Effects of age and hearing loss on amplitude modulation frequency selectivity - and potential implications for speech intelligibility

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The concept of a modulation filterbank has been shown to account well for psychophysical data from experiments assessing temporal envelope processing acuity in young normal-hearing (NH) listeners. Recent studies using functional imaging and physiological measurements observed a loss of modulation tuning in older listeners and acoustically traumatized animals, suggesting that modulation frequency selectivity may be adversely affected by ageing or hearing impairment. However, behavioural evidence of reduced modulation frequency selectivity in older and/or hearing-impaired (HI) listeners has not yet been provided. The present study investigated modulation frequency selectivity in older NH and HI listeners, as compared to young NH listeners, using psychophysical paradigms. Data were collected in conditions of amplitude modulation (AM) detection, AM frequency discrimination, and modulation masking. All conditions used sinusoidal modulations applied on a sinusoidal carrier, with target modulation rates of 4, 16, 64, and 128 Hz. Masked modulation thresholds were obtained for fixed-bandwidth noise modulation maskers centered at frequencies ranging from -5 to 2 octaves relative to the target modulation frequency. The results suggested a reduction in modulation frequency selectivity at all target modulation frequencies in older NH listeners as compared to the young NH group, particularly at the target modulation frequency of 4 Hz. Furthermore, the data indicate that modulation frequency selectivity is predominantly affected at low modulation rates in HI listeners. To quantify modulation frequency selectivity, the envelope power spectrum model of masking (EPSM) was used to derive modulation filters that account for the masking data. A similar quantitative framework has also been used to predict speech intelligibility in NH listeners in a variety of experimental conditions, including noisy backgrounds, reverberation and nonlinear distortions. Potential implications of a reduced modulation frequency selectivity on speech intelligibility in noise will be discussed.