PROCEEDINGS of the
23rd International Congress on Acoustics

9 to 13 September 2019 in Aachen, Germany

SiRENE-Survey Part 2: Effects of Intermittent versus Continuous Noise on Annoyance Reactions

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Extended ABSTRACT

The survey conducted as part of the SiRENE study aimed at establishing exposure-response relationships reflecting the percentage highly annoyed (%HA) as functions of road traffic, railway, and aircraft noise (1). Methodology and main results of this extensive population survey have been presented in "SiRENE-Survey Part 1" in the same session, considering the day-evening-night level (Lden) as single noise metric. In Part 2, the effect of the temporal pattern of sound on annoyance reactions is discussed. We hypothesized that in addition to the average noise exposure, expressed as Lden, the effects of noise on annoyance can be better explained when also considering the intensity of short-term variations of noise level over time.

Therefore, we introduced the acoustic indicator Intermittency Ratio (IR), which reflects the "eventfulness" of a noise situation, as a second noise metric in the statistical models explaining %HA. This metric expresses the proportion of the acoustical energy contribution in the total energetic dose that is created by individual noise events above a certain threshold (2). To calculate the metric, an estimate of the distribution of maximum pass-by levels has to be derived from information on geometry (distance and angle), traffic flow (number and speed) and single-event pass-by levels per vehicle category. By definition, IR only takes values between 0 and 100% (including 0% and 100%). An IR of higher than 50% means that more than half of the total sound dose is caused by “distinct” pass-by events. In situations that only consist of events that clearly emerge from background noise (e.g. a receiver point near a railway track), IR can get close to 100%. In contrast, constantly flowing road traffic, e.g. from a distant motorway, only yields small IR values. It could be shown that IR is widely decorrelated from the Leq, specifically in the case of road traffic noise, which is an eminent feature of a complimentary noise metric that aims at explaining remaining variance in epidemiological studies.

Results show that for road traffic noise, IR has an additional effect on %HA and can explain shifts of the exposure-response curve of up to about 6 dB between low and high IR exposure situations. Interestingly, road traffic noise situations with high IR, i.e., situations with typically few vehicle pass-bys with high emergence from background noise, were thereby perceived as less annoying, possibly due to the effect of longer durations of noise-free intervals between events. For railway and aircraft noise annoyance, the predictive power of IR was limited. The latter could be explained by the fact that these noise sources are eventful per se, producing in the vast majority of cases single pass-by events that clearly emanate from background noise with longer periods of calmness in between. One avenue for future research in this context, or for the further development of the IR metric, could be the investigation of the trade-offs between number, duration and profoundness of phases of respite in an otherwise noise-burdened environment.

Keywords: Transportation noise, Annoyance, Exposure-response relationship, Noise metric

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