Test	Description of Test	What is measured: response task	Research Articles	Summary
Appreciation of Music in Cochlear Implantees **(AMICI)**	**AMCI** developed by Spritzer, Mancuso, and Cheng (2008) assesses multiple dimensions of music perception for clinical purposes.	-Discrimination of **music vs. noise** -Identification of **musical instrument**s -Identification of **musical style** -Recognition of individual **musical excerpts**	Spitzer, Mancuso, and Cheng (2008)	**Spitzer et al. (2008**) reported that the test entailed different challenge levels for CI users: difficulty increased with each stage (melody recognition most challenging). CI users less accurate than NH listeners on all measures.
			Wright and Uchanski (2012)	**Wright and Uchanski (2012)** reported poor performance by CI on the AMICI melody subset.
			Cheng, Spitzer, Shafiro, Sheft, and Mancuso (2013)	**Cheng et al. (2013)** reported AMICI a reliable clinical test for music perception. Timbre Perception significantly more difficult for CI users than NH listeners. Strong correlation between music and speech perception.
Montreal Battery for Evaluation of Amusia (**MBEA**)	**MBEA** developed by Peretz, Champod, and Hyde (2003) with six musical subtests. It evaluates music perception and memory skills along both melodic and temporal dimensions.	-**Scale, contour, interval, rhythm—**melody discrimination (two melodies were the same or different?) -**Meter—**melodic pattern duple or triple meter? -**Melodic memory—**was pitch pattern just presented heard previously?	Cooper, Tobey, and Loizou (2008)	**Cooper, Tobey, and Loizou (2008)** reported that CI users performed higher on rhythm and meter tests, near chance on pitch tests, and significantly higher than pitch but lower than meter/rhythm on memory tests.

			Wright and Uchanski (2012)	**Wright and Uchanski (2012)** reported that CI users performed best on rhythm and meter subsets; melody or pitch tests were more challenging.
Melodic Contour Identification **(MCI)**	**MCI** developed by Galvin, Fu, and Nogaki (2007) for CI users. MCI stimuli are synthetic sounds with nine different five-note melodic contours. The contours presented vary by the lowest note in the melody and size of the musical interval (number of semitones).	-**Melodic contour recognition—** melodic contour presented; the listener selects one of the nine contours displayed on the computer screen	Galvin, Fu, and Nogaki (2007)	**Galvin, Fu, and Nogaki (2007)** reported CI subject performance significantly poorer than NH subjects across all trials. MCI performance of CI users improved with increased interval size. Computerized training on melodic contours improved MCI performance; this improvement generalized to familiar melody identification (FMI), which suggests MCI training can improve CI users' music perception and appreciation.
			Galvin, Fu, and Shannon (2009)	**Galvin, Fu, and Shannon (2009)** reported CI users had great difficulty extracting pitches from complex stimuli. However, musically experienced CI users often performed as well as NH listeners; MCI training

				also greatly improved performance. This suggests training and experience can improve music perception and appreciation.
			Wright and Uchanski (2012)	**Wright and Uchanski (2012)** reported that CI users performed more poorly than NH listeners and NH listeners on CI simulations on MCI. CI users were more accurate on contours made up of larger intervals.
University of Washington Clinical Assessment of Music Perception **(UW-CAMP)**	**UW-CAMP** developed by Nimmons et al. (2008) for CI users. Three subtests: pitch-ranking, melody identification, and timbre identification.	**-Pitch-ranking—**two notes are presented, the listener identifies whether the first or second sound had higher pitch **-Melody identification—**familiar melodies are presented, the listener identifies them (e.g., “Jingle Bells,” “Three Blind Mice,” etc.) **-Timbre identification—**one melody is presented by synthetic versions of eight different instruments; the listener selects which instrument was playing the melody	Nimmons et al. (2008)	**Nimmons et al. (2008)** concluded that the UW-CAMP may be used to measure music perception in CI users in a standardized and clinically practical manner.

			Kang et al. (2009)	**Kang et al. (2009)** validated this test and indicated that CI users need a larger interval range for discrimination. CI users also had poorer performance on melody and timbre recognition than NH listeners.
			Won, Drennan, Kang, and Rubinstein (2010)	**Won et al. (2010)** reported that spectral-ripple discrimination correlated with all three aspects of music perception studied. Music perception ability was also significantly correlated with speech perception ability. This suggests that materially improving spectral resolution could benefit both music and speech perception in CI users.
			Wright and Uchanski (2012)	**Wright and Uchanski (2012)** reported that CI users performed more poorly than NH listeners on melody, timbre, and pitch perception. CI users needed a larger interval size between pitches to hear a difference.

Multidimensional Scale Study **(MDS)**	**MDS** produces geometrical representation of the dissimilarities between objects. The objects (musical instrument sounds) are represented as points and the geometrical distances between points reflect the amount of dissimilarity estimated by the subjects.	**-Timbre perception—** investigated whether CI subjects use the same cues as NH listeners do to differentiate timbre of musical instruments	Macherey and Delpierre (2013)	**Macherey and Delpierre (2013)** reported that internal representation of timbre was similar in NH and CI listeners. This suggests that training procedures designed to improve timbre recognition in CIs will train CI subjects to use the same cues as NH listeners.
Music perception test **(MPT)**	**MPT** developed by Uys and Dijk (2011) for hearing aid users to evaluate music perception of structural features.	**-Rhythm—**rhythm identification, rhythm discrimination, and rhythm perception **-Timbre—**timbre identification (single instrument and instrumental blends) and identifying number of instruments playing **-Pitch—**pitch identification and pitch discrimination **-Melody—**melody perception, melody identification, and music-in-noise song identification task	Uys and Dijk (2011)	**Uys and Dijk (2011)** reported that hearing aid users scored lower than NH adults on the various sub-tests but performed well on rhythm. **Conclusion**: Hearing aids do not sufficiently transmit information for accurate timbral perception. Poor performance on pitch and melody may be due to dependence on temporal information and less on spectral information than NH listeners.
Iowa Music Perception Battery: **-**Familiar melody recognition **(FMR)**	Gfeller et al. (2008) developed this battery of tests to measure different aspects of music perception and appraisal by CI users.	**Recognition of previously familiar melody—**presented 12 familiar melodies without lyrics. Each song presented in two forms: melody only and melody plus harmony	Gfeller et al. (2005)	**Gfeller et al. (2005)** concluded that CIs are not effective in transmitting several key features of music (i.e. pitch, harmony, and timbre). Consequently, CI users must rely on musical features most accessible

-Timbre recognition **(TR)** -Musical excerpts recognition of real-world instrumental music (no lyrics) **(MERT-I)** -Musical excerpts of real-world music with lyrics **(MERT-L)** **-**Appraisal of musical excerpts of real-world instrumental music (no lyrics) **(MEAM-I)** -Appraisal of excerpts of real-world music with lyrics **(MEAM-L)** *Complex Melody Recognition **(CMR)**		**-Timbre recognition—**tested recognition of eight different musical instruments **-Recognition of "real-world" musical excerpts—**tested three commonly heard genres: classical, country, and pop; this included music with and without lyrics ***Complex Melody Recognition test (CMR)—**adaptation by Gfeller et al. (2012) that tested the impact of linguistic vs. nonlinguistic elements on melody recognition **-Appraisal of "real-world" musical excerpt**s**—**sound quality rating of "real-world" excerpts presented		through the implant, such as lyrics or rhythm, for music identification.

			Gfeller et al. (2010)	**Gfeller et al. (2010)** examined the stability of test outcomes over two years. With experience, adult CI users had fairly consistent music perception and appraisal measures. Gains were associated with characteristics such as use of hearing aids, listening experiences, or bilateral use (in the case of lyrics). Only FMR and MERT-L showed significant improvement from one year to the next.
			Gfeller et al. (2012)	**Gfeller et al. (2012)** reported that CI users were significantly less accurate than NH listeners on "real-world" music. However, melody recognition improved with linguistic cues (lyrics). CI users with acoustic plus electric stimulation were more accurate than CI users reliant upon electric stimulation alone.
Musical and vocal emotion perception	Paquette et al. (2018) tested CI users' ability to **perceive emotion in voices and music**. **Visual analogue scales** were used to rate different aspects of emotion. The procedure was	**-Type of emotion—** rated how much a stimulus expressed each emotion (happiness, sadness, fear, neutral)	Paquette et al. (2018)	**Paquette et al. (2018)** indicated that vocal and musical fear was not accurately recognized by CI users; items representing happiness obtained the highest recognition accuracy.

	adapted from Gosselin et al. (2007).	**-Confidence—**rated how confident they were about their emotional ratings **-Emotional valence—**rated from "Extremely negative" to "Extremely positive **-Level of arousal—**rated from "Not at all arousing" to "Extremely arousing"		Results revealed that CI users have difficulty perceiving emotions in voice and music; common timbral acoustic cues (energy and roughness) aided emotion perception.
Pure-Tone Frequency Discrimination Task **Pitch ranking test**	**Pure-Tone Frequency Discrimination Task** used pitch ranking scores for mean accuracy correlated with the just noticeable different (JND) for frequency of pure tones; JND is described in Gfeller et al. (2002) **Pitch ranking test** was described in Gfeller et al. (2007); studied how accurately the participant could determine the direction of pitch change (higher or lower).	**-Pure-Tone Frequency Discrimination Task—**indicated which pure tone had the different frequency but did not require participants to indicate the direction of pitch change. **-Pitch ranking test—**tested standard frequencies of 131 to 1048 Hz; the size of pitch-change intervals ranged from 1 to 4 semitones.	Gfeller et al. (2007)	**Gfeller et al. (2007)** found that low-frequency acoustic hearing improves pitch discrimination as compared with traditional, electric-only CIs. LE recipients were less accurate than participants in the NH and A+E group but generally performed with greater accuracy in the higher frequency range. A+E recipients performed similarly to NH users in the low frequency range but less accurately in upper frequencies.

Musical Sounds in Cochlear Implants **(Mu. S.I.C)**	**Mu.S.I.C** was developed by Brockmeier et al. (2010). It tests six objective and two subjective measures of music perception.	**-Objective subsets—**pitch, rhythm, melody, harmony, and timbre perception **-Subjective subsets—**emotion and dissonance perception Used musical recordings of non-synthesized instruments	Brockmeier et al. (2010)	**Brockmeier et al. (2010)** reported that CI users with Electric + Acoustic Stimulation (EAS) performed better on music perception tests, though not timbre-based tasks, than standard CI participants. EAS users did not reach accuracy level of NH participants. This indicates that acoustic hearing in low frequencies helps music perception but is not the only important factor.
			Brockmeier et al. (2011)	**Brockmeier et al. (2011)** found that CI and NH participants performed significantly differently on pitch discrimination, melody discrimination, chord discrimination, instrument detection, and instrument identification. No significant difference in performance was seen on subtests of rhythm discrimination or dissonance rating and emotion rating.
MUltiple Stimulus with Hidden Reference and Anchor **(MUSHRA)**	**MUSHRA** was adapted by Roy et al. (2012) to assess musical sound quality for CI users.	**-Sound quality—**CI users are provided a set of systematically degraded versions of musical stimulus and asked to provide ratings on sound quality differences.	Roy et al. (2012)	**Roy et al. (2012)** found that CI users had greater difficulty making sound quality discrimination as a function of bass frequency loss than normal hearing controls.

Music quality rating test battery **(MQRTB)**	**MQRTB** was developed by Looi, Winter, Anderson, and Sucher (2011) to assess music sound quality for CI users.	**-Sound quality—**compared appraisal ratings of "real-world" music items from CI recipients using the fine-structure processing (FSP) and high-definition continuous interleaved sampling (HDCIS) speech processing strategies.	Looi et al. (2011)	**Looi et al. (2011)** indicated the FSP strategy for MED-EL recipients had a more positive effect on music appreciation than HDCIS. The MQRTB was found to be an effective tool for assessing music sound quality, which can be used to compare different listening conditions or device settings.