

Title: Time Constant of Auditory Adaptation to Noise: Psychoacoustic and Neurophysiological Evidence with Clicks

Category: Speech perception

Authors: Joaquin T. Valderrama^{1,2,3,#}, Francisco Sánchez-Martínez¹, Miriam I. Marrufo-Pérez^{4,5}, Enrique A. Lopez-Poveda^{4,5,6}

Affiliations: ¹ Department of Signal Theory, Telematics and Communications, University of Granada, Granada, Spain. ² Research Centre for Information and Communications Technologies, University of Granada, Granada, Spain. ³ Department of Linguistics, Macquarie University, Sydney, Australia. ⁴ Institute of Neuroscience of Castilla y León, Salamanca, Spain. ⁵ Institute for Biomedical Research of Salamanca, Salamanca, Spain. ⁶ Department of Surgery, Faculty of Medicine, University of Salamanca, Salamanca, Spain. # Presenting author (jvalderrama@ugr.es).

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Abstract

Background: *Adaptation to noise* refers to the better detection or recognition of a signal when it is delayed in the noise. This probably reflects the auditory system's ability to adjust its settings to optimise the neural encoding of information in acoustically challenging venues such as noisy cafeterias and restaurants. While psychoacoustic and computational studies have examined this effect, the underlying physiological mechanisms remain unclear. This study aimed to estimate the activation time constant of these mechanisms and, for the first time in humans, to test whether the neurophysiological representation of a target sound improves when its onset is delayed relative to noise using non-invasive methods.

Methods: Speech intelligibility thresholds (50% recognition) were measured in 15 normal-hearing adults (7 females; 19–46 years) for vocoded words presented at 50 ms (early), 800 ms (middle), and 1600 ms (late) after the onset of speech-shaped noise presented at 60 dB nHL (63.7 dBA). Auditory brainstem responses (ABRs) were recorded in 12 normal-hearing adults (7 females; 20–40 years) using bursts of clicks presented 50 ms (early) and 800 ms (delayed) after noise onset. In addition, click detection thresholds in noise under the same conditions are currently being measured in a further cohort of normal-hearing adults (>10 participants expected by February 2026).

Results: Speech intelligibility thresholds improved by 2.4 dB ($p < 0.001$) and 2.9 ($p < 0.001$) in the middle and late conditions, respectively, compared to the early condition. The two delayed conditions yielded statistically comparable benefits ($p > 0.05$). ABR morphologies were statistically indistinguishable between early and delayed conditions, with no significant differences in wave I or wave V amplitude or latency ($p > 0.05$ in all analyses).

Conclusions: Consistent with previous literature, the improvement in speech intelligibility with delayed target presentation confirms a robust adaptation-to-noise effect. The lack of additional benefit at 1600 ms re 800 ms suggests an activation time constant below 800 ms, consistent with mechanisms such as medial olivocochlear reflex activation and dynamic range adaptation of neurons along the auditory pathway. The absence of an ABR effect replicates previous animal findings and indicates that clicks may not be optimal for objectively characterising these processes. Ongoing psychoacoustic experiments will clarify whether click adaptation to noise occurs at the behavioural level. Stimuli based on synthesized speech may ultimately provide greater sensitivity for probing the neurophysiological basis of this phenomenon.