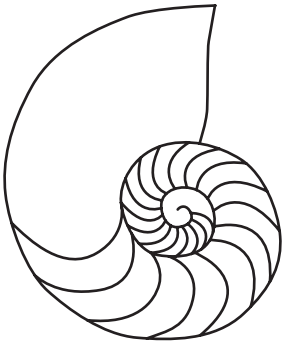
On the Color of Voices

The relationship between cochlear implant users' voice cue perception and speech intelligibility in cocktail-party scenarios

Nawal El Boghdady



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Abstract

Cochlear implant (CI) users experience severe difficulties understanding speech in crowded environments, especially when more than one person are speaking simultaneously (the cocktail-party setting). In this dissertation, the hypothesis was that such a difficulty could be largely attributed to the poor representation of voice cues in the implant arising from degraded spectrotemporal resolution from signal processing strategies. Human voices are characterized not only by their F0 (i.e. their pitch), but also by a second dimension called the vocal-tract length (VTL). This dimension directly scales with the size of the speaker and, therefore, plays a crucial role in the distinction between male and female talkers, or between adults and children.

In CI users, most spectral aspects of F0 are lost, but temporal aspects are largely preserved, allowing a degraded but persistent pitch percept. VTL perception, however, entirely depends on the ability of the listener to perceive some spectral features that appear to be lost in the implant. In this dissertation, the following research questions were investigated: whether CI users' speech intelligibility in the presence of a competing talker (speech-on-speech; SoS) is related to their sensitivity to the underlying F0 and VTL differences between the speakers, whether this relationship is influenced by the inherent spectral resolution in the implant, and whether optimizing signal processing strategies could improve the perception of such cues.

Results from this dissertation demonstrated that CI users' SoS intelligibility was related to their sensitivity to both F0 and VTL cues, and that this relationship was influenced by the inherent spectral resolution in the implant. In addition, spectral enhancement techniques and optimization of frequency quantization maps in the implant were both shown to contribute to an improvement in SoS intelligibility and VTL sensitivity, respectively. These findings lay the foundations for future coding

strategies and optimization techniques that aim to improve CI users' speech intelligibility in noisy settings.

Keywords: cochlear implant, voice, cocktail-party, F0, vocal-tract-length, spectral resolution, channel interaction, spectral enhancement, frequency quantization map

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