

Older adults' rating of arousal in speech: The roles of hearing loss and loudness processing abilities

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1. Introduction

Listeners derive affective meaning from prosodic cues in the speech signal, e.g., from pitch, intensity, and tempo [1-3]. Listeners have been found to base their rating of arousal (calm/aroused) mainly on mean intensity of the speech, and their rating of valence (positive/negative attitude) mainly on mean pitch [4]. Consequently, in order to rate degree of arousal in speech, listeners need to be sensitive to differences in intensity. The current study investigated whether individual hearing sensitivity and individual performance on a specific auditory processing task (i.e., loudness scaling for intensity processing) influence ratings of arousal in affective speech. We investigated this in a group of older hearing-aid users who rated natural affective speech with and without their hearing aids.

2. Method

Twenty-three Swiss German older hearing-impaired adults (aged 65-82 yrs) were financially compensated for their participation. Participants had moderate hearing loss and used bilateral hearing aids in everyday life (mean unaided pure-tone average over 0.5, 1, 2 and 4 kHz = 50 dB HL; SD = 8.7).

2.1. Emotion Rating Task

Affect perception was tested using a dimensional emotion rating task. Participants indicated the level of arousal in natural speech stimuli on a 5-step scale once while wearing the hearing aids and once without them. Stimuli consisted of 24 short audio-only, semantically neutral utterances from an authentic and affectively-coloured German conversational speech corpus [5]. Mean intensity was calculated for each utterance by averaging over the utterance using Praat [6].

2.2. Loudness Scaling

Given the link between perceived arousal and intensity [4], we assessed participants' loudness processing ability. The measure was obtained without hearing aids. Loudness processing was assessed using a subjective loudness scaling task. Narrow-band noises were presented at three different centre frequencies (500 Hz, 1 kHz, 2 kHz) at levels between 0-90 dB SPL (5 dB step size). Participants indicated their subjective loudness impression per trial on an 11-step-loudness scale (spanning from "not heard" to "uncomfortably loud"). The median loudness range across frequencies served as an overall measure of loudness processing ability and correlated significantly with hearing sensitivity ($r = -.60$).

3. Results

The data were analyzed using linear mixed-effects regression models with random intercepts for stimulus and participant. The initial model allowed for a two-way interactions between hearing sensitivity and listening condition on the one hand and hearing-sensitivity and mean intensity on the other hand. The overall measure of loudness processing ability was then added in separate analyses as interactions with the relevant acoustic parameters. Model fit was assessed using ANOVA and comparing AICs. Results of the analysis of the arousal ratings showed that fragments with higher intensity were rated as more aroused ($\beta = 0.077$, $SE = 0.013$, $p < 0.001$), and that those with poorer hearing sensitivity gave less aroused ratings ($\beta = -0.010$, $SE = 0.004$, $p < .05$). The effect of using hearing aids on arousal rating behaviour is more pronounced for those with poorer hearing sensitivity ($\beta = 0.007$, $SE = 0.002$, $p < 0.01$). However, hearing sensitivity did not modulate the use of the intensity cue. Adding individual loudness scaling ability to this model did not explain additional variance beyond that explained by hearing sensitivity.

In conclusion, arousal ratings were generally influenced by hearing sensitivity whereas individual loudness scaling thresholds did not explain additional variance. Notably, the use of the relevant acoustic parameter for arousal (mean intensity) was independent of both. Nevertheless, wearing hearing aids makes arousal perception in hearing-impaired listeners more similar to that in better-hearing listeners, and hence underlines the importance of using hearing aids.

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