Tonal Detection in Noise: An Auditory Neuroscience Insight

Karunarathne, B[1,*] and So, R H Y[1,2]

[1]Department of Industrial Engineering and Logistics Management, HKUST, Hong Kong

[2]Division of Bio-medical Engineering, HKUST, Hong Kong

***Email of Presenting Author: jbpdk@ust.hk**

In a recent industrial consultation study involving workers, it was observed that they could detect a 62dBA alarm in the presence of 80dBA noise. This interesting finding which indicated a signal-to-noise (SNR) of -18dBA, had not been reported in the past. Results of subsequent re-constructed experiments suggested average masked thresholds around -15dBA and -30dBA SNR for monaural and free-field spatial information respectively. Substantial individual differences between subjects were observed ranging from -14dBA to -46dBA. In an attempt to uncover the mechanism behind the detection of an alarm at -30dBA (or -46dBA in one listener), a customized biologically inspired model for hearing was constructed. The model was based on the existing Matlab Auditory Periphery (MAP), a computational neuroscience model developed by Meddis (2006). It contains basic modules to simulate and predict sound transmission from the pinna to the middle ear, the cochlea and the subsequent excitations of auditory nerves. The simulation results of the initial model indicated small but repeatable changes in the auditory nerve firing patterns associated with the presence of the alarm with SNR of -15dB. Using the computational neuroscience model, the role of medial olivo-cochlear system (MOCS) efferent feedback on individual performance in tonal detection in noise is explored. Results of laboratory studies suggested that MOCS efferent feedback has a significant adverse effect on tonal detection performance when the SNR is negative. This finding is interesting and goes against the current finding that MOCS feedback will improve speech intelligibility in noise.

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