Perception of Tamil Laterals and Trills by Native and Non-Native Speakers

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Abstract

The present study investigated native (Tamil) and non-native (Hindi) speaker's ability to discriminate Tamil laterals and trills. Tamil has three laterals - the alveolar /l/, the retroflex /l. / and the retroflexed palatal / l̃ / and two trills - one flap /r/ and one trill /r̃/, but Hindi has only alveolar /l/ and flap /r/. So it was hypothesized that the ability of Hindi listeners in discriminating non-native laterals and trills will be poorer compared to Tamil listeners. A set of stimuli with minimal word pairs consisting of Tamil laterals and trills was prepared. Subjects were audio presented with the word pairs and were instructed to identify two words in a pair as 'same' or 'different'. ANOVA showed significant difference between groups with a score of 59% and 80% in non-native and native speakers, respectively.

Introduction

Developmental research has indicated that the influence of the native language on phonetic perception is evident by 10-12 months at least for some consonantal distinctions (Werker & Tees, 1984; Best, McRoberts & Sithole, 1988). Cross-language studies of adult speech perception have repeatedly shown that in tasks approaching the demands of natural language processing perception of non-native contrasts is often less accurate and efficient than perception of phonetic distinctions that convey meaning in the native language (Lisker & Abramson, 1970; Goto, 1971; Caramazza, Yeni-Komshian, Zurif & Carbone, 1973; Miyawaki, Strange, Verbrugge, Liberman, Jenkins & Fujimura, 1975; Strange & Jenkins, 1978; Best, MacKain, & Strange, 1981; Flege, 1984; Werker & Tees, 1984). The general claim about adult cross-language speech perception is also qualified by evidence that some non-native speech contrasts present greater perceptual difficulty than others (Eilers, Gavin & Sithole, 1988; Werker, Gilbert, Humphrey & Tees, 1981; Burnham, 1986; Best, McRoberts & Sithole, 1988). Thus a complete understanding of the role of linguistic experience in speech perception must address the diverse nature of phonetic categories themselves which may lead to variations in adult perception of different kinds of non-native speech distinctions.

The present study was designed to investigate the native (Tamil) and non-native (Hindi) speaker's ability to discriminate Tamil laterals and trills. Tamil is a language spoken by the native people of the state of Tamil Nadu, in South India. It is classified as a Dravidian language (Ladefoged & Maddieson, 1996). Tamil has three laterals - the alveolar /l/, the retroflex /l. / and the retroflexed palatal/ l̃ / and two trills - flap /r/ and a trill / r̃/. In the production of the alveolar

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/l/, the tip of the tongue has contact with the alveolar ridge in such a way that there is complete blockage of air in the middle of the mouth. In the production of the retroflex /l. /, the tip of the tongue is slightly curved and made to contact the middle of the palate. The air stream is completely blocked in the middle of the mouth. In the production of the retroflexed palatal /l̃ /, the tongue is curled back and the tip of the tongue is placed very near the roof of the mouth. The flap /r/ is produced by a single quick flap of the tongue at the alveolar arch. The breath escapes through the tip of the tongue and palate. This is described as a voiced alveolar flap. The trill / r̃ / is produced by the rapid vibrations by the tip of the tongue against the middle of the alveolar ridge. This is described as a voiced alveolar trill (Rajaram, 1972). Hindi is an Indo-Aryan language spoken in the northern parts of India and it has only one alveolar lateral /l/ and alveolar flap /r/. Table 1 shows laterals and trills in both the languages.

Table 1: Lateral and trills in Tamil and Hindi languages

	Tamil	Hindi
Laterals	Alveolar /l/	Alveolar /l/
	Retroflex /l./	–
	Retroflexed palatal / l̃ /	–
Trills	Alveolar flap /r/	Alveolar flap /r/
	Alveolar trill /r̃/.	–

Thus Hindi listeners are not exposed to retroflex /l. /, retroflexed palatal / l̃ / and alveolar trill /r̃/. Therefore it was hypothesized that the ability of Hindi listeners in discriminating non-native laterals and trills will be poorer compared to that of Tamil listeners.

Method

Subjects: Two groups of subjects participated in the study. All subjects had normal hearing, normal intelligence and had no history of ear discharge or earache. Group I consisted of 20 native Tamil speaking adults in the age range of 18-25 years (mean age - 20.9 years) with equal number of males and females. Group II consisted of 20 native Hindi speaking adults in the age range of 18 - 25 years (mean age - 20.8 years) with equal number of males and females.

Material: Eighty Tamil mono/bi/tri syllabic words with laterals and trills in word-medial and word-final position were considered. These words as uttered by a native Tamil adult female speaker (age - 22years) were audio-recorded (care was taken to see that the F0 pattern was same in both the words). Four sets of stimuli with word pairs were prepared, with minimal pairs contrasting in laterals and trills. All four sets had 20 word pairs. In set I each word pair had minimal pairs contrasting alveolar /l/ and retroflex /l. /. In set II the contrast was between retroflex /l. / and retroflexed palatal /l˜/. Set III had contrast between alveolar /l/ and retroflexed palatal /l˜/ and set IV had minimal pairs contrasting alveolar flap /r/ and alveolar trill /r ˜/. These word pairs were used to test the discrimination ability. In addition each word was paired with itself forming 40 word pairs in each set. These word pairs were used as catch trials. The word pairs were randomized in their corresponding sets and iterated thrice. The inter-stimulus interval used was 3 sec. Thus a total of 720 word pairs formed the material. For example if two words were CVlV - CVl.V then the word pairs will be (a) CVlV - CVl.V, (b) CVlV – CVlV and (c) CVl.V - CVl.V.

Procedure: Subjects were tested individually. They were audio-presented the material through headphones at comfortable listening levels. They were instructed to identify the words in a pair as 'same' or 'different' and record their response on a binary forced-choice response sheet which was provided to them. The responses were tabulated and percent 'same/different' were calculated.

Results and Discussion

In general results indicated that native Tamil speakers discriminated significantly better than non-native Hindi speakers on all four sets. Table 2 shows percent different scores obtained by male and female speakers of both groups on all four sets.

Table 2: Percent different scores in two groups across 4 sets of stimuli

Sets	Native Speakers			Non-native Speakers		
	M	F	A	M	F	A
Set I (l – l.)	66	81	74	59	63	61
Set II (l. - l̃)	77	86	81	58	56	57
Set III (l - l̃)	80	91	85	72	78	75
Set IV (r - r̃)	79	83	81	46	38	42
Average	76	85	80	59	59	59

(M = Male; F = Female; A = Average)

ANOVA showed a significant difference between groups [F (1, 36) = 17.858, ($p<0.05$)]. Hence independent t-test was done for all 4 sets between groups (i.e., native and non-native speakers) for males and females, separately. Results showed no significant difference between groups on Set I {male - [t (18) = 0.829, $p>0.05$]; female – [t (18) = 1.779, $p>0.05$]} and Set III {male - [t (18) = 0.832, $p>0.05$]; female - [t (18) = 1.609, $p>0.05$]} and a highly significant difference on Set II {male - [t (18) = 2.115, $p<0.05$]; female - [t (18) = 5.025, $p<0.05$]} and Set IV {male - [t (18) = 4.622, $p<0.05$]; female - [t (18) = 4.644, $p<0.05$]}. Independent t-test did not show any significant difference between gender [t (18) = 2.099, ($p>0.05$)] in both groups for all four sets. Also there was no significant interaction effect (gender x group) [F (1, 36) = 0.534, ($p>0.05$)].

Individual scores in both groups across four sets were examined. Subjects were stratified into two groups having good discrimination (>70%) and poor discrimination (<70%). In Set I (alveolar-retroflex lateral contrasts) 9 subjects (native) had poor discrimination and 11 subjects had good discrimination scores. Among non-native speakers 12 subjects had poor discrimination and 8 subjects had good discrimination scores. Figure 1 shows the individual scores obtained by both groups on alveolar-retroflex lateral contrasts.

In Set II (retroflex-retroflexed palatal contrasts) 2 subjects (native) had poor discrimination and 18 subjects had good discrimination scores. Among non-native speakers 15 subjects had poor discrimination and 5 subjects had good discrimination scores. Figure 2 shows individual scores obtained by both groups on retroflex-retroflexed palatal contrasts.

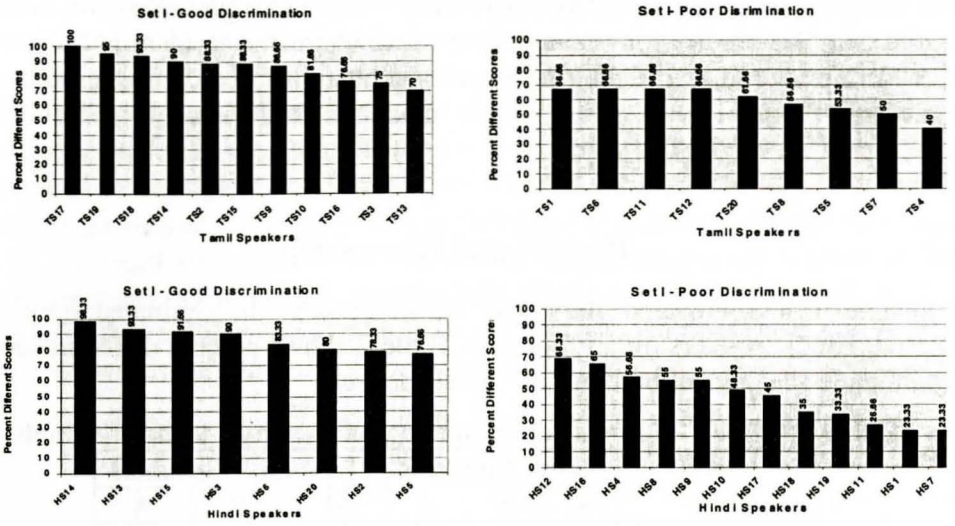

Figure 1: Individual scores obtained by both groups on alveolar - retroflex lateral contrasts

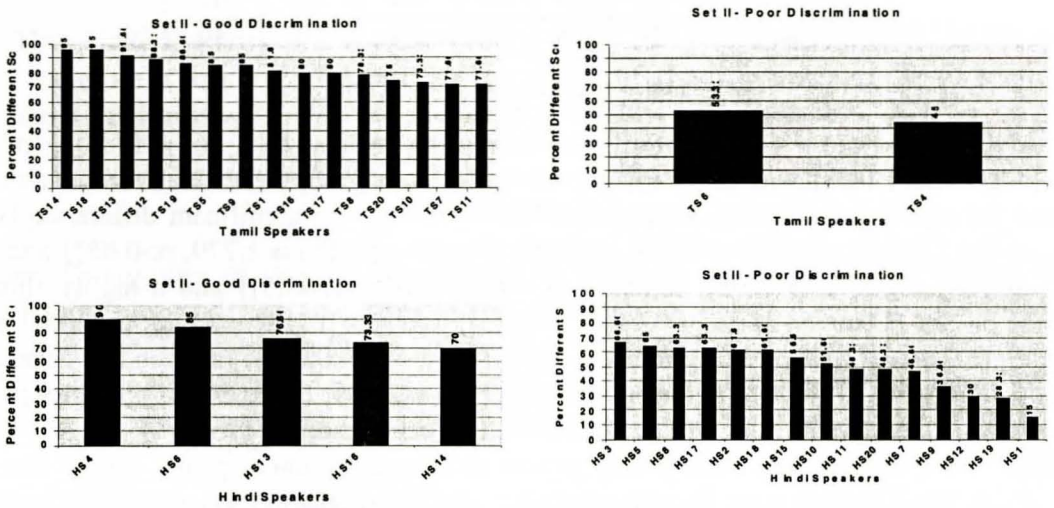

Figure 2: Individual scores obtained by groups on retroflex - retroflexed palatal lateral contrasts

In Set III (alveolar-retroflexed palatal lateral contrasts), 3 subjects (native) had poor discrimination and 17 subjects had good discrimination scores. Among non-native speakers, 6 subjects had poor discrimination and 14 subjects had good discrimination scores. Figure 3 shows the individual scores obtained by both groups on alveolar-retroflexed palatal lateral contrasts.

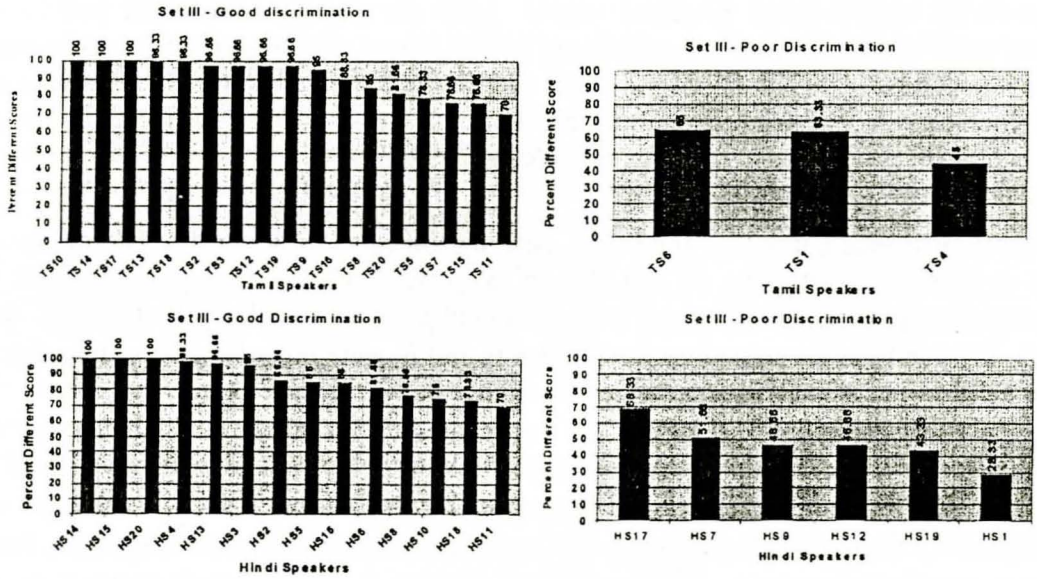

Figure 3: Individual scores obtained by groups on alveolar-retroflexed palatal lateral contrasts.

In Set IV (alveolar flap-alveolar trill contrasts), 2 subjects (native) had poor discrimination and 18 subjects had good discrimination scores. Among non-native speakers, 17 subjects had poor discrimination and 3 subjects had good discrimination scores. Figure 4 shows the individual scores obtained by both groups on alveolar flap-alveolar trill contrasts.

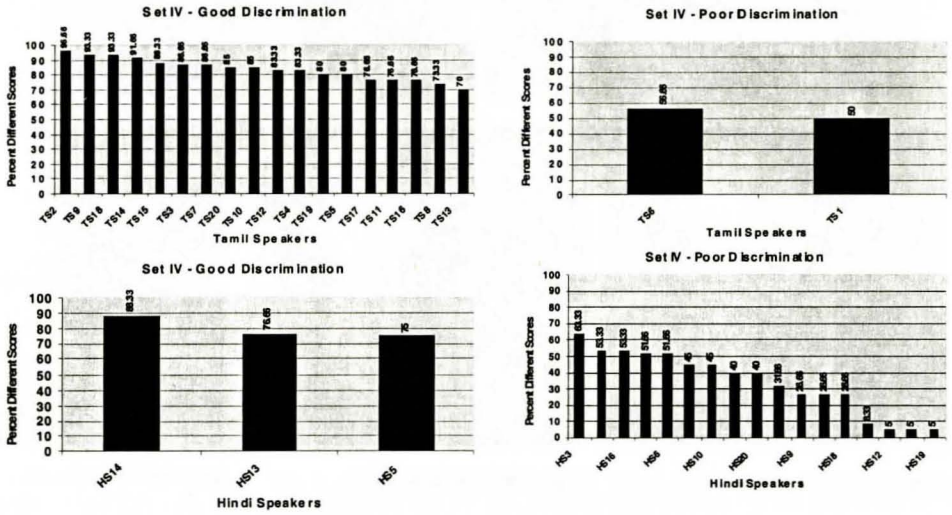

Figure 4: Individual scores obtained by both groups on alveolar flap - alveolar trill contrasts.

The results of the study indicated several points of interest. First of all the native speakers had significantly higher discrimination scores than non-native speakers. This is in consonance with the earlier studies (Lisker & Abramson, 1970; Goto, 1971; Caramazza, Yeni-Komshian, Zurif & Carbone, 1973; Miyawaki, Strange, Verbrugge, Liberman, Jenkins & Fujimura, 1975; Strange & Jenkins, 1978; Best, MacKain & Strange, 1981; Flege, 1984; Werker & Tees, 1984). This suggests that native Tamil speakers are fine tuned to the differences in laterals and trills as they continue to get exposed to these laterals and trills in native language.

Secondly, native Tamil Speakers scored higher on alveolar-retroflexed palatal lateral (85%) contrast followed by retroflex-retroflexed palatal lateral (81%) contrast, alveolar-retroflex lateral (74%) contrast and alveolar flap-alveolar trill (81%) contrasts. Non-native Hindi speakers scored higher on alveolar-retroflexed palatal lateral (75%) contrasts followed by alveolar-retroflex lateral (61%) contrasts, retroflex-retroflexed palatal lateral (57%) contrasts and alveolar flap-alveolar trill (42%) contrasts.

As native speakers it is easy for Tamil speaking subjects to discriminate laterals and trills. However in Hindi only alveolar /l/ and flap /r/ is present. Therefore a phoneme that Hindi speakers can discriminate should have a very good contrast with alveolar /l/ and flap /r/. Among laterals, /l - ɭ / have F_1 at the same frequencies; but F_2 and F_3 were higher in / ɭ/ compared to /l/. /l - l. / have F_1 and F_2 at same frequencies; but F3 higher in /l./ compared to /l/. /l. - ɭ/ have F_1 and F_3 at same frequencies; but F_2 was higher in / ɭ/ compared to /l. /. Given that Hindi speakers are exposed to alveolar /l/, their discrimination score should be better in laterals contrasting alveolar /l/. i.e., /l - l. / and /l - ɭ/. Among, these two pairs the contrast between /l/ and / ɭ/ was high as they differ in F_2 and F_3. Hence Hindi speakers might have performed better on /l - ɭ/ contrast followed by /l - l. / contrast and poor on /l. - ɭ/ contrasts as /l. - ɭ/ do not occur in Hindi. Table 3 shows the formant frequencies of Tamil laterals and figure 5 shows spectrograms and LPC frequency response of laterals in Tamil words.

Table 3: Formant frequencies of Tamil laterals

	F1	F2	F3
/ l /	446	1330	2409
/ l. /	576	1479	3274
/ ɭ/	660	2474	3200

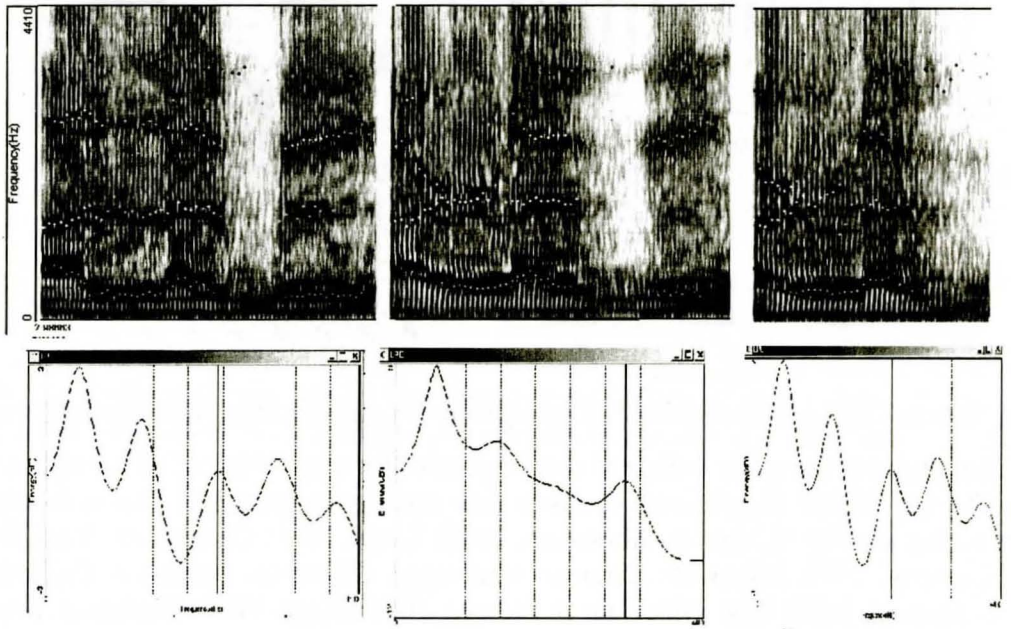

Figure 5: Spectrogram and LPC frequency response of /l/, / l./ and / ɭ/ as in the words /alagu/, /al.agu/, and /a ɭ agu/

Flap /r/ and trill /r˜/ differ in F_2 and F_3. Alveolar trill /r˜/ had higher F_2 and F_3 compared to flap /r/. Therefore the contrast between these two phonemes is good and non-native speakers also should have discriminated these phonemes. Poor discrimination score on this phoneme may be attributed to low F2 amplitude in flap /r/. Because of low F2 amplitude and prominent F_3 that coincides with F_2 of trill /r˜/, these two phonemes might be confused by non-native speakers (see LPC frequency response in Figure 7). Also a comparison of F_2 and F_3 of trills indicated that the alveolar trill ($\tilde{r}$) has higher F_2, F_3 and distantly spaced F_2- F_3 and those of the alveolar flap (r) has lower F_2, F_3 and distantly spaced F_2-F_3. Therefore the acoustic difference between the alveolar flap and alveolar trill (r-$\tilde{r}$) is confusing which may perhaps be the reason for poor discrimination of these trill contrasts by non-native speakers. Table 4 shows the formant frequencies of Tamil trills and figure 6 shows spectrograms and LPC frequency response of trill in Tamil words.

Table 4: Formant frequencies of Tamil trills

	F1	F2	F3
/ r /	483	1125	2158
/ $\tilde{r}$ /	362	1944	3060

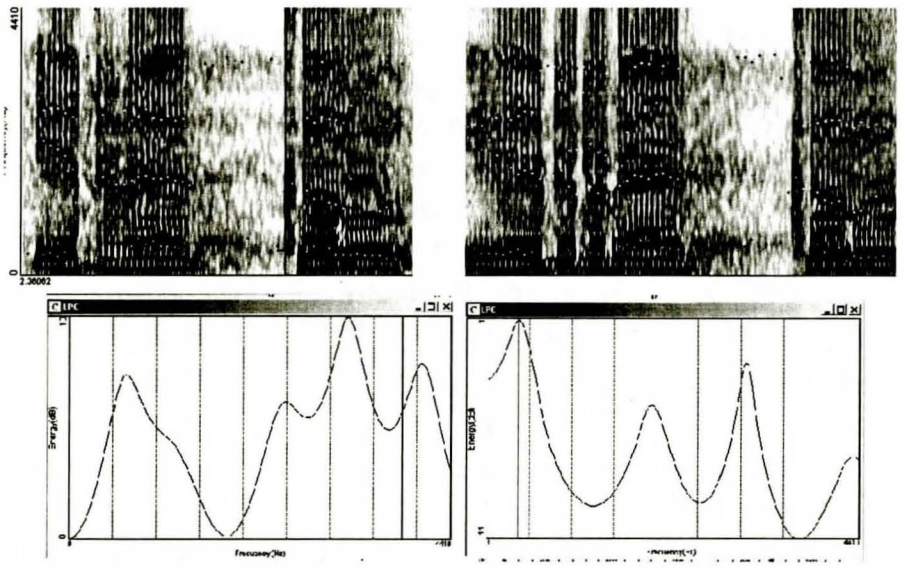

Figure 6: Spectrogram and LPC frequency response of /r/ and /r˜/ as in the words /irakkam/, and /ir˜akkam/.

The results support the earlier findings of poor discrimination of phonemes by non-native speakers. This implies that perceptual abilities undergoes refinement with language experience and can limit listeners' sensitivity to some non-native phonemic distinctions. Also the results support in validating the non-native contrasts in terms of its phonological status. The alveolar-retroflex lateral contrast would be an assimilable contrast, since it can be assimilated to an intermediate phone in the native language, whereas the alveolar-retroflexed palatal-lateral contrast would be of category goodness type as it can be assimilated to an intermediate phoneme in the native language, as in assimilable, but one which will stand out as clearly a better instance of that category than the others. Thus the results support the studies of Best, MacRoberts &

Sithole (1988). The results indicated that adult speakers of Hindi language have difficulty in perceiving differences in phonemes that are not present in their language and would require intensive training to perceive and produce them better.

Future research is warranted in perception of non-native contrast (laterals and trills) by speakers of other Indo-Aryan languages which may reflect the cross-language differences in perception. Also studies can be done in development of perception from infancy through childhood so that one can infer the point of time at which the child shifts to perception of native phonemes. This will support the universal theory and the connectionist model i.e., whether an infant can perceive all phonemes but looses such ability and is restricted to the perception of phonemes of language he is exposed to as he grows.

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Appendix

Material used in the study

Sl. No.	Set I	Set II	Set III	Set IV
1.	alagu-al.agu	al.agu-a͡lagu	alagu-a͡lagu	aram-a͡ram
2.	ali-al.i	al.i-a͡li	ali-a͡li	aran-a͡ran
3.	alai-al.ai	al.ai-a͡lai	alai-a͡lai	ari-a͡ri
4.	a:l-a:l.	a:l.-a:͡l	a:l-a:͡l	ariva:l-a͡riva:l
5.	ilai-il.ai	il.ai-i͡lai	ilai-i͡lai	arundu-a͡rundu
6.	ulavu-ul.avu	ul.avu-u͡lavu	ulavu-u͡lavu	aria-a͡rai
7.	ulai-ul.ai	ul.ai-u͡lai	ulai-u͡lai	iratal-i͡ratal
8.	oli-ol.i	ol.i-o͡li	oli-o͡li	irakkam-i͡rakkam
9.	kali-kal.i	kal.i-ka͡li	kali-ka͡li	irumbu-i͡rumbu
10.	kalai-kal.ai	kal.ai-ka͡lai	kalai-ka͡lai	irai-i͡rai
11.	ka:li-ka:l.i	ka:l.i-ka:͡li	ka:li-ka:͡li	ural-u͡ral
12.	talai-tal.ai	tal.ai-ta͡lai	talai-ta͡lai	uravu-u͡ravu
13.	ta:l-ta:l.	ta:l.-ta:͡l	ta:l-ta:͡l	uri-u͡ri
14.	mulai-mul.ai	mul.ai-mu͡lai	mulai-mu͡lai	uru-u͡ru
15.	vali-val.i	val.i-va͡li	vali-va͡li	eri-e͡ri
16.	valai-val.ai	val.ai-va͡lai	valai-va͡lai	kurangu-ku͡rangu
17.	va:lai-va:l.ai	va:l.ai-va:͡lai	va:lai-va:͡lai	kurugu-ku͡rugu
18.	va:l-va:l.	va:l.-va:͡l	va:l-va:͡l	kurai-ku͡rai
19.	vila:-vil.a:	vil.a:-vi͡la:	vila:-vi͡la:	ku:rai-ku:͡rai
20.	vilai-vil.ai	vil.ai-vi͡lai	vilai-vi͡lai	tirai-ti͡rai