Modification of the human eye blink startle reflex by air-conducted low-frequency and infrasound

Kathrin Kugler[1], Bonifaz Baumann[1], and Markus Drexl[*†2,1]

[1]German Center For Vertigo and Balance Disorders, University Hospital Munich – Germany
[2]Norwegian University of Science and Technology, Department of Neuromedicine and Movement Science, Trondheim – Norway

Abstract

Emissions from anthropogenic low-frequency and infrasound sound (LFIFS) sources receive increasing attention from the public due to concerns that they represent a health hazard. The complainants report a variety of symptoms, not necessarily related to the auditory system. Nevertheless, the auditory system appears to be a reasonable starting point for any investigation into the causes of potential annoyances or even health impairments. It has been postulated that effects of IFSLFS on humans exist, even when sound emission levels are below the individual hearing threshold. An interesting question is therefore whether IFSLFS with sound pressure levels below the individual hearing threshold can cause changes of an objective measure. Here, we chose the human eye blink acoustic startle reflex (ASR) amplitude because this reflex can be modulated by many acoustic, multi-modal, and emotional pathways, which might respond with different thresholds to LFIFS presented with several frequency-level combinations.
We recorded the electromyogram of the Musculus orbicularis oculi in response to diotic noise bursts in 28 participants. Preceding the startle-evoking stimulus, we presented pure-tone stimuli with frequencies between 16 Hz and 125 Hz and levels below and above the individually measured hearing threshold (pre-pulses). As a readout, we quantified how the ASR amplitude was modified relative to control measurements without pre-pulses.

As a general trend, we found that pre-pulses with frequencies starting from 20 Hz caused a startle facilitation when presented with slightly sub-threshold levels, and an inhibition when presented with levels above the threshold. This pattern of level-dependent pre-pulse facilitation and pre-pulse inhibition became more pronounced with increasing frequencies and was consequently most prominent with a pre-pulse frequency of 125 Hz, while it was absent at 16 Hz, where ASR amplitude changes were highly individual.
The most interesting result here is that sound with low frequencies and levels below the individual hearing threshold can cause changes of the ASR. This might suggest that IFLFS is also detected by sensory systems other than the auditory system (such as the vestibular system), with presumably lower thresholds, or that a sub-conscious auditory pathway contributes to ASR modification.

*Speaker
†Corresponding author: markus.drexl@ntnu.no