A perceptual-learning investigation of selectivity in the amplitude-modulation domain

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The importance of the slow amplitude modulations (AM) of speech is demonstrated by near-normal speech identification with preserved temporal-envelope but degraded temporal fine-structure and spectral cues, and by the co-occurrence of temporal-processing deficits and language/reading impairments. Evidence from psychophysical and electrophysiological studies suggests that AM processing is modulation-frequency (fm) specific, either in terms of different (neural synchrony vs. rate) coding mechanisms for slow and fast AM, or via a bank of selective AM channels, each tuned to a different fm. The present study used a perceptual-learning paradigm to test the existence of either form of selectivity: if selectivity exists, training on AM detection using a single fm should improve post-training detection thresholds (relative to pre-training thresholds) for the trained but not for the untrained fm; if no selectivity exists, learning should generalize to untrained fm. Sensitivity to AM was measured using an adaptive 3-interval, 3-alternative forced-choice procedure and a 3-down 1-up stepping rule. Listeners were trained for eight daily 1-hour sessions to detect a 5- or 97.2-Hz AM applied to a 4-kHz carrier. Results showed a uniform decrease in thresholds for trained and untrained fm that largely remained when retested after ten weeks. This observation is consistent with the notion that sensitivity in the present task was limited by internal noise at a post AM-channel stage and that the fm-unspecific effect reflects a reduction in this noise. Possible training-induced selective changes in AM channels (e.g. narrowing of the bandwidth) might have occurred but could not be demonstrated given the use of unmasked AM. Hence, the experiment was replicated using AM presented within a notched noise in the AM domain, making it more likely that sensitivity would be limited by noise in the AM channels, and allowing effects of improved selectivity to be revealed. Similar improvements as previously were observed for trained fm, but less learning occurred for untrained fm. This pattern of thresholds is consistent with selectivity in the AM domain and persisted seven weeks after training. Taken together, the data demonstrate long-lasting AM-detection learning in the adult auditory system. The fact that the specificity of this improvement depended on the type of training stimulus might be important for the design of rehabilitation strategies.