Perceptual contribution of fundamental frequency contour and its implication to assistive hearing devices for Chinese-speaking hearing-impaired users

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Abstract

For Chinese speech perception, tonal information mainly carried by fundamental frequency (F0) contour plays an important role to lexical tone identification. Recent work showed that for Mandarin sentence recognition at ideal listening conditions (e.g., in quiet), the distortion of F0 contour can be compensated by other contextual cues, and hence F0 contour may be treated as relatively redundant cue for Mandarin sentence intelligibility in quiet. However, at adverse listening conditions (e.g., in noise), tone contour is important for the recognition of Mandarin sentences. The present work assessed the contribution of F0 contour to Mandarin speech perception simulating two scenarios of 1) high-frequency hearing loss and 2) understanding frequency-compressed speech.

In Experiment 1, the wideband Mandarin speech was first processed to have a flat F0 contour, and then low-passed filtered, which simulated the high-frequency hearing loss. In Experiment 2, the F0-flattened Mandarin sentences were processed by a non-linear frequency compression strategy, which compressed the spectral information up to 700 Hz to 500 Hz (Chen and Chan, JASA, 2016). The processed stimuli were presented to normal-hearing Mandarin-speaking listeners to recognize, and the intelligibility scores were compared with those of counterpart conditions with normal F0 contour.

Results showed that flattening F0 contour significantly reduced the intelligibility of low-pass filtered and frequency-compressed Mandarin speech, compared with conditions with normal F0 contour. This indicates the importance of preserving F0 contour for Mandarin speech perception in conditions of high-frequency hearing loss and designing assistive hearing techniques (e.g., frequency compression) for Chinese-speaking hearing-impaired users.

Index Terms: Chinese speech perception; fundamental frequency contour; assistive hearing devices; frequency compression