inter·noise 96
25th Anniversary Congress – Liverpool

INCE: 61

THE INFLUENCE OF STIMULUS RANGE ON THE JUDGMENTS OF LOUDNESS AND ANNOYANCE

F Müller, A Schmidt & R Paulsen

Medical Institute of Environmental Hygiene, Heinrich-Heine-University, Düsseldorf, Germany

In application the magnitude of perceptual attributes of sounds like loudness, pitch, or annoyance is usually quantified by using category scales or comparable scaling methods. Out of a discrete set of quantifying adjectives (e.g.: this sound is very soft, soft, medium, loud, very loud) the subjects have to choose the one that best describes their sensation.

The two assumptions made in using category scales are that the data obtained are veridical descriptions of the perceived environment and that they are isomorphous mappings of the subject´s impressions. Whether or not these asumptions are always met has been and still is a lively discussion among psychophysicists. Category scalings are strongly influenced by the context in which the data are collected, especially when a situation calls for successive judgments of different stimuli. In this case, the scale values may be biased and do not reflect the sounds per se, but the context in which the judgments are made.

One of the most prominent source for context effects in category scaling, as well as in other methods like absolute magnitude estimation, is the range of the stimulus set represented by the minimum and maximum of the stimuli. [1, 2]. The smaller the stimulus ranges the steeper the resulting psychophysical functions. According to the orientation theory of psychophysical judgment [3], range effects can be prevented. The requirement for obtaining veridical level information is the use of psychologically valid scales and ecologically valid stimulus series. Valid scales should contain verbal labels as they are commonly used in everyday life. A stimulus series is called ecologically valid, if the intensity range of the stimuli corresponds to the intensity range as experienced outside the laboratory. The most important requirement, however, is the isomorphic relation between the stimulus series presented and the scale used.

The following experiment was designed to demonstrate that scaling data may lead to serious misinterpretations if the principle of stimulus-scale isomorphy is violated.

THE EXPERIMENT

Stimulus series

Two stimulus series were composed. One, the H-series, representing a definite part of environmental sounds, consisted of 6 recordings made at the distances 12.5 m, 25 m, 50 m, 100 m, 200 m, and 400 m to a busy highway with Leq's of 83.4 dB(A), 75.7 dB(A), 71.3 dB(A), 67 dB(A), 61.3 dB(A) and 54.9 dB(A), respectively. To these (critical) sounds which retained their original sound pressure levels four additional stimuli were added which were produced by increasing the levels of the 400 m, 200 m, 50 m, and 25 m sound by 2 to 3 dB, respectively.

Another stimulus set, the E-series, consisted of 28 different sounds, representing an everyday sound environment with the ticks of a clock (35.9 dB(A)) being the faintest and the highway at 12.5 m distance (83.4 dB(A)) being the loudest sound. Other sounds included in the E-series were the rustling of paper when pages of a newspaper are turned over (46.3 dB(A)), steps on a stone floor (59.2 dB(A)), a crying baby (63 dB(A)), church bells (63.9 dB(A)) or a glass bottle falling on a stone floor (83.4 dB(A)). Stimulus durations were always 6 seconds.

Subjects and Procedure

Fourty employees of the Medical Institute for Environmental Hygiene participated as subjects. All subjects were screened for hearing deficits. Subjects were divided into 4 groups of 10. The subjects of group I scaled the loudness of the stimuli of the E-series, group II the loudness of the H-serie stimuli. The remaining subjects either scaled the annoyance (Lästigkeit) of the E-series stimuli (group III) or of the H-series stimuli (group IV).

The test room was a sound treated room in the basement.The digitally stored signals were presented using a computer. The stimuli were presented monophonically through 2 loud speakers (Magnat 10p) placed at about 3 m distance from the subjects. The stimuli of a series were presented to each subject in a different irregular order. The stimuli of the E-series were presented once to each subject while the stimuli of the H-series were presented 3 times in different irregular order without any break in between and without informing the subjects that the stimuli were to be presented repeatedly

As measuring devices 5 point category scales were used. The verbal labels of the categories were 1=very soft (resp. very little annoying), 2=soft (a little annoying) 3=middle, 4=loud (annoying), 5=very loud (very annoying). The instruction for group I and II was: „You will be presented a series of different sounds. Please listen carefully to each sound and indicate by using one of the verbal labels given on the scale, whether the just heard sound is very low, low, middle, loud or very loud.".

RESULTS

In fig. 1 the average scaling values for both series E (upper plots) and series H (lower plots) and for both attributes, loudness (left plots) and annoyance (right plots), are shown. The data are arithmetic means of 10 subjects. For the critical highway noises the standard deviations are indicated by vertical bars. The loudness scalings are approximately linear functions over the sound pressure level dB(A) Leq. The judged annoyance, however, is linear only for the series H.

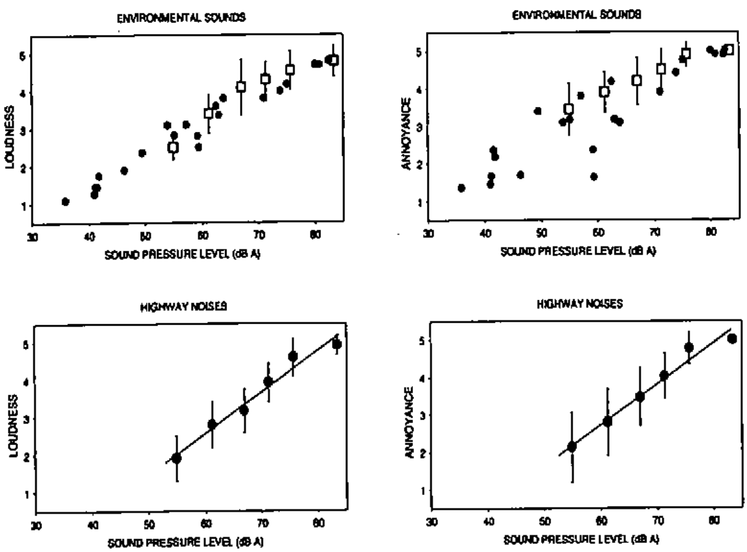

Fig. 1: Category scaled loudness and annoyance for 28 environmental sounds (upper plots) and for 6 noises recorded at different distances to a busy highway. Series E: upper two plots, series H: lower plots.

In fig. 2 the data sets shown in fig. 1 are compared with each other. The upper graphs, comparing theE- with the H-series, show significant differences in both loudness and annoyance values of the same critical highway noises with the stimuli at lower sound pressure levels judged lower in the context of the H-series. These shifts in judgment indicate a clear tendency to use the entire range of the category scale when describing the loudness and annoyance of restricted stimulus sets.

As can be seen in the lower plots where the measured attributes are compared, the range tendency applied to both loudness and annoyance data results in nearly identical scale values for both attributes.

DISCUSSION

If absolute level information is required the experimental setting should be designed in such a manner as to enable absolute descriptions of the perceived magnitudes as given without any comparisons, judgments or estimations whatsoever. Combining stimulus series covering only restricted parts of the environment with scales covering the entire perceptible range, however, will disturb the spontaneous description and result in a judgement routine where scale values are generated by comparison between stimuli and between series and scale [4]. As a result, context effects will occur, and among them range effects, as demonstrated with the experiments described above.

When referring only to the data obtained from the H-series where loudness and annoyance data are perfectly correlated one could argue that annoyance of sounds is either completely determined by loudness or that both terms may describe a similar experience. As demonstrated with the E-series this cannot be true, because distinct differences between the scaled attributes were shown.

These findings call for careful interpretation of data obtained by magnitude scales as well as for detailed descriptions of the scaling procedures applied and the experimental setting when psychoacoustical experiments are published.

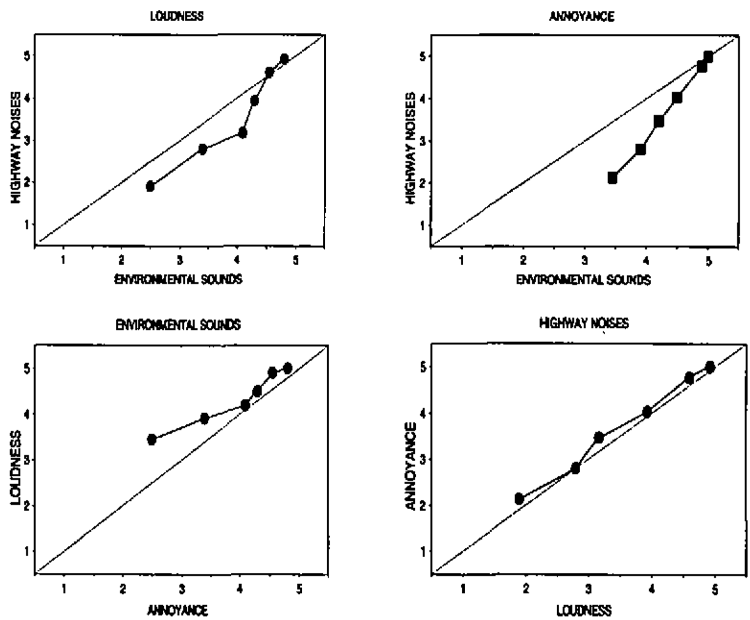

Fig. 2: Comparisons between scale values applied to similar sounds embedded in 2 different stimulus contexts. Comparisons between the series presented are shown in the upper plots. Comparison between the attributes scaled are in the lower plots. Perfect fit would result in data lying on the diagonal.

References

[1] A. Parducci, Range-Frequency Compromise in Judgment. Psychological Monographs, 77(2), 1-50 (1963).

[2] D. Algom & L. E. Marks, Range and Regression, Loudness Scales, and Loudness Processing: Toward a Context-Bound Psychophysics, J Experim. Psychology: Human Perception and Performance, 16(4), 706-727 (1990).

[3] O. Heller, Orientierung innerhalb von phänomenalen Steigerungsreihen. In V. Sarris & W. Lauterbach (Eds.), Beiträge zur psychologischen Bezugssystemforschung. (Huber, Bern, 1980).

[4] O. Heller, Scaling and Orientation In: F. Müller (Ed.), Proceedings of the 6th Annual Meeting of the International Society for Psychophysics, Würzburg, 52- 57 (1990).