REFERENCES

Arnoldner, C., Kaider, A. & Hamzavi, J. (2006). The role of intensity upon pitch perception in cochlear implant recipients. *Laryngoscope*, *116*, 1760-1765.

Balaguer-Ballester, E., Clark, N.R., Coath, M., et al. (2009). Understanding pitch perception as a hierarchical process with top-down modulation. *PLoS Computational Biology*, *5*, e1000301-

Bigand, E. & Pineau, M. (1997). Global context effects on musical expectancy. *Perception and Psychophysics*, *59*, 1098-1107.

Blamey, P.J., Dooley, G.J., James, C.J., et al. (2000). Monaural and binaural loudness measures in cochlear implant users with contralateral residual hearing. *Ear and Hearing*, *21*, 6-17.

Boltz, M. (1989). Rhythm and "good endings": Effects of temporal structure on tonality judgments. *Perception and Psychophysics*, *46*, 9-17.

Boltz, M. (1993). The generation of temporal and melodic expectancies during musical listening. *Perception and Psychophysics*, *53*, 585-600.

Boltz, M.G. (1999). The processing of melodic and temporal information: independent or unified dimensions? *Journal of New Music Research*, *28*, 67-79.

Brattico, E., Tervaniemi, M., Näätänen, R., et al. (2006). Musical scale properties are automatically processed in the human auditory cortex. *Brain Research*, *1117*, 162-174.

Chatterjee, M. (1999). Effects of stimulation mode on threshold and loudness growth in multielectrode cochlear implants. *Journal of the Acoustical Society of America*, *105,* 850-860.

Collins, L.M. & Throckmorton, C.S. (2000). Investigating perceptual features of electrode stimulation via a multidimensional scaling paradigm. *Journal of the Acoustical Society of America*, *108*, 2353-2365.

Cooper, W.B., Tobey, E. & Loizou, P.C. (2008). Music perception by cochlear implant and normal hearing listeners as measured by the Montreal Battery for Evaluation of Amusia. *Ear and Hearing*, *29*, 618-626.

Cowan, N. (1984). On long and short auditory stores. *Psychological Bulletin*, *96*, 341-370.

Cox, R.M. & Alexander, G.C. (1995). The abbreviated profile of hearing aid benefit. *Ear and Hearing*, *16*, 176-186.

Deutsch, D. (1998). *The psychology of music*. San Diego: Academic Press.

Donaldson, G.S., Kreft, H.A. & Litvak, L. (2005). Place-pitch discrimination of single- versus dual-electrode stimuli by cochlear implant users (L). *Journal of the Acoustical Society of America*, *118*, 623-626.

Dorman, M.F., Smith, L. & Parkin, J.L. (1993). Loudness balance between acoustic and electric stimulation by a patient with a multichannel cochlear implant. *Ear and Hearing,* *14*, 290-292.

Dorman, M.F., Smith, L., Smith, M., et al. (1992). The coding of vowel identity by patients who use the Ineraid cochlear implant. *Journal of the Acoustical Society of America*, *92*, 3428-3431.

Dorman, M.F., Smith, L.M., Smith, M., et al. (1996). Frequency discrimination and speech recognition by patients who use the Ineraid and continuous interleaved sampling cochlear-implant signal processors. *Journal of the Acoustical Society of America*, *99*, 1174-1184.

Firszt, J.B., Koch, D.B., Downing, M., et al. (2007). Current steering creates additional pitch percepts in adult cochlear implant recipients. *Otology and Neurotology*, *28*, 629-636.

Foxton, J.M., Dean, J.L., Gee, R., et al. (2004). Characterization of deficits in pitch perception underlying "tone deafness". *Brain*, *127*, 801-810.

Foxton, J.M., Nandy, R.K. & Griffiths, T.D. (2006). Rhythm deficits in "tone deafness". *Brain and Cognition*, *62*, 24-29.

Franck, K.H., Xu, L. & Pfingst, B.E. (2002). Effects of stimulus level on speech perception with cochlear prostheses. *Journal of the Association for Research in Otolaryngology*, *4*, 49-59.

Fu, Q.J. & Shannon, R.V. (2000). Effects of dynamic range and amplitude mapping on phoneme recognition in Nucleus-22 cochlear implant users. *Ear and Hearing*, *21*, 227-235.

Fu, Q.J. & Shannon, R.V. (2002). Frequency mapping in cochlear implants. *Ear and Hearing*, *23*, 339-348.

Fu, Q.J. & Shannon, R.V. (1998). Effects of amplitude nonlinearity on phoneme recognition by cochlear implant users and normal-hearing listeners. *Journal of the Acoustical Society of America*, *104*, 2570-2577.

Fujita, S. & Ito, J. (1999). Ability of Nucleus cochlear implantees to recognize music. *Annals of Otology, Rhinology and Laryngology*, *108*, 634-640.

Galvin, J.J., Fu, Q.J. & Nogaki, G. (2007). Melodic contour identification by cochlear implant listeners. *Ear and Hearing*, *28*, 302-319.

Gfeller, K., Christ, A., Knutson, J., et al. (2003). The effects of familiarity and complexity on appraisal of complex songs by cochlear implant recipients and normal hearing adults. *Journal of Music Therapy*, *40*, 78-112.

Gfeller, K., Christ, A., Knutson, J.F., et al. (2000). Musical backgrounds, listening habits, and aesthetic enjoyment of adult cochlear implant recipients. *Journal of the American Academy of Audiology*, *11*, 390-406.

Gfeller, K. & Lansing, C. (1992). Musical perception of cochlear implant users as measured by the *Primary Measures of Music Audiation*: An item analysis. *Journal of Music Therapy*, *29*, 18-39.

Gfeller, K. & Lansing, C.R. (1991). Melodic, rhythmic, and timbral perception of adult cochlear implant users. *Journal of Speech and Hearing Research*, *34*, 916-920.

Gfeller, K., Olszewski, C., Rychener, M., et al. (2005). Recognition of "real-world" musical excerpts by cochlear implant recipients and normal-hearing adults. *Ear and Hearing*, *26*, 237-250.

Gfeller, K., Turner, C., Mehr, M., et al. (2002). Recognition of familiar melodies by adult cochlear implant recipients and normal-hearing adults. *Cochlear Implants International*, *3*, 29-53.

Gfeller, K., Turner, C., Oleson, J., et al. (2007). Accuracy of cochlear implant recipients on pitch perception, melody recognition, and speech reception in noise. *Ear and Hearing*, *28*, 412-423.

Gfeller, K., Woodworth, G., Robin, D.A., et al. (1997). Perception of rhythmic and sequential pitch patterns by normally hearing adults and adult cochlear implant users. *Ear and Hearing*, *18*, 252-260.

Gifford, R.H., Shallop, J.K. & Peterson, A.M. (2008). Speech recognition materials and ceiling effects: Considerations for cochlear implant programs. *Audiology and Neurotology*, *13*, 193-205.

Gray, P.M., Krause, B., Atema, J., et al. (2001). The music of nature and the nature of music. *Science*, *291*, 52-54.

Griffiths, T.D. (2003). The neural processing of complex sounds. In I. Peretz & R. J. Zatorre (Eds). *The cognitive neuroscience of music* (pp. 168-177). Oxford: Oxford University Press.

Griffiths, T.D. & Warren, J.D. (2002). The planum temporale as a computational hub. *Trends in Neurosciences*, *25*, 348-353.

Grose, J.H. & Buss, E. (2007). Within- and across-channel gap detection in cochlear implant listeners. *Journal of the Acoustical Society of America*, *122*, 3651-3658.

Hartmann, W.M. (1998). *Signals, sound, and sensation*. New York: Springer Science+Business Media.

Horacek, L. & Lefkoff, G. (1970). *Programed ear training*. New York: Harcourt Brace Jovanovich.

Hoth, S. (2007). Indication for the need of flexible and frequency specific mapping functions in cochlear implant speech processors. *European Archives of Oto-Rhino-Laryngology*, *264*, 129-138.

Hughes, M.L. & Abbas, P.J. (2006). Electrophysiologic channel interaction, electrode pitch ranking, and behavioral threshold in straight versus perimodiolar cochlear implant electrode arrays. *Journal of the Acoustical Society of America*, *119*, 1538-1547.

Hyde, K.L. & Peretz, I. (2004). Brains that are out of tune but in time. *Psychological Science*, *15*, 356-360.

Jones, M.R. (1993). Dynamics of musical patterns: How do melody and rhythm fit together? In T. A. Tighe & W. J. Dowling (Eds). *Psychology and music: The understanding of melody and rhythm* (pp. 67-92). Hillsdale: Lawrence Erlbaum Associates.

Kaas, J.H., Hackett, T.A. & Tramo, M.J. (1999). Auditory processing in primate cerebral cortex. *Current Opinion in Neurobiology*, *9*, 164-170.

Kang, R., Nimmons, G.L., Drennan, W.R., et al. (2009). Development and validation of the University of Washington Clinical Assessment of Music Perception test. *Ear and Hearing*, *30*, 411-418.

Kidd, G., Boltz, M. & Jones, M.R. (1984). Some effects of rhythmic context on melody recognition. *American Journal of Psychology*, *97*, 153-173.

Koelsch, S., Fritz, T., Schulze, K., et al. (2005). Adults and children processing music: an fMRI study. *NeuroImage*, *25*, 1068-1076.

Koelsch, S., Gunter, T., Friederici, A.D., et al. (2000). Brain indices of music processing: "Nonmusicians" are musical. *Journal of Cognitive Neuroscience*, *12*, 520-541.

Koelsch, S., Gunter, T.C., Van Cramon, Y., et al. (2002). Bach speaks: a cortical "language-network" serves the processing of music. *NeuroImage*, *17*, 956-966.

Koelsch, S. & Siebel, W.A. (2005). Towards a neural basis of music perception. *Trends in Cognitive Sciences*, *9*, 578-584.

Koelsch, S., Wittfoth, M., Wolf, A., et al. (2004). Music perception in cochlear implant users: An event-related potential study. *Clinical Neurophysiology*, *115*, 966-972.

Kong, Y.Y., Cruz, R., Jones, J.A., et al. (2004). Music perception with temporal cues in acoustic and electric hearing. *Ear and Hearing*, *25*, 173-185.

Krumhansl, C.L. (1990). *Cognitive foundations of musical pitch*. New York: Oxford University Press.

Krumhansl, C.L. (1979). The psychological representation of musical pitch in tonal context. *Cognitive Psychology*, *11*, 346-374.

Krumhansl, C.L. (2000). Rhythm and pitch in music cognition. *Psychological Bulletin*, *126*, 159-179.

Kwon, B.J. & Van den Honert, C. (2006). Dual-electrode pitch discrimination with sequential interleaved stimulation by cochlear implant users. *Journal of the Acoustical Society of America*, *120*, EL1-EL6.

Laneau, J., Wouters, J. & Moonen, M. (2006). Improved music perception with explicit pitch coding in cochlear implants. *Audiology and Neurotology*, *11*, 38-52.

Leal, M.C., Shin, Y.J., Laborde, M.L., et al. (2003). Music perception in adult cochlear implant recipients. *Acta Oto-Laryngologica*, *123*, 826-835.

Lebrun-Guillaud, G. & Tillman, B. (2007). Influence of a tone's tonal function on temporal change detection. *Perception and Psychophysics*, *69*, 1450-1459.

Levitin, D.J. & Menon, V. (2003). Musical structure is processed in "language" areas of the brain: a possible role for Brodmann Area 47 in temporal coherence. *NeuroImage*, *20*, 2142-2152.

Levitt, H. (1971). Transformed up-down methods in psychoacoustics. *Journal of the Acoustical Society of America*, *49*, 467-477.

Liégeois-Chauvel, C., Peretz, I., Babaï, M., et al. (1998). Contribution of different cortical areas in the temporal lobes to music processing. *Brain*, *121*, 1853-1867.

Lim, J.S., Rabinowitz, W.M., Braida, L.D., et al. (1977). Intensity perception VIII. Loudness comparisons between different types of stimuli. *Journal of the Acoustical Society of America*, *62*, 1256-1267.

Limb, C.J. (2006b). Structural and functional neural correlates of music perception. *Anatomical Record - Part A Discoveries in Molecular, Cellular, and Evolutionary Biology*, *288*, 435-446.

Limb, C.J. (2006a). Cochlear implant-mediated perception of music. *Current Opinion in Otolaryngology Head and Neck Surgery*, *14*, 337-340.

Limb, C.J., Molloy, A.T., Jiradejvong, P., et al. (2010). Auditory cortical activity during cochlear implant-mediated perception of spoken language, melody, and rhythm. *Journal of the Association for Research in Otolaryngology*, *11*, 133-143.

Loizou, P.C. (1999). Introduction to cochlear implants. *IEEE Engineering in Medicine and Biology Magazine*, *18*, 32-42.

Looi, V., McDermott, H.J., McKay, C., et al. (2008). Music perception of cochlear implant users compared with that of hearing aid users. *Ear and Hearing*, *29*, 421-434.

Looi, V., McDermott, H.J., McKay, C., et al. (2004). Pitch discrimination and melody recognition by cochlear implant users. *Proceedings of the VIII International Cochlear Implant Conference*, 197-200.

Marmel, F., Tillman, B. & Dowling, W.J. (2008). Tonal expectations influence pitch perception. *Perception and Psychophysics*, *70*, 841-852.

McDermott, H. & Varsavsky, A. (2009). Better fitting of cochlear implants: modeling loudness for acoustic and electric stimuli. *Journal of Neural Engineering*, *6*, 1-8.

McDermott, H.J. (2004). Music perception with cochlear implants: A review. *Trends in Amplification*, *8*, 49-82.

McDermott, H.J., Looi, V. (2004). Perception of complex signals, including musical sounds, with cochlear implants. *International Congress Series*, *1273*, 201-204.

McDermott, H.J. & McKay, C.M. (1994). Pitch ranking with nonsimultaneous dual-electrode electrical stimulation of the cochlea. *Journal of the Acoustical Society of America*, *96*, 155-162.

McDermott, H.J. & McKay, C.M. (1997). Musical pitch perception with electrical stimulation of the cochlea. *Journal of the Acoustical Society of America*, *101*, 1622-1631.

McDermott, H.J., Sucher, C.M. (2007). Speech processing for cochlear implants and bimodal stimulation. *8th EFAS Congress/10th Congress of the German Society of Audiology*, 1-4.

McKay, C.M., McDermott, H.J. & Clark, G.M. (1996). The perceptual dimensions of single-electrode and nonsimultaneous dual-electrode stimuli in cochlear implantees. *Journal of the Acoustical Society of America*, *99*, 1079-1090.

Meyer, L.B. (1956). *Emotion and meaning in music*. Chicago: University of Chicago Press.

Middlebrooks, J.C., Bierer, J.A. & Snyder, R.L. (2005). Cochlear implants: the view from the brain. *Current Opinion in Neurobiology*, *15*, 488-493.

Milczynski, M., Wouters, J. & Van Wieringen, A. (2009). Improved fundamental frequency coding in cochlear implant signal processing. *Journal of the Acoustical Society of America*, *125*, 2260-2271.

Mirza, S., Douglas, S.A., Lindsey, P., et al. (2003). Appreciation of music in adult patients with cochlear implants: A patient questionnaire. *Cochlear Implants International*, *4*, 85-95.

Moore, B.C.J. (2003). Coding of sounds in the auditory system and its relevance to signal processing and coding in cochlear implants. *Otology and Neurotology*, *24*, 243-254.

Moore, B.C.J. & Glasberg, B.R. (1988). Gap detection with sinusoids and noise in normal, impaired and electrically stimulated hearing. *Journal of the Acoustical Society of America*, *83*, 1093-1101.

Moore, D.R. & Shannon, R.V. (2009). Beyond cochlear implants: awakening the deafened brain. *Nature Neuroscience*, *12*, 686-691.

Nicholson, K.G., Baum, S., Kilgour, A., et al. (2003). Impaired processing of prosodic and musical patterns after right hemisphere damage. *Brain and Cognition*, *52*, 382-389.

Nittono, H., Bito, T., Hayashi, M., et al. (2000). Event-related potentials elicited by wrong terminal notes: effetcs of temporal disruption. *Biological Psychology*, *52*, 1-16.

Oxenham, A.J., Bernstein, J.G.W. & Penagos, H. (2004). Correct tonotopic representation is necessary for complex pitch perception. *Proceedings of the National Academy of Sciences of the United States of America*, *101*, 1421-1425.

Pandya, D.N. (1995). Anatomy of the auditory cortex. *Revue Neurologique*, *151*, 486-494.

Patel, A.D. (2003). Language, music, syntax and the brain. *Nature Neuroscience*, *6*, 674-681.

Patterson, R.D., Uppenkamp, S., Johnsrude, I.S., et al. (2002). The processing of temporal pitch and melody information in auditory cortex. *Neuron*, *36*, 767-776.

Peretz, I. (2002). Brain specialization for music. *Neuroscientist*, *8*, 374-382.

Peretz, I. (1990). Processing of local and global musical information by unilateral brain-damaged patients. *Brain*, *113*, 1185-1205.

Peretz, I. & Babaï, M. (1992). The role of contour and intervals in the recognition of melody parts: Evidence from cerebral asymmetries in musicians. *Neuropsychologia*, *30*, 277-292.

Peretz, I., Brattico, E., Järvenpää, M., et al. (2009). The amusic brain: in tune, out of key and unaware. *Brain*, *132*, 1277-1286.

Peretz, I., Champod, A.S. & Hyde, K. (2003). Varieties of musical disorders: The Montreal Battery of Evaluation of Amusia. *Annals of the New York Academy of Sciences*, *999*, 58-75.

Peretz, I. & Coltheart, M. (2003). Modularity of music processing. *Nature Neuroscience*, *6*, 688-691.

Peretz, I. & Hyde, K.L. (2003). What is specific to music processing? Insights from congenital amusia. *Trends in Cognitive Sciences*, *7*, 362-367.

Peretz, I. & Kolinsky, R. (1993). Boundaries of separability between melody and rhythm in music discrimination: a neuropsychological perspective. *Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, *46*, 301-325.

Peretz, I., Kolinsky, R., Tramo, M., et al. (1994). Functional dissociations following bilateral lesions of auditory cortex. *Brain*, *117*, 1283-1301.

Peretz, I. & Zatorre, R.J. (2005). Brain organization for music processing. *Annual Review of Psychology*, *56*, 89-114.

Peretz, I. & Zatorre, R.J. (2003). *The cognitive neuroscience of music*. Oxford: Oxford University Press.

Pijl, S. (1997). Labeling of musical interval size by cochlear implant patients and normally hearing subjects. *Ear and Hearing*, *18*, 364-372.

Pijl, S. & Schwarz, D.W.F. (1995a). Intonation of musical intervals by musical intervals by deaf subjects stimulated with single bipolar cochlear implant electrodes. *Hearing Research*, *89*, 203-211.

Pijl, S. & Schwarz, D.W.F. (1995b). Melody recognition and musical interval perception by deaf subjects stimulated with electrical pulse trains through single cochlear implant electrodes. *Journal of the Acoustical Society of America*, *98*, 886-895.

Platel, H., Price, C., Baron, J.-C., et al. (1997). The structural components of music perception: A functional anatomical study. *Brain*, *120*, 229-243.

Pretorius, L.L. & Hanekom, J.J. (2011). Perception of some melodic characteristics by cochlear implant users: an exploratory study. *(In review)*

Pretorius, L.L. & Hanekom, J.J. (2008). Free field frequency discrimination abilities of cochlear implant users. *Hearing Research*, *244*, 77-84.

Pretorius, L.L., Hanekom, J.J. & Venter, P.J. (2010). Rhythm perception by cochlear implantees in conditions of varying pitch. *(In review)*

Purwins, H., Herrera, P., Grachten, M., et al. (2008). Computational models of music perception and cognition I: The perceptual and cognitive processing chain. *Physics of Life Reviews*, *5*, 151-168.

Reed, C.M. & Delhorne, L.A. (2005). Reception of environmental sounds through cochlear implants. *Ear and Hearing*, *26*, 48-61.

Rubinstein, J.T. (2004). How cochlear implants encode speech. *Current Opinion in Otolaryngology Head and Neck Surgery*, *12*, 444-448.

Samson, S., Ehrlé, N. & Baulac, M. (2001). Cerebral substrates for musical temporal process. *Annals of the New York Academy of Sciences*, *930*, 166-178.

Schonwiesner, M., Rübsamen, R. & Von Cramon, D.Y. (2005). Hemispheric asymmetry for spectral and temporal processing in the human antero-lateral auditory belt cortex. *European Journal of Neuroscience*, *22*, 1521-1528.

Schulkind, M.D. (2004). Conceptual and perceptual information both influence melody identification. *Memory and Cognition*, *32*, 841-851.

Schuppert, M., Münte, T.F., Wieringa, B.M., et al. (2000). Receptive amusia: Evidence for cross-hemispheric neural networks underlying music processing strategies. *Brain*, *123*, 546-559.

Scott, S.K. & Johnsrude, I.S. (2003). The neuroanatomical and functional organization of speech perception. *Trends in Neurosciences*, *26*, 100-107.

Semple, M.N. & Scott, B.H. (2003). Cortical mechanisms in hearing. *Current Opinion in Neurobiology*, *13*, 167-173.

Shannon, R.V. (1989). Detection of gaps in sinusoids and pulse trains by patients with cochlear implants. *Journal of the Acoustical Society of America*, *85*, 2587-2592.

Shannon, R.V. (2005). Speech and music have different requirements for spectral resolution. *International Review of Neurobiology*, *70*, 121-134.

Shannon, R.V., Fu, Q.J., Galvin, J., et al. (2004). Speech perception with cochlear implants. In F.-G. Zeng, A. N. Popper, & R. R. Fay (Eds). *Cochlear implants: auditory prostheses and electric hearing* (pp. 334-376). New York: Springer.

Shannon, R.V., Zeng, F.-G., Kamath, V., et al. (1995). Speech recognition with primarily temporal cues. *Science*, *270*, 303-304.

Singh, S., Kong, Y.Y. & Zeng, F.-G. (2009). Cochlear implant melody recognition as a function of melody frequency range, harmonicity, and number of electrodes. *Ear and Hearing*, *30*, 160-168.

Smith, Z.M., Delgutte, B. & Oxenham, A.J. (2002). Chimaeric sounds reveal dichotomies in auditory perception. *Nature*, *416*, 87-90.

Stevens, S.S. (1955). The measurement of loudness. *Journal of the Acoustical Society of America*, *27*, 815-829.

Stevens, S.S. (1935). The relation of pitch to intensity. *Journal of the Acoustical Society of America*, *6*, 150-154.

Stewart, L., Overath, T., Warren, J.D., et al. (2008). fMRI evidence for a cortical hierarchy of pitch pattern processing. *PLoS ONE*, *3*, e1470-e1475.

Sucher, C.M. & McDermott, H.J. (2007). Pitch ranking of complex tones by normally hearing subjects and cochlear implant users. *Hearing Research*, *230*, 80-87.

Swanson, B., Dawson, P. & McDermott, H. (2009). Investigating cochlear implant place-pitch perception with the Modified Melodies test. *Cochlear Implants International*, *10*, 100-104.

Throckmorton, C.S. & Collins, L.M. (2001). A comparison of two loudness balancing tasks in cochlear implant subjects using bipolar stimulation. *Ear and Hearing*, *22*, 439-448.

Tillman, B., Bharucha, J.J. & Bigand, E. (2000). Implicit learning of tonality: a self-organizing approach. *Psychological Review*, *107*, 885-913.

Townshend, B., Cotter, N., Van Compernolle, D., et al. (1987). Pitch perception by cochlear implant subjects. *Journal of the Acoustical Society of America*, *82*, 106-115.

Trainor, L.J., McDonald, K.L. & Alain, C. (2002). Automatic and controlled processing of melodic contour and interval information measured by electrical brain activity. *Journal of Cognitive Neuroscience*, *14*, 430-442.

Trainor, L.J. & Trehub, S.E. (1994). Key membership and implied harmony in Western tonal music: developmental perspectives. *Perception and Psychophysics*, *56*, 125-132.

University of South Africa (1970). *Aural tests: For the guidances of teachers and candidates preparing for the examinations of the University of South Africa* (Primarynd ed.). Pretoria: University of South Africa.

Van Zuilenberg, P.L. (1996). *Practical musicianship: Pre-grade 1- Grade 3*. Pretoria: University of South Africa.

Vongpaisal, T., Trehub, S.E. & Schellenberg, E.G. (2009). Identification of TV tunes by children with cochlear implants. *Music Perception*, *27*, 17-24.

Vos, P.G. & Troost, J.M. (1989). Ascending and descending melodic intervals: statistical findings and their perceptual relevance. *Music Perception*, *6*, 383-396.

Warren, J. (2008). How does the brain process music? *Clinical Medicine*, *8*, 32-36.

Wessinger, C.M., Vanmeter, J., Tian, B., et al. (2001). Hierarchical organization of the human auditory cortex revealed by functional magnetic resonance imaging. *Journal of Cognitive Neuroscience*, *13*, 1-7.

Wier, C.C., Jesteadt, W. & Green, D.M. (1977). Frequency discrimination as a function of frequency and sensation level. *Journal of the Acoustical Society of America*, *61*, 178-184.

Wilson, B.S. & Dorman, M.F. (2007). The surprising performance of present-day cochlear implants. *IEEE Transactions on Biomedical Engineering*, *54*, 969-972.

Wilson, B.S. & Dorman, M.F. (2008). Cochlear implants: A remarkable past and a brilliant future. *Hearing Research*, *242*, 3-21.

Woods, D.L. & Alain, C. (2009). Functional imaging of human auditory cortex. *Current Opinion in Otolaryngology Head and Neck Surgery*, *17*, 407-411.

Zatorre, R. (2003). Neural specializations for tonal processing. In I. Peretz & R. Zatorre (Eds). *The cognitive neuroscience of music* (pp. 231-246). Oxford: Oxford University Press.

Zatorre, R.J. (2001). Neural specializations for tonal processing. *Annals of the New York Academy of Sciences*, *930*, 193-210.

Zatorre, R.J. & Belin, P. (2001). Spectral and temporal processing in human auditory cortex. *Cerebral Cortex*, *11*, 946-953.

Zatorre, R.J., Belin, P. & Penhune, V.B. (2002). Structure and function of auditory cortex: Music and speech. *Trends in Cognitive Sciences*, *6*, 37-46.

Zatorre, R.J., Evans, A.C. & Meyer, E. (1994). Neural mechanisms underlying melodic perception and memory for pitch. *Journal of Neuroscience*, *14*, 1908-1919.

Zeng, F.-G. (2004). Trends in cochlear implants. *Trends in Amplification*, *8*, 1-34.

Zeng, F.-G. (2002). Temporal pitch in electric hearing. *Hearing Research*, *174*, 101-106.

Zwicker, E. & Fastl, H. (1999). *Psychoacoustics: Facts and models* (2nd ed.). Berlin: Springer.

Appendix A

COCHLEAR IMPLANT SAMPLE SELECTION

A.1 CONTEXT OF RECRUITMENT

The context in which the sample of CI participants was recruited and selected for participation deserves mention. The Pretoria Cochlear Implant Programme is one of only five academic CI centres in South Africa. Of these, the Tygerberg Cochlear Implant Unit and the Pretoria Cochlear Implant Programme are the oldest, with the other three having been established only after 2009. At the time of data collection for the current study (2005–2009) only a limited group of CI recipients were thus available for recruitment to participate in research studies, a constraint exacerbated by the decision to include only post-lingually deafened adult CI recipients in this study. Furthermore, most of the CI research conducted at these academic implant centres pertain to clinical application and rehabilitation; the research group at which the study reported in this thesis was conducted is the only in the country that focuses on the technology that supports CI hearing.

The benefit cochlear implantation affords profoundly deaf individuals paradoxically also complicates recruitment of participants for research that involves substantial time commitment from them. The improved quality of life afforded by cochlear implantation allows many implantees to stand in demanding jobs and lead busy social and family lives.

This greatly impacts on their time availability and although the majority have expressed willingness to contribute to CI research, the time commitment required from them in a study of the nature reported in this thesis, is impractical.

The nature of sound field studies further impacts participant availability, since experimental conditions as controlled as possible need to be created. Participants thus have to travel to the research facility, whereas electrode-level studies are less prone to such logistic constraints. Furthermore, even when participants are committed to participating in research and set time aside for experiments after or before work hours and over weekends (as several have done over the course of this study), the investigator should strive for study designs that are practical for both parties and which do not become too drawn out so as to minimise the risk of non-completion. Aligning all parties’ schedules becomes challenging when one considers these logistical constraints.

New CI centres established recently (as mentioned earlier) offers the opportunity for access to a larger potential local research population. Also, the insights and experience regarding relevant experimental design that have emerged from this study, creates an opportunity for improved intercentre collaboration, which would not only facilitate more authoritative studies to be conducted but also establish a stronger CI research community in South Africa.

A.2 PARTICIPANTS' DETAILS

Relevant demographic details of CI participants are provided in Table A1. Please note that, owing to listeners' time availability and the study having spanned several years, the same group of listeners did not participate in all investigations reported in the respective chapters. Each listener's participation in specific investigations is specified in Table A1.

Functional hearing ability of all CI participants, as rated by the treating audiologist at the local implant centre, is shown in Table A2. The rating instrument is based on the Abbreviated Profile of Hearing Aid Benefit questionnaire (Cox & Alexander 1995), but has been adapted slightly to allow for assessment by the audiologist. Assessment is done according to a 7-point Likert-type scale whereby the frequency of a listener's hearing success in various conditions is rated. The scale ranges from 1 (always) to 7 (never). The assessment regarding general perceptual success experienced with the CI device is a composite value based on the ratings for the preceding categories.

Table A1: Demographic particulars of participants. Some participants received new processor or map settings between investigation and hence have double entries. Asterisks indicate bilaterally implanted subjects.
F = female; M = male; YoB = year of birth; FAT = frequency allocation table (only applicable to investigation reported in Chapter 2); YoI = year of implantation

Subject (Gender)	YoB	Chapter	Implant	Processor	Strategy	FAT	YoI	Test ear
S3 (F)	1949	2	24R (CA)	Esprit 3G	ACE (500 Hz)	7	2004	Right*
		3, 4, 5	24R (CA)	Freedom	ACE (500 Hz)	NA	2004	Right*
S4 (M)	1970	5	CI24M	Freedom	ACE (900 Hz)	NA	2000	Left
S5 (F)	1967	3, 5	24M	Esprit 3G	Speak (250 Hz)	NA	1999	Right
		4	24M	Freedom	Speak (250 Hz)	NA	1999	Right
S8 (M)	1950	4,5	Nucleus 22	Freedom	Speak (250 Hz)	NA	1995	Right*
S10 (F)	1953	2	24M	Esprit 3G	ACE (900 Hz)	6	2000	Right
		4, 5	24M	Freedom	ACE (900 Hz)	NA	2000	Right
S11 (F)	1944	2	24 Freedom (CA)	Freedom	ACE (720 Hz)	22	2005	Left*
		3	24M	Freedom	ACE (900 Hz)	NA	1999	Right*
S12 (M)	1984	3, 4 & 5	Freedom	Freedom	ACE (1200 Hz)	NA	2006	Right
S13 (F)	1950	2	24R (CA)	Freedom	ACE (900 Hz)	20	2004	Left*
S14 (M)	1984	2, 5	24R (CS)	Esprit 3G	ACE (900 Hz)	7	2004	Right
S15 (F)	1988	3	24R (CA)	Freedom	ACE (900 Hz)	NA	1992	Left*
S16 (F)	1988	3	Not available	Freedom	ACE (Not available)	NA	1996	Right*
S17 (F)	1949	3	24R (CA)	Sprint	ACE (900 Hz)	NA	2005	Right

S18 (M)	1943	4, 5	Freedom (CA)	Freedom	ACE (1200 Hz	NA	2003	Right*
S21 (F)	1970	4	Freedom (CA)	Freedom	ACE (1200 Hz)	NA	2007	Left

Table A2: Rating of functional hearing ability of CI participants

	Participant						
Description of perceptual ability[a]	**S3**	**S4**	**S5**	**S8**	**S10**	**S11**	**S12**
Able to follow a conversation with familiar speaker, in quiet listening environment	2	1	3	2	4	2	2
Able to follow a conversation in quiet listening environment, even when speaker is not familiar	3	2	4	2	4	2	2
Able to follow a conversation/speech in room with substantial echoes	4	3	4	3	5	3	2
Able to follow a whisper conversation/soft speech	3	3	3	2	4	2	2
Able to follow a conversation/speech without visual cues (e.g. radio talk show)	3	3	3	2	5	3	3
Able to use a telephone successfully	5	5	5	3	6	3	3
Able to follow a conversation amidst other speech noise (e.g. at a party, in a restaurant)	4	5	5	3	6	3	3
Able to follow a conversation in an environment with substantial background noise (which is not speech)	4	4	5	3	6	3	3
Find environmental sounds (e.g. rain, wind, a passing aeroplane, thunder, construction noise, washing machine, etc.) disturbing	2	3	5	5	3	4	5
General CI-mediated perceptual success[b]	3	2	3	1	4	2	2

[a] The scale used for rating perceptual ability items is as follows:
1 = always; 2 = almost always; 3 = usually; 4 = half the time; 5 = occasionally; 6 = seldom; 7 = never.

[b] The scale for rating general perceptual success with the CI device is:
1 = excellent; 2 = very good; 3 = good; 4 = average; 5 = below average; 6 = poor; 7 = very poor

Table A2 (continued): Rating of functional hearing ability of CI participants

	Participant						
Description of perceptual ability[a]	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S21**
Able to follow a conversation with familiar speaker, in quiet listening environment	1	1	2	4	1	2	2
Able to follow a conversation in quiet listening environment, even when speaker is not familiar	2	2	2	4	2	2	2
Able to follow a conversation/speech in room with substantial echoes	3	3	2	5	2	3	2
Able to follow a whisper conversation/soft speech	2	2	2	4	2	2	2
Able to follow a conversation/speech without visual cues (e.g. radio talk show)	2	2	3	5	3	3	2
Able to use a telephone successfully	2	2	3	6	5	3	2
Able to follow a conversation amidst other speech noise (e.g. at a party, in a restaurant)	3	3	2	5	5	3	3
Able to follow a conversation in an environment with substantial background noise (which is not speech)	3	3	2	5	5	3	3
Find environmental sounds (e.g. rain, wind, a passing aeroplane, thunder, construction noise, washing machine, etc.) disturbing	4	5	5	4	3	5	5
General CI-mediated perceptual success[b]	1	1	1	4	4	2	1

[a] The scale used for rating perceptual ability items is as follows:
1 = always; 2 = almost always; 3 = usually; 4 = half the time; 5 = occasionally; 6 = seldom; 7 = never.

[b] The scale for rating general perceptual success with the CI device is:
1 = excellent; 2 = very good; 3 = good; 4 = average; 5 = below average; 6 = poor; 7 = very poor