

# Emotional experience of Frequency Modulated sounds: Implications for the design of alarm sounds

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## **Abstract**

Emotions are often placed onto a two-dimensional space spanned up by the dimensions activation and pleasantness. We investigated how frequency modulated sounds (often used as alarm sounds) relate to these dimensions. The study consisted of two parts. In the first part, the pleasantness and activation values of 14 animations that represent cognitive emotions (Premo tool, Desmet, 2003) were determined. Cognitive emotions are emotions that stem from a process of complex appraisal. Two groups of 7 positive and 7 negative emotions resulted. In the second part, the animations had to be associated with a frequency-modulated sound that matched the animation the most closely. One-hundred-and-twenty sounds were generated by systematically varying modulation frequency and modulation depth. Two groups of 7 negative emotions and 7 positive emotions could be identified on the basis of modulation frequency and modulation depth. A strong and negative association between modulation frequency and the pleasantness values and a strong and positive association between modulation depth and activation were found. Consequently, frequency modulated sounds could be placed onto the pleasantness and activation dimensions. Some suggestions were made how these results could be used in the design of alarm sounds.

## **Introduction**

Synthesized feedback sounds become increasingly more important in our households. For example, microwaves, stoves, telephones, and dishwashers all contain certain simple beeps (sine waves) to warn us. If all these alarms go off at the same time, problems of source recognition and identification may occur. The next step in our behaviour will be to prioritize a certain sound and take action accordingly. In intensive care units and in operating rooms many different monitoring sounds are present. The number of different sounds can be as high as forty (Chambrin, 2001). Of course, not all these sounds will go off at the same time, but nurses and physicians should be able to recognize them. It has been found that the medical staff recognizes approximately 40% of the sounds correctly (e.g., Momtahan, Heut and Tansley, 1993) and that the localization of the sounds can be a problem dependent on how they are situated in a room (Svenson & Tap, 2003). The learnability, recognition, identification, and urgency mapping have been investigated