features to another emotion, hence it might be difficult to distinguish between the two when listening to a recorded knocking sound. An example of such similarity of two emotions is anger-fear, according to their knocking frequencies, loudness and IOI variations. Other times, instead, one emotion appeared to be stand out compared to the others, such as happiness for knocking frequency and global frequency.

Correlations between relevant records and acoustic properties By exploring the properties of recordings that had the greatest effects on respondents' judgments, inferences can be made regarding which acoustic characteristics people use to interpret emotional content in knocking sounds. An interesting example is the knocking frequency. The value is low for records perceived as sad (1.79 regarding *S2* and *S3*). But if we consider the records almost never qualified as sad, the value is very high (6.29 regarding *A3*, *H3*, *H4* and *H5*). For this feature, the mean value is 4.06 knocks per second. We can then hypothesise that sadness perception is correlated with a low knocking frequency.
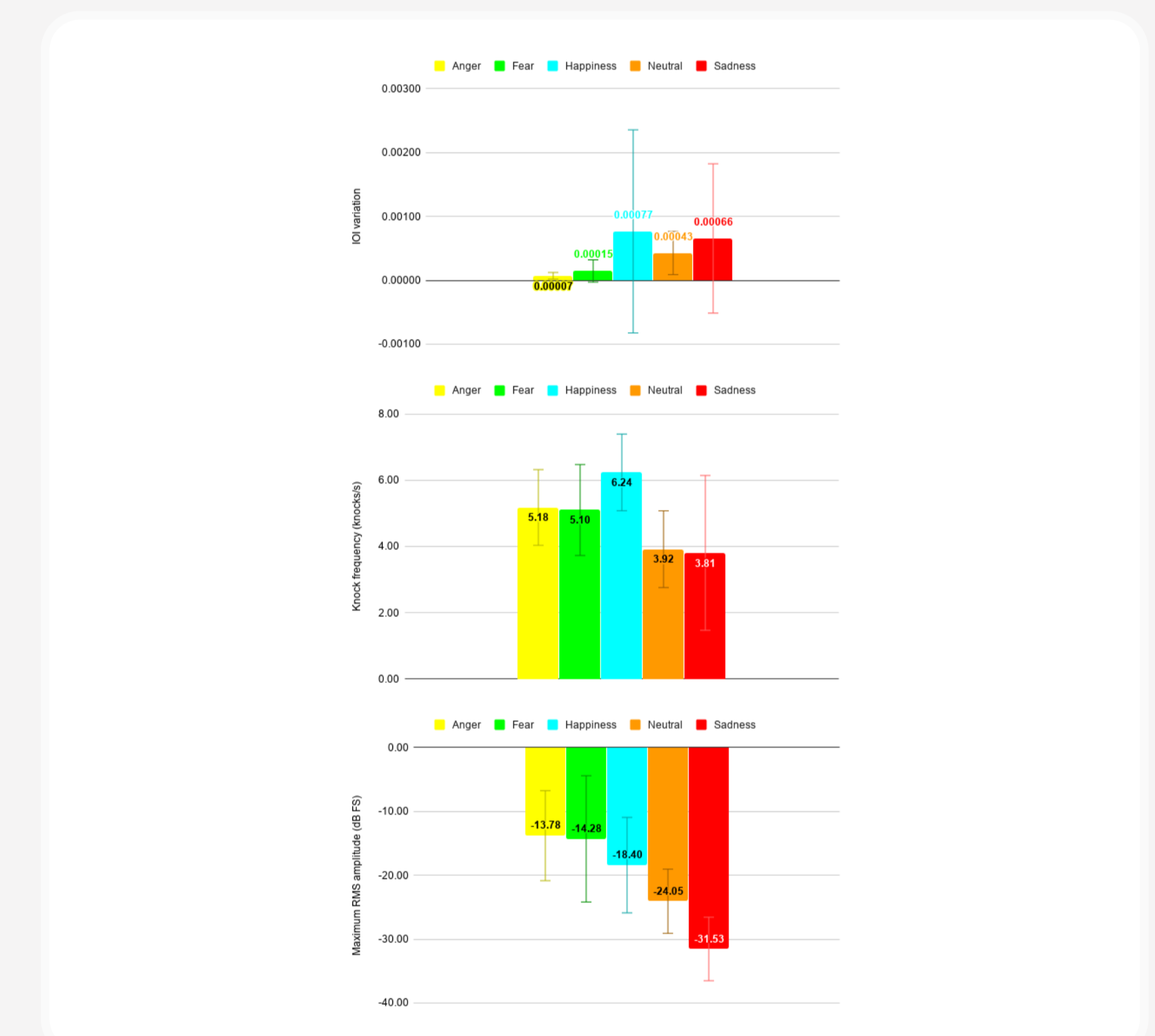

Figure 1: Examples of notable acoustic features

7 Conclusions

The perception test indicates that people are able to identify emotional content from the knocking sounds. In addition, certain acoustic features like loudness, IOI variation and knocking frequency seem to be correlated with specific emotions. In the future, such features could then be used to predict emotional judgements, or alternatively be altered synthetically in order to affect respondents' emotional judgements.

8 References

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