Perception of Tone and Intonation in noisy environments

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Tone is an important phenomenon in the distinction of lexical items in tone languages hence a lot of research has gone on to understand how it is perceived. Specifically, there has been a need to understand how noise affects tonal perception. A study was carried out recently to investigate the level of perception of American English and Igbo in noisy environments. Four speakers – two adult Igbo speakers and two adult American English speakers – were used to generate data for the study. They produced one hundred and seventy six (176) speech samples. The duration of the pairs of the utterances was between eight and twelve (12) seconds as used in the ITU – T PESQ and POLQA standardization efforts. Various types of added noise comprising babble, car noise, restaurant noise, multiplicative noise, etc. were used to degrade the speech samples. Twenty four speakers of Igbo and twenty four speakers of American English were made to listen to these speech samples. The perception of the Igbo speakers were discovered to be more hampered than the perception of American English speakers. A confirmatory experiment was further conducted with the Igbo subjects. They were given two hundred (200) degraded Igbo speech samples to listen to. Their perception of these words were however also hampered though to a lesser degree. That noise also hampered the Igbo subjects' perception of the Igbo database negates the reports of some earlier scholars that in a noisy environment, one can achieve a high level of perception of tone. The argument is that in a noisy environment, the perception of consonants and vowels is low while that of tone can be high. In practical terms, this argument cannot hold since it is the consonants and vowels that bear the tones which give the phonemes their sounds. Thus, if the perception of the phonemes is lowered by noise, the perception of the tones will consequently not be high. The following observations were generally made from the study:

1. Igbo speakers are more disturbed by additive (extraneous) noise than American English speakers hence one could state that from a quality perspective, tonal languages are more enhanced by noise suppression than intonation languages. In other words, perception of tone languages is more enhanced in quiet environments (when compared to noisy environments)

while the perception of intonation languages are not so much enhanced in quiet environments (when compared to noisy environments).

2. Dynamic sound filtering which suppresses noise in silent intervals and filters noise in speech active intervals, depending on the power spectrum, should provide a larger speech quality enhancement for a tone language like Igbo than those available for intonation languages.

The findings of this research confirm those of a previous study in which acoustic analysis was used to determine the harmonics-to-noise ratio of English and Ika Igbo intonation patterns. Ika Igbo, in addition to lexical tone, manifests intonation system that is similar to what exists in English. Sixteen utterances (eight English and eight Igbo) were pronounced by male native speakers, fed into the computer and digitized at 8000 kHz. The cross – correlation method was used to obtain their harmonic-to-noise ratios (degree of acoustic periodicity). The analysis showed that Ika Igbo had lower harmonic-to-noise ratio than English and that it could be the existence of tone in the former that resulted in this. Thus, we may conclude from the two studies that tone language perception is hampered in noisy environments because tone results in lower periodicity (voicing) and this appears to be heightened in noisy environments. Thus this has to be considered in manufacturing speech perception enhancement gadgets for Igbo speakers.