

Temporal Perceptual Cues of Velar and Bilabial Stop Consonants

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Human speech perception is an area under study since several decades and still remains as an unsolved puzzle. With the emergence of knowledge on the speech production differences in various languages, perceptual processes are being studied in different languages of the world.

The present study, aims to determine the effect of closure duration, preceding vowel duration, transition durations of preceding and following vowels and VOT on the perception of medial geminate unaspirated bilabial and velar stop consonants across the language groups of Kannada and Hindi.

Four meaningful Kannada words with the geminate bilabial and velar stop consonants (/akka/, /agga/, /appa/ and /abba/) were chosen for the experiments. The study involved the perceptual judgement of 10 native Kannada (5 males and 5 females) speakers and 5 native Hindi speakers (4 males and 1 female) in an age range of 15 to 35 and 15 to 25 years respectively.

The test stimuli were synthesized by analysis-by-synthesis/synthesis-by-rule methods. Five different experiments were conducted to determine the effect of the various temporal parameters.

The first experiment dealt with the variation in closure duration of the stop consonants /kk/, /gg/, /pp/ and /bb/ in the words /akka/, /agga/, /appa/ and /abba/ which were synthesized by truncating the closure duration in 10 ms steps, till the stops had almost no closure duration (<10ms). The second experiment dealt with the duration of the preceding vowel, wherein, the effect on perception was studied by truncating the steady state of the initial vowel in these words in 10ms steps, till the duration of the vowel was reduced to half its value.

The third experiment involved the determination of the effect on the perception of the stop consonants by truncating the transition duration (of F1, F2 and F3) of the preceding vowel, in 10ms steps along with one stimulus of F1 cutback.

In the fourth experiment the transition duration (of F1, F2 and F3) of the following vowel was truncated in 10ms steps and one stimulus with F1 cutback was synthesized.

The fifth experiment evaluated the effect of reducing the VOT in 10ms steps till the stop consonants had almost no VOT (<10ms).

In total there were 91 stimuli. All these were audio recorded three times each. The various test stimuli of all the 5 experiments were played on an audio-cassette for the perceptual judgement of 15 subjects (one at a time).

The results of the judgement were assessed in terms of the effect of the temporal parameters on voicing and clustering features of the stop consonants. An attempt was also made to study the differences in perception among males and females and across native Kannada and Hindi speakers.

It was observed that there existed no differences across the languages and between the two sexes except for F1 cutback.

The results indicted the following :

1. There was a change in the percept from cluster to non-cluster as closure duration was reduced.
2. The percept changed from voiceless to voiced with a reduction in closure duration.
3. Preceding vowel duration and the transition duration of the preceding vowel did not influence the perception of stop consonants.
4. Following vowel transition did not have any influence on the stop perception except for F1 cutback. Under F1 cutback condition for voiced stops, females reported a perception of voiceless whereas under F1 cutback condition for voiceless stops, males reported to have perceived voiced stop.
5. VOT did not seem to cue voicing or clustering.

A ranking of the cues for the voicing and clustering features was noticed in terms of major and minor cues. Voicing seemed to have major cues of closure duration, VOT and transition duration of the following vowel (in order), while clustering seemed to be primarily cued by closure duration, with the others relegated to the background.

It could be concluded that the perceptual process perhaps, takes into consideration first the major cues

for a particular feature, which when absent, might lead to the consideration of the other cues in the rank order. However, the interaction among the major and minor cues seems to be necessary, when several features have the same cue.

The results of this study has contributed to enhance the knowledge in the field of speech perception. This warrants the necessity to study the effect of multiple cues of a percept and the interaction of these cues.

For Hindi speakers, 2 words /akka/ and /agga/ are meaningless, whereas for Kannada speakers all the four words are meaningful. This negates the participation of semantic processing in Hindi speakers which involves higher cortical areas (Wernicke's, supramarginal and Angular gyrus). The results indicate no difference in the percept by Kannada and Hindi speakers. This suggests non-participation of semantic processing areas for these percepts. This could be further tested by embedding the synthetic words in meaningful Kannada and Hindi sentences and presenting it to listeners.

Also, different patients with lesions in specific areas of the auditory pathway could be tested to obtain a knowledge on speech processing in the auditory pathway. This would enable us to enhance the speech processing in speech and hearing handicapped.