

**Supplemental Material S2.** Summary of studies focused on prosody perception in hearing aid and cochlear implant users.

Authors, Year	Sample size	Age range	Study language	Type of auditory prosthesis	Method	Types of prosody	Result
Luo et al., 2007	8 adult NH subjects 8 adult CI users	22–40 years 41–73 years	English	CI	Behavioral measures: The House Ear Institute emotional speech database (HEI-ESD)	Affective	Although CI performance remained lower than that of NH individuals, CI users were able to use some of prosodic cues (amplitude and duration) to obtain moderate levels of vocal emotion perception. Removing the amplitude variations worsened the performance of CI users.
Meister et al., 2009	12 CI recipients 12 NH listener	38–75 years 34–68 years	German	CI	Behavioral measures: question/statement test, a sentence stress test, and a speaker gender test	linguistic	The identification of sentence stress, questions/statements, and speaker gender in CI users were qualitatively similar to the NH group. In contrast, most CI recipients had poor performance quantitatively, particularly in sentence stress test.
Straatman et al., 2010	14 NH children 19 children with bimodal fitting	6.8–16.7 years 6.0–19.8 years	Dutch	CI alone and bimodal hearing	Behavioral measures: - Discrimination of pitch movements in bisyllabic non-words - Discrimination between questions and affirmations	linguistic	Compared to using CI-only, bimodal fitting improved the performance of children in discriminating F0 excursions and identifying questions vs. affirmations. However, even with a hearing aid, children need exaggerated F0 contour.
Meister et al., 2011	13 CI recipients 13 NH listeners	19–81 years 18–73 years	German	CI	Behavioral measures: discrimination and identification task for stress-based sentences (Natural utterances and artificial manipulations of stimuli)	linguistic	Discrimination and stress identification based on F0 and intensity had been degraded in CI users compared to NH group. This effect was not shown for duration cues.
Most et al., 2011	23 adults	17–65 years	English	CI alone and bimodal hearing	Behavioral measures: - Intonation test - Syllable stress test - Word emphasis test	linguistic	Bimodal fitting showed better score in all three tests compared to CI-only condition, suggesting HA in non-implanted ear provides better low-frequency acoustic

							hearing which is required for prosody perception.
Cullington & Zeng, 2011	13 adults with CI 13 children with bimodal fitting	18 years and above	English	Bilateral CI and bimodal hearing	Behavioral measures: - Hearing in Noise Test (HINT) - Montreal Battery of Evaluation of Amusia - Aprosodia Battery - Talker identification	Affective	The mean score of affective prosody discrimination was not significantly different between the bimodal and bilateral groups; however, the bimodal group had a better performance. Such finding was also observed for all the other tests.
Most & Michaelis, 2012	26 children with HL 14 children with NH who mostly wear HA	4.0–6.6 years	Nonsense sentence "bado mino gana"	HA	Behavioral measure: The Emotion Identification Test (EIT) under three presentation conditions: auditory, visual, and auditory–visual	Affective	The corrected mean percent scores were higher for children with NH compared to children with HL in each of the three conditions. However, children with HA performed better in auditory–visual condition than auditory alone condition, suggesting benefiting from auditory cues provided by HA.
Agrawal et al., 2012	28 NH listeners	25–55 years	German	Simulating CI processing	Behavioral measures: reaction time and accuracy rates for neutral sentences and vocoded stimuli which had been simulated two CI speech-coding strategies (PACE and ACE) Electrophysiological test: An N100-P200 complex	Affective	Faster responses, higher identification rates, and larger P200 amplitude were detected for original stimuli. For vocoded stimuli, better recognition of happy and angry sentences was demonstrated in comparison to natural ones especially for PACE strategy.
Agrawal et al., 2013	20 CI users (2 subgroups based on coding strategy: MP3000 and ACE) 20 normal-hearing participants	25–60 years	German	CI	Behavioral measures: Reaction time and accuracy rates for sentences with neutral, happy and angry prosody Electrophysiological tests: Recording N100-P200 complex, Time-Frequency measure	Affective	CI users had difficulty in prosody recognition, as demonstrated by lower accuracy, longer reaction time, prolong ERP latencies, and reduced amplitude. However, MP3000 strategy was better than ACE one on happy emotion. In addition, time-frequency results supported the behavioral and ERP findings by showing power increase of Theta and Gamma bands for MP3000 strategy than ACE on emotional stimuli.
Hegarty & Faulkner, 2013	9 children with HL	7.4–14.6 years	English	CI alone and bimodal condition	Behavioral measures: - Discrimination test for bisyllabic word with	linguistic	In both conditions (CI alone and bimodal fitting), better perception of prosodic patterns when children were presented

					manipulated F0 and amplitude - Focus sentence test		with natural speech stimuli compared to sentences with pitch manipulations. Also, there was no bimodal advantage for stress and intonation perception compared to CI alone.
Van Zyl & Hanekom, 2013	10 adult CI user 10 adults with NH	21–70 years	Afrikaans	CI	Behavioral measures: - question/statement distinction - The discrimination of attitude as sarcastic or sincere - Vowel recognition task Under quiet and noise	linguistic	No significant difference was observed for certain/hesitant task and vowel recognition task between adults with NH and CI users, suggesting CI gives access to durational cues even in noise condition. But CI recipients performed worse in question/ statement discrimination as this task was highly dependent on F0 variation, which were degraded in CI technology especially in the presence of noise.
Kalathottukaren et al., 2015	12 adult CI users 15 NH adults (normative data)	25–78 years 23–57 years	English	CI	Behavioral measures: 1- Profiling Elements of Prosody in Speech-Communication (PEPS-C) 2- DANVA 2 (diagnostic analysis of non-verbal accuracy 2) 3- MBEA (Montreal battery of evaluation of amusia)	Affective and linguistic	Lower score of CI users in turn-end, affect, music, and contrastive stress reception subtests was demonstrated, suggesting degraded pitch perception in electrical hearing. However, they showed no difference in chunking reception subtest.
Chatterjee et al., 2015	31 children with NH 36 children with CI 10 adults with NH 9 adults with CI	6.3–18.7 years 6.8–18.4 years mean age = 23.9 years 27.3–69.8 years	English	CI	Behavioral measures: - 12 sentences from the HINT database spoken with five emotions - CI simulated of the same sentences	Affective	The mean score of emotion identification for CI children and CI adults were as good as adults with NH listening to a CI simulated speech. However, NH children showed significantly poorer performance in response to CI-simulated speech. Taken together, this finding showed that not only CI technology but also sufficiently developed cognitive system in CI adults and learned adaptive strategies in CI children can help them to extract emotion from degraded speech.

Schmidt et al., 2016	23 older adults with mild to moderate HL  22 NH adults	65–82 years	German	Bilateral HA for at least 2 years	Behavioral measure: Rating level of emotion dimensions arousal (calm vs. aroused) and valence (positive vs. negative attitude) by using utterances from an authentic and affectively-colored German conversational speech corpus	Affective	No significant difference was detected between hearing aid users and their NH peers in the perception of both valence and arousal emotions. However, for arousal dimension, HA users were more sensitive to intensity differences than NH adults.
Goy et al., 2016	11 older adults with mild to severe HL  27 NH younger adults	mean age = 77.2 years  mean age = 18.3 years	English	HA with a median of 5 years experience	Behavioral measure: word-recognition measure and emotion-identification measure for Toronto Emotional Speech Set	Affective	Older adults with HL performed worse on both word recognition and emotion identification when they were unaided. In the aided condition, their performance improved significantly for word recognition without much benefit for emotion identification.
Goy et al., 2017	Using simulated materials instead of recruiting people with HL and HA users	-	English	Simulating HA processing	Behavioral measure: Analyzing and comparing the acoustic cues used in emotional sentences of Toronto Emotional Speech Set after being manipulated to simulate sloping bilateral HL and HA outputs in different compressions (linear, slow, and fast)	Affective	Acoustic analysis of received sounds in the ear canal of a mannequin showed that hearing aid processing made emotions less distinguishable in aspect of intensity variation and spectral cues. The hearing aid effect varied according to the type of emotion.
Arefi et al., 2017	40 NH young adult subjects	20–35 years	Persian	Simulating HA processing	Behavioral measure: Emotion recognition task before and after hearing aid compression simulation using sentences from Persian emotional speech database (ESD)	Affective	Depending on the type of emotion, recognition of Fear, sad, angry, and happy was reduced following simulating HA amplitude compression.
Laugen et al., 2017	130 children with NH	4–5 years	Norwegian	HA	Behavioral measure:	Affective	Children with HA performed similarly to the normal hearing children, despite

	35 preschool children with mild to severe HL				The test of emotion comprehension		having lower vocabulary scores. Also, parents of hearing-impaired children were more accurate in the estimations of their children's emotional and cognitive development
Christensen et al., 2019	22 adults with mild to severe HL 30 NH adults	22–74 years 21–75 years	English	Bilateral HA	Behavioral measure: Evaluating accuracy rate and reaction time for emotion recognition of 12 sentences from the HINT database recorded in different emotions	Affective	In addition to age-related declines in emotion recognition, hearing loss further impacted the ability to perceive emotions, which was showed by reduced accuracy and increased reaction time.
Cannon & Chatterjee, 2019	19 school-aged children with mild to moderate HL 20 children with NH 11 NH young adults	8–14 years 6–17 years 9–24 years	English	HA	Behavioral measure: Emotion recognition using 12 sentences from the HINT database which had been produced in a child- and adult-directed manner	Affective	Children with mild to moderate hearing loss had similar accuracy and reaction time on emotion recognition tasks using either child- or adult- directed manner, although all participants performed better with child-directed materials. However, in children with HL, linguistic ability had strong role in emotion recognition. Also, they showed that NH adults outperformed both groups of children, attributed to significant effect of developmental age on performance in the emotion recognition task.
Singh et al., 2019	12 NH adults 10 adults with HL but without (unaided condition) 10 hearing-impaired adults with HA (aided condition)	mean age = 66.8 years mean age = 73.5 years mean age = 73.5 years	English	Bilateral HA	Behavioral measures: - 16-item version of the self-report questionnaire (the Emotional Communication in Hearing Questionnaire or EMO-CHeQ) - Emotion-identification task under audio and audiovisual conditions	Affective	Both the HI and HA groups showed greater vocal emotion communication handicap on the EMO-CHeQ compared to NH group. However, the groups of aided and unaided listeners reported similar degrees of handicap. On the emotion-identification task, the HI and HA group performed worse than to the NH group in audio alone condition, with no group differences were observed for audiovisual condition.

Legris et al., 2021	29 subjects with mild to moderate presbycusis  29 NH subjects	50–90 years  50–75 years	French	Bilateral HA	Behavioral measures: - Montreal Affective Voice test (MAV) - The Profile of Emotional Competence questionnaire * Comparing patients' scores before and after hearing aid fitting	Affective	Despite the use of HA, the presbycusis individuals' score remained poorer compared to normal subjects. Based on the MAV results, the impaired auditory emotion perception of presbycusis patients was correlated with pure-tone average and age.
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*Note.* HL = hearing loss; NH = normal hearing; HA = hearing aid; CI = cochlear implant.