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Emotion and meaning in interpretation of sound sources

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Research regarding the perception of sound focuses in large on the acoustical properties of the sound. We argue that, for a more complete picture of sound perception, one must take the non-physical properties into account. By changing the emotional descriptor of a sound the perception in terms of level of annoyance will change. The present study investigates how a priming picture placing the origin of the sound to either a positive or negative environment affects the level of annoyance to same sound. 3 different sounds were used in the experiment, all based on pink noise. The participants were in the beginning of each sound exposed to a picture telling where the sound originated. The picture was either a positive environment (a picture of a waterfall) or a negative environment (a picture of a larger factory). While listening to the sounds the participants completed different performance tasks. In the end of each sound the participants rated level of annoyance to the sound. Results show that the annoyance ratings are significantly lower when primed with a positive picture. Results also indicate that for more attention demanding tasks this correlation is stronger. The findings are discussed in relation to theories of sound perception.

1 Introduction

Noise is an important factor in determining the well-being and performance level in a work environment. The noise produced in a typical office environment is seldom detrimental but causes increased stress levels and performance decrements. We argue that the meaning associated with the sound is of great importance in evaluation of noise in work environments. In the following study we show that a test design with changed meaning associated with the sound result in significant differences in rated annoyance.

Noise is commonly described as *unwanted sound*. Noise annoyance describes the disturbance/or interference on other tasks caused by noise and is considered to be the main effect of environmental noise [6]. Annoyance is closely linked to performance decrements. Noise also give effects on e.g. stress levels (i.e. cortisol levels) [10] and mental health [4].

Annoyance is a vastly studied field, especially the factors contributing to it. Several studies have shown that physical factors (e.g. acoustic energy or spectral balance) only have a minor influence on the perceived annoyance. Approximately 33 per cent of the variation in annoyance can be related to acoustic parameters [4, 9, 6].

The non-physical factors that may accrue to annoyance are situational variables or individual traits. An important non-physical factor that affects level of annoyance is the meaning of the noise. People afraid of flying are the ones most annoyed by plane noise for instance [4]. There is a strong correlation of affect and annoyance.

The emotional content in the sound may differentiate between different persons due to noise sensitivity, current mood etc. The latter has been shown in a study where a slight annoyance (compared to a neutral affective state) affected both preference of sounds as well as rated annoyance to sounds [11].

In another study white noise was either primed to the subjects as a positive reinforcing signal or as an error message signal. This creates a strong self-relevant emotional context to the sound. When the white noise was used as a positive signal the annoyance to the white noise was less than when the white noise was used as a negative signal. In that study it was a high self-relevant feature of the primer, the sound symbolized a reward or a punishment.

This study will focus on whether it is possible to assign different meanings to a sound and by that affect the percieved annoyance through how the situational variable is percieved. By placing the origin of the sound in two different environments we argue that it would be possible to change percieved annoyance when performing commonly used performance tasks.

2 Method

The following study demonstrates a within-subjects design where 19 participants have rated level of annoyance by use of the Self Assessment Manikin (SAM)-scales when listening to three different sounds, all based on pink noise either assigned with a positive meaning of a waterfall-scenario or with a negative meaning of an industrial work environment scenario. During the sounds the participant had to complete different performance tasks. The study was a part of a bigger study where the effects of environmental noise on performance were tested, to be presented in [2].

2.1 Participants

19 individuals participated in the listening test, 7 male participants and 12 female. The mean age was 25 years old (standard deviation 3.7). All participants were tested for normal hearing. The participants were tested individually in a sound-attenuated room.

2.2 Instrument

The scope of this study was to measure level of annoyance, how it changes with changed emotional descriptor and if the emotional responses changes with a cognitive load. Annoyance may be measured in several different ways. A common method is to measure subjective loudness. However, on lower sound levels the subjective loudness is not representative for perceived annoyance and may only explain approximately 20 per cent of the variances in annoyance ratings, [8, 7]. Another method to measure annoyance is, by measures of valence and activation. It has been shown that these two measures are highly correlated with annoyance ratings [12, 5].

Valence is a basic dimension of all emotional responses. It ranges from negative over neutral to positive. Valence has a correlation factor of 0.6 to annoyance [12]. Activation (also referred to as arousal) is a second orthogonal dimension of experience that relate how active versus passive the experience is [13]. Activation has a correlation factor of 0.4 to annoyance [12].

2.3 Set up

The participants were presented to two different sections (a "positive" section and a "negative" section) with a small break in between, see figure 1 . Each section con-

Positive env. primer			Short	Negative env. primer		
Stimuli 1	Stimuli 2	Stimuli 3	break	Stimuli 1	Stimuli 2	Stimuli 3

Figure 1: Example of presentation structure

sisted of three subsections each. Each subsection consisted of five minutes of sound stimuli and five minutes of silence. In the beginning of each subsection the participants were exposed to a picture telling where the sound originated. The subsections of the positive section presented a positive environment (a picture of a waterfall) and the subsections of the negative section presented a negative environment (a picture of a larger factory). During the exposure to a stimulus the participant completed different performance tasks. Subsequent to the stimuli the participant rated level of annoyance to the stimuli. This was done using the paper and pencil version of the SAM-scales of valence and activation, see figure 2. The scales ranges from 1 through 9. The exper-

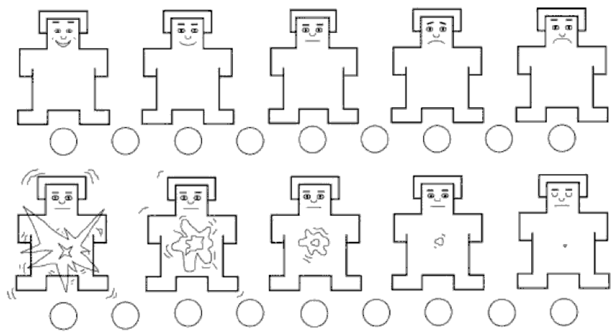

Figure 2: The self-assessment manikin scales [3], above valence, below activation

iment had a block design where the order of the sections and the subsections within the section was presented in six different orders. Due to a limit of participants there was no alteration between the sounds and the performance tasks.

2.4 Stimuli

Three different stimuli were used, all based in pink noise. The first two stimuli were the same for both the positive environment and the negative environment. The third stimuli differed slightly between the positive and the negative environment.

Stimuli 1) Solely pink noise.

Stimuli 2) Pink noise together with a "screechy" noise played in periodical loops.

Stimuli 3) Pink noise together with the above-mentioned "screechy" noise and a bird quitter. In the positive section the bird quitter is played normally and in the negative section the bird quitter is played backwards.

When exposed to stimuli 1 the participants had to complete a proofreading task; when exposed to stimuli 2 the participants had to complete a response-time task; and when exposed to stimuli 3 the participants had to complete a memory-task.
The proof-reading task is a moderately demanding task that requires concentration and processing of information. The participants were to read texts and detect typographical errors and mark how many they found. The response-time task is a low-demanding monotonous task. Here the participant were exposed to different words with different affective meanings the assignment was to, as quick as possible, decide whether it was a positive, negative, or neutral word. The memory-task was a low-demanding short-term memory task where the participant had to remember different color-orders [1].

3 Results

A 2×3 repeated measures analysis of variances on the positive and negative environment-primer, and the three different performance tasks were conducted on valence and activation respectively. Greenhouse-Geissers' corrected F-value was used to correct for possible unequal variance (violation of sphericity). The results are presented in table 1 and table 2. The ratings of valence in regard to annoyance to the sounds were significantly different between each other. The interaction effect

Table 1: Anova for Valence ratings

Factor	df	F-value	p-value	η_p^2
Env.primer	1	8.563	0.009	0.322
Perf. tasks	1.581	2.888	0.083	0.138
Env.*Perf.	1.659	2.095	0.148	0.104

Table 2: Anova for Activation ratings

Factor	df	F-value	p-value	η_p^2
Env. primer	1	0.648	0.431	0.035
Perf. tasks	1.757	0.103	0.879	0.006
Env.*Perf.	1.386	0.505	0.543	0.027

of the valence ratings was not significant. However, it appeared as it was primarily the proof-read task that contributed to the significant differences between the different environment-primers in the valence ratings, see figure 3. As the effect-sizes often are fairly small in these kind of studies, even when the stimuli are very different from each other we conducted t-tests of the different tasks to follow up of the results. This yielded (Holm-Bonferroni corrected) significant difference of the proof-read task between the positive and the negative environment primer, $t(18)= 2.840$, $p=0.011$. The memory task as well as the response time task were however not significantly separated from each other (memory task: $t(18)=0.720$, $p=0.481$; response time task: $t(18)=0.383$, $p=0.706$).

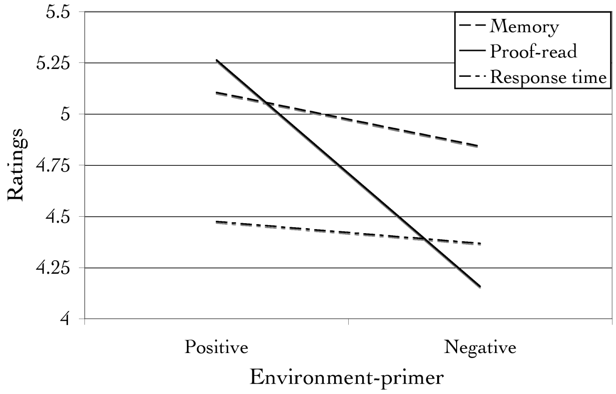

Figure 3: Valence ratings over the different tasks

4 Discussion

The emotional content of a sound or noise is of great importance when analyzing the possible negative effects it may have on performance and well-being in work environments. The aim of this study was to examine whether it was possible to change the emotional content of a sound by means of a positive or negative primer. Support for this was found in the valence-ratings of annoyance where there were significant difference between the positive and the negative environment. Notable is also that the different ratings of valence on the environmental primers also showed a rather large effect size. We can conclude that it is possible, even in a within-subjects design, to change the emotional content of a sound.

Further, we could find a stronger difference between the positive and negative primer when the participants completed the proof-read task. This being the most demanding task in terms of concentration and processing level in comparison to the memory and response time task could be the explanation for this. The emotional meaning of the three different stimuli may be affected by the primer but as neither the memory nor the response time task requires enough cognitive load or processing demand the rated annoyance is kept rather constant. It seems like the effect of the meaning of a sound is noticeable only when the required load of the sound together with the performance task exceeds the mental capacity. Studies on performance decrements due to noise often show a similar pattern; more difficult tasks are affected by noise whereas more simple task are not.

The study performed was not a full factorial design so there is a possibility that it is easier to assign an emotional meaning when the stimuli is solely pink noise without any repeated transients. As the third stimuli differed in the physical properties as well as the different environmental primer it should theoretically be a larger difference in perceived annoyance when exposed to the positive and the negative environmental primer respectively.

5 Conclusion

This study's aim was to investigate whether it is possible to assign different meanings to a sound and by that affect the perceived annoyance when completing performance tasks. This was supported in the valence ratings of annoyance between the positive and negative environment and we can conclude that it is possible, even in a within-subjects design, to change the emotional content of a sound and thus the meaning to it.

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