Perceptual Gender Identity of Voices in Pre-pubertal children

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Abstract

The present study investigated sexual dimorphism in voices of children. Ten children each in the age group of 4-5 years and 5-6 years participated in the study. Listener's identification of gender in phonation and speech tasks were obtained. Results revealed that gender identification was better in the older age group, and in speech compared to phonation. The results are discussed with reference to perceptual cues taken by the listeners to identify the gender of the preadolescents.

Key words: Voice, Prepubertal, Perceptual, gender identity

It is widely assumed that listeners are able to identify the gender of a person through the recordings of speech. Lass,Schwartz, Coleman (1976) stated that listeners can accurately differentiate the recorded voices of men and women and these perceptions are related to acoustic variable reflecting their gender differences in overall head and neck size. Listeners have no difficulty in differentiating the voice of adult men and women on the basis of voice alone suggesting that the acoustic parameters which underlie gender identity in adult voice are prominent. Indeed both phonation and vocal tract resonances appear to provide highly relevant information about the sex of an adult speaker (Lass et.al, 1976). Negus (1949) pointed out that larynx develops most rapidly between three and five years and during puberty.

Until recently, the extent of our knowledge regarding gender differences of children's voices consisted of speculative comments and opinions. Several investigators have revealed that gender characteristics in voice are indeed perceptually prominent in many pre pubertal speakers. Curry (1940) suggested that the voices of boys and girls are highly similarly prior to pubescence. Moses (1954) on the other hand believes that gender differences in children's voices emerge early in life. Bennett and Weinberg (1971) were the first to report on the gender identification by voice in preadolescents. They recorded 66 spontaneous speech samples of 5-6 year old children and 61 listeners heard the recorded samples of each child. The listener's task was to identify the gender of the child and the results indicated that 78% of listeners identified male voices correctly and for 71% of listeners identified female voice correctly.

Bennett and Weinberg (1978) studied the acoustic cues that influenced the listener's judgments of gender identity in children. They tool recordings of 73 children (6 to 7 years) of four utterance types – whispered and normally phonated vowels , spoken sentences in normally and monotonous fashion. Perceptual judgments of gender identity is obtained in response to these recordings and they reported many of their 6to 7 years old children showed sexual dimorphism in their voices. Peta-white (2000) studied a total of 44 children in the age of 1 to 11 years in three tasks – singing a song, repeating syllable /pa/ at three loudness levels and speaking vowels. The results indicated significant differences in LTAS spectrum (variability in high frequency region), formant frequencies and glottal waveform which gives substantial evidence that significant gender specific articulatory behaviors occur in childhood which enhance gender distinction in voice.

Rashmi (1983) also studied various acoustic parameters in 220 children of age range of 4 to 15 years and found that F0 in phonation decreased gradually in females and in males there was a sharp decrease after 14 years. More recently in 2001, Perry, Ohde and Ashmead took vocal recordings on seven diphthongal vowels of American English and gross physical measurements of 4,8,12,16 year old children (10 boys and 10 girls per age group). 20 adults rated the voices of children based on seven point gender rating scale and results indicate that vowel formant frequencies differentiate children's gender as young as four years of age. It has also been reported earlier that intonation patterns also provide listeners with perceptually relevant information. Regarding this, Richards (1975) has reported the differences in the intonation patterns /contours of adult men and women.

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Literature supports the gender related perceptual differences present in the voices of preadolescents in western population. But this kind of information is limited in Indian scenario. The present work was undertaken to broaden the understanding of perceptual sexual identity in the voices of pre pubertal children in Indian population. Therefore this study proposed to find the earliest age at which preadolescents can be identified correctly as male or female by their voices.

Method

Subjects

The subjects considered here were 5 boys and five girls each, ranging in the age from 4 to 5 years and five to six years. All the subjects were from mono lingual home and spoke the dialect common to respective region. Subjects were free from vocal abnormalities and demonstrated error free production of experimental utterances.

Material

The material consisted of two tasks. 1) Phonation of vowel /a/, and 2) three spoken sentences in Kannada language. These sentences were / ha:lu kudi:ta ida:ne/, /hallu udzutha ida:ne/, and /batte ha:ko:ltha ida:ne/. These sentences were chosen so as to avoid any kind of possible cues for speaker gender recognition. Elicitation of sentences is done by using picture cards.

Procedure

Tape recordings were obtained from each child producing sustained phonation of vowel /a/ in a normally phonated mode. Then children were presented picture cards and they were asked to describe them. Recordings were made in the quiet room using a high fidelity tape recorder. (Sony TCM 150)

Perceptual judgments

Tape recorded samples obtained from these children were given for perceptual judgments to 20 judges who were adult native Kannada speakers proficient in language. Judges were young adult males and females (10 each) in the age range of 19 to 30 years with normal hearing acuity. The judges were not related directly or indirectly to any speech and hearing services. None of the judges were familiar with the subjects selected. The judges were asked to listen to each utterance carefully and indicate whether the sample (phonation and speech) was of a boy or girl.

Intrajudge reliability

Each judge was asked to listen to the samples for a second time after a span of one week to verify the intrajudge reliability. If the intra judge reliability was less that 50 % in either phonation or speech sample, that judge was excluded from the study and the sample was given to another judge for perceptual evaluation. There fore it was ensures that intrajudge reliability of all the judges in the study were 50% or above. During the perceptual evaluation, six judges were eliminated in each age group because of poor reliability scores (50%). Reliability analysis of SSPS package (version10.0) was used to calculate the intra and inter judge reliability.

Results

Percentage of correct gender identification

Results indicated better than chance identification of gender in 5-6 years of age, and in speech task compared to phonation. Table 1 shows the percentage of correct identification of gender in both age groups with respect to both phonation and speech tasks.

	Phonation		Speech	
	4-5 years	5-6 years	4-5 years	5-6 years
Boys	38%	73%	52%	66%
Girls	45%	61%	58%	58%

Table1: Percentage corrects identification in phonation and speech.

In phonation task, 38% of males, 45% of girls were identified correctly in 4-5 years age group whereas in 5-6 years, 73% of males and 61% of girls were identified correctly. This indicated that in phonation task, there is large variation in the identification of gender between both the age groups. In addition, data reveals that girls are better identified than boys in both the age groups in the phonation task.

For speech task, 52% of boys and 58% of girls were indentified correctly in 4-5 years group where as 66% of boys and 58 % of girls were identified correctly in 5-6 years group by the listeners. Figure 1 depicts the percentage of correct identification of both boys and girls with respect to phonation and speech tasks.

Association of perceptual identification and age

Chi-square revealed no significant association between age and perceptual judgments in speech task, ($p>0.005$) and a high significant association between age group and judgments ($p<0.001$) in phonation task. Table 2 shows the association between perceptual

judgments and age in both phonation and speech tasks.

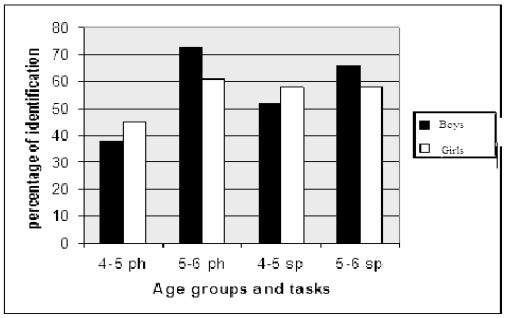

Figure 1: Percentage of correct identification of both genders in phonation and speech tasks.

	Phonation		Speech	
	Correct	Incorrect	Correct	Incorrect
4-5 years	83	117	110	90
5-6 years	134	66	124	76

Table 2: Number of correct and incorrect responses in both the groups in two tasks.

Association of perceptual identification and gender

Chi-square test revealed no significant association between gender and perceptual judgments in both tasks indicating that judges identified boys and girls equally. Table 3 shows association between the perceptual identification and gender of children.

Interjudge reliability analysis

The results revealed that high inter-judge reliability in phonation - 73.32% and 91.50 % in 4-5 and 5-6 years respectively. The interjudge reliability for younger group of children was lower compared to older group. This is indicative of more confusion in judging the gender from phonation samples of 4-5 years. In speech task, interjudge reliability was 87% and 88% respectively in the two groups. This suggests less variability in judgments of gender based on speech sample. Several additional cues like formant frequencies, place and manner of articulation, suprasegmental features abundant in speech can contribute to reason this.

	Phonation		Speech	
	Correct	Incorrect	Correct	Incorrect
Boys	111	89	118	82
Girls	106	94	116	84

Table 3: Association between judgments and gender.

Discussion

Till date there are research reports supporting that gender identification by the voices of prepubertal children in the western population. The results of present study indicate that more than 50% of listeners identified the gender of children correctly in both phonation and speech in 5-6 years. In 4-5 year old children, gender identification was better in speech samples (more than 50 % of times) compared to phonation. This finding can be explained on the basis of additional cues in speech such as suprasegmentals which include intonation, stress patterns and rate of speech.

The results indicated that the perceptual identification of gender was better at 5-6 years compared to 4-5 years. This can be explained on the basis that gender related changes in voice appear, as children grow older. Negus (1949) pointed out that larynx develops most rapidly between three to five years and during puberty. Also Crelin (1973) stated that the sex related changes in larynx begin to appear as early as third or fourth year. These structural modifications may result in age related fundamental frequency lowering. However, it is important to note that such sexual dimorphism in voice varied across race, geographical conditions and physical characteristics of the subjects. Hence it is very likely that in Indian children, sexual dimorphism in voice emerges in 5 years or so as the percentage of identification is more than 50%.

There was significant difference in the identification scores of gender in phonation task across the two age groups. The perceptual cues that are present in phonation are formant frequencies, fundamental frequencies etc. Eguchi & Hirish (1969) reported that variability of formant frequencies for vowels between subjects is independent of age and sex. Kirchner (1970) stated that the larynx of a preadolescent boy and girl is likely to be the same size given the same height and weight. It has been suggested that gender specific articulatory behavior, such as difference in jaw opening and lip rounding, could be of significance to the variance in formant frequencies between boys and girls.In the speech task, both the age groups were identified relatively with more ease. This could be due to dynamic cues like formant transitions, voice onset time, place and manner and co-articulatory patterns that are supplementary to speech unlike phonation. Perry, Ohde and Ashmead (2001) indicated that vowel formant frequencies differentiate children's gender as young as four years of age. Also suprasegmentals act as a cue for gender identification. In this context, Richards (1975) reported differences in intonation contours of men and women and if such differences exist in the voices of preadolescents it would give important gender relate information.

In both Phonation and speech, girls were better identified at the age of 4-5 years and boys were better identified at the age of 5-6 years. There is lot of evidence to support the fact that puberty takes place earlier in girls than boys. Fant (1966) argued that there are differences other than size between vocal tract anatomies in men and women and those children appear more like women in configuration of vocal tract. Kent (1967) reported that in the case of females, decrement of F0 in infancy to childhood is somewhat in excess of an octave where as males exhibit an overall decrease approaching two octaves. Zemlin, (1981) states that the prepubertal female is developmentally more mature. Also female larynx requires less growth per unit time to reach maturity. Another possibility that may be speculated is rate differences. Feminine speech sounds smooth and fast due to decrease in inter-word pause time, coupled with increase in phoneme duration (Avery and Liss, 1996) which would have some effect on the durational characteristics of speech. This could speculate a number of possibilities for perception of gender differences.

Conclusions

To conclude, it can be stated that sex related changes in voice begin early in life and continue through out life. It is said that age of onset of puberty varies greatly, and is determined by factors such as race, heredity and perhaps general nutrition among others. The present study revealed that sexual dimorphism exists for speech at a younger age whereas it emerges only by 5 to 6 years for phonation in Indian population. The information obtained in the study is of application in speaker verification tasks and preparation of synthetic speech stimuli. If we know that children's gender is identified as early as 4-5 years of age, this helps in forensic voice science in speaker verification tasks. However, this needs further research probing into acoustic parameters confirming the gender identification in the children as young as 5 years.

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