TRADING RELATIONSHIP BETWEEN BURST AND TRANSITION IN KANNADA STOP CONSONANTS

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Dedicated to

MY VICTOR MAMA,
who enlightened my life
and this professional career.

KANCHI AKKA,
who is like the soul of confidence
for my achievements.

DR. SAVITHRI,
my teacher & Guide for
nurturing my thought, feeling
and knowledge with her
sincerity, kindness & benevolence.

CERTIFICATE:

This is to certify that this Dissertation entitled :

TRADING RELATIONSHIP BETWEEN BURST AND TRANSITION IN KANNADA STOP CONSONANTS,

is the bonafide work in part fulfillment for the Final Year M. Sc. (Speech and Hearing), of the Student with Reg. No. M. 9115..

MYSORE
MAY, 1993.

Dr. (Miss) S. Nikam
Director
All India Institute
of Speech and Hearing,
MYSORE.

CERTIFICATE

This is to certify that this Dissertation entitled :

"TRADING RELATIONSHIP BETWEEN BURST AND TRANSITION IN KANNADA STOP CONSONANTS",

has been prepared under my supervision and guidance.

Savithri S.R.

MYSORE
MAY, 1993.

Dr S. R. Savithri,
Guide.

DECLARATION

/ hereby declare that this Dissertation entitled,

'TRADING RELATIONSHIP BETWEEN BURST AND TRANSITION IN KANNADA STOP CONSONANTS",

is the result of my own study under the guidance of Dr. S. R. Savithri, Lecturer, Department of Speech Sciences, Alt India Institute of Speech and Hearing, Mysore, has not been submitted earlier at any University for any other Diploma or Degree.

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INTRODUCTION

Speech is a form of communication in which the transmission of information takes place by means of speech wave which are in the form of acoustic energy, (Fant 1960). It is known from the speech production studies that the speech sounds have different acoustic cues like the formant transition, formant frequencies, bandwidths, duration of closure burst, direction of transition, VOT etc.,

In most of perceptual studies, speech sounds are constructed from their known spectral & temporal parameters and are presented to the listeners for judgements. Various parameters of the acoustic signal could be altered individually or in combination to evaluate the effects of the cue on listener's perception.

Most of the perceptual studies have been conducted on the stop consonants as they demonstrate the redundancy of acoustic cues available to distinguish speech sounds and have consistently produced evidence for phonetic level of processing. The various parameters that have been studied as perceptual cues for stop consonants parameters are as fol1ows :

Spectral Parameters:

1. Frequency of formant 1,2 & 3
2. Bandwidth of formant 1,2 & 3
3. Amplitude of formant 1,2 & 3
4. Direction of second & third formant (F2 & F3)
5. Transition
6. Burst amplitude
7. Burst frequency
8. Double burst release
9. Fo changes in preceding & following vowels
10. Amplitude of following vowel

Temporal Parameters:

1. Preceding Vowel duration
2. Closure duration
3. VOT (Voice-onset Time)
4. Voice off-set time
5. Stop consonant duration
6. Off-set glide duration of second formant (F2)
7. Off-set Glide duration of first formant (Fl)
8. Burst duration & Transition duration
9. Speed of transition of the first formant of preceding vowel etc.

It has been reported that these parameters in combination (Raphael et al, 1980) or in trading relation with one another (Liberman & Studdert Kennedy 1977; Bailey & Summer field 1978; Fitch, Halwes et al, 1980) cue for the perception of stop consonants.

Virtually any phonetic distinction has multiple correlates in the acoustic signal, that is the orticulatory adjustments required to change from one phonetic catagory to the other causes changes along several separable dimensions of Physical spectrum, amplitude and time. While listeners typically perceive only a single change viz, one of the phonetic category - the physical change leading to this unitary percept can be described in the form of multiple entries, when the signal is manipulated individually. It is generally found that they all have perceptual cue value for the relevant phonetic distinction, although they may differ in their relative importance. If one cue in such an ensemble is changed to favour category B; another cue can be modified to favour catagory 'A', so that phonetic precepts remain unchanged.

Presumably any two cues for the same phonetic distinction can be traded of against each other with in the limits set by their acceptable range of values and by their relative perceptual weights. It has been well known for many years that several cues may signal a single phonetic contrast (Denes 1955). Thus it is possible to demonstrate that when the perceptual utility of one cue is attenuated, another cue may take on primary effectiveness in signaling the contrast under scrutiny because both cues, it is assumed, are equivalent. This is called phonetic trading relationship (Repp 1982).

These trading relations are the manifestation of the more general perceptual principle of cue integration by which the information conveyed by a variety of acoustic cues is integrated and combined in to an unitary perceptual experience that can be described in terms of linguistic categories (Repp, 1983).

Several studies have been conducted in the past on the trading relationship of stop consonants. Fitch et al (1980), examined trading relation between silent closure duration and vocalic formant transition onset as cue to stop manner in the /slit/, /split/ distinction & found trading relation between them. Fitch et al (1981), Repp et al (1983), examined silence & burst as cues for discrimination of stop consonants. The trading relationship between silence duration and duration of fricatives along with vocalic segements (Summerfield et al 1981),Duplex perception of cues for stop consonants considering vocalic formant transition and burst along with closure duration (Liberman et al 1981); onset frequency of the lowest tone as spectral cue & duration of closure interval as temporal cue (Best et al 1981) burst amplitude and silence duration in stop consonants (Repp et al 1984) have been investigated.

Research in the past has shown that the phonetic perception relies on the multiplicity of the acoustic cues. Human listeners respond to their reduaunt cues typically as linguistic. Thus acoustic cues are identified with reference to the linguistic background. Evidence for this comes from the studies of Lotz et al (1960), Singh & Black (1966), Stevens & Blumstein (1975), Strange and Jenkins (1978), Fox and Lehiste (1984), Usha Rani (1989) and Vinay Rakesh (1990). These studies have shown that the language of the listeners or speaker plays a role in the perception. This warrants studies in various languages.

In this context the present study was planned. It aims to find out the trading relationship between the burst and transition in Kannada Stop Consonants.

REVIEW OF LITERATURE

In recent years, Phonetic trading relationship have been cited as evidence for a specialized speech mode of perception. There appears to be two reasons for this view; Viz,- (1) some demonstration of phonetic trading relations involve both spectral & temporal cues that are distributed over relatively long temporal intervals, and (2) the second line of evidence for specialization of speech perception involves demonstration that phonetic trading relations do not apparently arise for non-speech sounds (Repp(1983)); These evidences are therefore taken as proof that the integration of multiple cues giving rise to trading relations are peculiar to the processing of speech signal.

Several researchers in the past have experimented on the trading relationship in the stop consonants. Winitz et al (1972), conducted an experiment to investigate the identification of the stops & vowels from the burst portion of /p,t,k/(Voiceless stops p,t,k appearing in pre & post vocalic portion of one syllable words in the vocalic contest of /i,a,u) The duration of the plosive was isolated. These stimulus were randomized and presented to the subjects. The subjects were asked to select correct p,t,k. The other task involved two different procedure: (i), The consonant varied & the vowel remained constant. (ii) The vowel varied & the consonant remained constant.

The experiment II was the partial replication of experiment I, but with the modification that the Final /k/ with the vowel /i/ had been inadverently replaced by /t/ in Experiment I. The findings of the study support the coarticulatory effects, especially for /i/. Results also suggested that for the burst alone, the initials were identified better than finals & /t/ showed the highest level of identification. Vowel could be identified on the burst port ion.

LaRivere et al(l975) conducted two experiments to test the transition dependency and integration hypothesis. The stimuli in these studies were nine stop-vowel monosyllables from /p,t,k/ and /a,i,u/. In experiment - 1, the vocalic transition was gated from each of the syllables, dubbed the aperiodic portion to one channel and the vowel to the other. The temporal relation between aperiodic portion was varied from 0, 40, 80, 160, 250 Msec yielding 45 stimuli. Results indicated that the vocalic transition is not a necessary cue for stop consonant recovery. Also the experiment involving bivocalic glides have shown no masking seen in transition--less stops, as the vowel information was conveyed by the a periodic portion.

Experiment - 2 was conducted to examine to what extent the vocalic transition is a sufficient cue. The following segments were gated from each original utterances, (i) aperiodic portion, (ii) aperiodic portion + vowel transition, (iii) vocalic transition alone, (iv) vocalic transition + vowel. The results were in agreement with experiment - 1. The vocalic transition was not a sufficient cue for initial prevocalic unvoiced stops. It was also indicated that the cues available for parallel processing to stop + vowel might be largely confined to aspiration portion.

Blumstein et al 1977. conducted adaptation experiment to investigate the role of initial noise bursts and transition as cues to place of articulation in stop consonants. A test continuum consisting of 14 Synthetic stimuli in which transition of formant two and formant three were systematically varied to range along the [b,d,g] phonetic dimension. The adapting Stimuli consisting of full-cue stimuli in which place of articulation was signaled by transition only; and conflicting-cue stimuli in which the burst frequency signaled one phonetic dimension (eg.[d]. eg.[g]). The experiment determines the influence of several types of adapting stimuli on listeners responses to partial cue stimuli with no burst. The result shows that the adapting effect of partial-cue stimulus is modified when a burst is appended to the beginning of the stimulus. Adaptation is increased when the burst and transitions are associated with the same place of articulation and is decreased when the burst and transition cues different place of articulation. The auditory display of the burst is not influenced by that of the formant transition and vice versa, and the property of the burst extracted independently of the properties of the transitions. Thus it is assumed that there is an interaction between burst and transition, such that both contributes to an integrated acoustic property for each place of articulation for stop consonant.

Dorman et al(l977) in three experiments assessed the role of release bursts and formant transitions as acoustic cues to place of articulation in syllable initial voiced stop consonants, by systematically removing them from English /b/ /d/ /g/ spoken before nine vowels by two speakers. The stimulus were digitized and, Stimulus were constructed by the following steps,-(l) each syllable was left in original form (2) Burst removed from CVCV (3) burst attached to its corresponding VCV syllable. (4) removing of voicing pulse from CVC syllable and (5) Each burst-plus-devoiced Formants attached to its corresponding VCV syllable, and ' were presented to the listeners in the experiment 1 & 2. The purpose of experiment - 3 was to test the hypothesis that initial release burst of /bvd, dvd. gvd/ syllable may be a functionally invariant cue to the consonantal place of articulation across set of syllable-nucleus types. The over all results shows that burst and transition tended to be reciprocally related where the perceptual weight of one increased, the weight of the other decreased/declined. They were thus shown to be functionally equivalent, context-dependent cues, each contributing to the rapid changes that follow consonantal release.

Not much of studies were conducted on the trading relationship between burst & transition. However, literature reveals that most of the trading relationship experiments were done on the silence and burst, burst amplitude & VOT. One of the frequently investigated trading relations involves the stop manner contrast in the word pairs such as "Say" - "Stay" or "Slit - split".

Erickson et al (1977): Investigated on the perceptual effect of independent variation in two different cues for the medical stop consonants in /split/ vs /slit/, one was temporal cue, the duration of silence between the /s/ noise and the vocalic part of the syllable and spectral cue was the presence or absence of formant transition that distinguish /piit/ and /lit/. The results show that the amount of silence required was about 25Msec. less (more) when the spectral cue was present (absent) indicating a trading relationship between silence & burst.

Repp (1979) in two experiments demons-traded that the amplitude of aspiration noise was a cue for the distinction between voiced and voiceless syllable initial stop consonant in English, and that it could be traded for aspiration noise duration i.e. voice onset time.

In experiment I, the category boundary on a synthetic VOT continuum (/da/-/ta/ with-out bursts) was found to be a linear function of the amplitude ratio between the aspirated and vocalic portion. In experiment II, release burst was added to the synthetic stimuli, and burst aspiration amplitudes were varied orthogonally. Both factors affected the voicing boundary in the expected direction but not independently. The effect of burst amplitude were very small compared to that of aspiration amplitude & other things being equal in synthetic stop sounds voiceless sounds were percieved with more aspiration.

Fitch et al (1980) in his experiment examined the effect of orthogonal variation of two acoustic cues silent closure & vocalic formant transition for the trading relationship. To determine the amount of silence required to compensate for a certain difference in formant onset frequency, he devised a discrimination task containing three different type of trails:- Single cue trails stimuli differed only in the spectral cue), co-operating cue trail stimuli differed in both, conflicting cue trials, one favoured "split" (stay) and other "slit" (say). The silence difference chosen was the one found to compensate exactly for the spectral difference in the identification task, the stimuli in conflicting cue condition were phonetically equivalent. The results of these experiments indicated a clear difference among the three conditions and the subject discrimination performance in the category boundary region was best in the co-operating cue condition.

The pattern of discrimination results indicated that stimuli that differ in two dimensions simultaneously are still categorically percieved. It is likely that the listeners could be trained to become more sensitive to the physical differences that do exist between phonetically equivalent stimuli.

Fitch et al (1981): synthesized two syllables, one having formant transition basing the perception of the syllable /lit/ and another syllable /plit/, /s/ frication was appended to the beginning of each syllable stimulus were generated by varying the closure interval between /s/ frication and the vocalic portion of each stimuli and presented for the identification. For both series, stimuli with sufficiently short closure durations were heard as /slit/ and stimuli with long closure duration were hard as

/split/. This demonstrated that inspite of the formant transition the duration of closure interval could include identification of stimulus from both series as either /slit/ or /split/. Results showed that on average, relatively, more silence (approximately 20Msec.) was required for identification of /split/ for the /s/ + /lit/ than the /s/ + /piit/ series. Hence the finding demonstrated the formant transition cues and closure duration trade off in producing perception of the presence or absence of the stop /p/.

Liberman et al (1981) investigated the duplex perception for stop consonants and the results indicated that when the vocalic formant transition appropriate for the stops in a synthetic approximate for the stops in a synthetic approximation to /spa/, /sta/ were presented to one ear and remainder of the acoustic pattern to the other, listeners reported duplex percept-One side of the duplexity — was the coherent syllable (/spa/or/sta/) which was percieved when the pattern was presented in its original, undivided form. The other was a non speech chirp that corresponded to what the transition sounds like in isolation. The results showed that the silence cue affected the formant transition differently, When on the side of the duplex percept, the transitions support the perception of the stop consonants and when, on the other, they percieved it as non-speech chirps. This indicated that the effectiveness of silence cue was owing to distinctively phonetic process.

To support the notion that the phonetic trading relations are peculiar to speech processing Best et al (1981) performed an experiment using sine wave analogues of 'say' and 'stay' a contrast which demonstrated the similar trading relation to that of slit & split. Two version of stimuli were constructed, in one, the sine -wave portion of the stimulus & low onset of the lowest tone and in another, high onset of lowest tone. Noise was appended to the beginning. Stimulus were presented to the subject for identification of an ABX procedure.

Identification function for 'speech' or 'say=stay', listeners revealed a trading relation; those who failed to hear the stimuli as speech, failed to display identification function, of a trading relationship. The non speech cues and attended to either spectral cue or temporal cue. Appraently subjects who heard the stimuli as speech percieved the stimuli in a phonetic mode in which the spectral & temporal cues were integrated into a unitary percept.

Repp (1983): indicated that the trading relations are the manifestation of a. more general perceptual principle of cue integration.variety of acoustic cues are integrated & combined into a unitary perceptual experience that can be described in terms of linguistic experience considering speech as traces in the multidimensional auditory space. Also harbours appropriately tuned category types & phonetic categories are selected on the basis of distance metric. The properties that makes the speech special is the unique structure of the patterns that are to be recognized which are reflected from the special properties of the production apparatus & the language specific conventions according to which it is operated.

On one hand, phonetic trading relation are speech specific but on the other hand they are not special as a phenomenon. They are speech-specific because their specific form, can only be understood by examining the typical patterns of the language. They are not special, because once the prototypical patterns are known in any perceptual domain, trading relation among the stimulus discussion follow as the inevitable production of general pattern matching operation.

Repp investigated the role of release burst as a cue the perception of stop consonants following [s].This study demonstrated a perceptual trading in which, when the burst was cut, further increasing the amount of silence was necessary to achieve a percept of stay. The truncation of the release burst not only created variation in burst duration, but also changed the over all amplitude in its onset amplitude charecteristics.

The second experiment demonstrated trading relation between release burst amplitude & closure duration as a joint cue to the stop manner perception. This study showed trading relation, & it also showed that severely attenuated (truncated)burst has a perceptual effect.

The third experiment was done to find out whether the perceptually relevant aspects of burst amplitude is its absolute magnitude or its magnitude relative to surrounding signal portion. Attenuating the burst environment did not have same effect as amplifying the burst by the same amount. Contrary to the expectation, attenuation of the vocalic portion did not increase stop responses. jPerhaps, the additional stop manner cues,maintained in that portion were weakened by the attenuation thus counteracting the gain in burst salience, relative to its environment.

Experiment-4 was to examine the effect of fricative noise & vowel attenuation seperate from their effect on the relative salience of the burst. Experiment 3&4 suggest that absolute, not relative burst amplitude was important.

Experiment 5 - examined the point at which a burst became ineffective & ceased to trade with closure silence & whether coincides with the auditory threshold detection for the burst. The results provided strong evidence of the sensitive phonetic categorization process to very subtle changes in the acoustic information.

Experiment -6 was conducted to demonstrate a trading relationship between burst amplitude & closure duration for the perception of Labial stop consonant. The effect of burst attenuation or elimination demonstrated that the labial burst have a function as stop manner cues. The absence of any effect of burst amplification, suggested that the slit-split boundary cannot be shifted towards short values of silence. Amplitude increment was either ignored or canceled into decision about stop place articulation rather than stop manner.

Experiment - 7 was similar to experiment - 6 except for the stimuli and the ranges of closure duration and burst amplification values. The finding replicated the results of experiment - 6. Attenuation of the burst necessiated in longer interval of silence, where as burst amplification did not have opposite effect.

Morrongiello et al (1984) tested five year old children for perceptual trading relation between temporal & (silence duration) spectral cue (Fl onset frequency) for the 'say-stay' distinction. Identification functions were obtained for two synthetic 'say-stay' continua, each containing variation in the amount of silence following the /s/ noise. In one continuum vocalic portion had a lower Fl onset than in the other. Children showed a smaller trading relationship than has been found with the adult. However for 'ay - day' continuum formed by varying fl onset frequency only, the result of discrimination task in with the two acoustic cues were made to co-operate or conflict phonetically supported the notion of perceptual equivalence. The result indicated that young children like adult, perceptually indicate multiple cues to a speech contrast in a phonetically relevant manner, but may not give same perceptual weight to various cues as do adults.

These studies conducted for phonetic trading relationship has provided the newest source of information. The result of phonetic trading relation are equivocal. Also, it appears that the cues differ in languages depending upon the structure of the language. In this context the present study was aimed to investigate the trading relationship between burst and transition in Kannada Stop consonants.

METHODOLOGY

SUBJECTS:

Twenty normal (10 males and 10 females),native speakers of Kannada served as subjects for the study. Their age ranged from 18 - 25 years.

MATERIAL:

Six Kannada meaningful paired words (ie.,CVCV & VCV) were considered, where C in CVCV = P, t, k and V = i, a. These were Tiru/iru, pari/ari, pidi/idi, Kale/ale, Kiru/iru and Tale/ale.

These word pairs as uttered by an adult male Kannada speaker aged 19 years were digitized at 8000 Hz sampling frequency with a 12 Bit A/D converter.

Five types of synthetic tokens were prepared using the program DSW (VSS, Bangalore) for each word pair which were as follows.

1. Original signal (CVCV).
2. Truncating the burst from the original CVC consonant.

3. Concatenating the removed burst to the VCV word of the same pair, eg., burst + ari.
4. Truncating transition from the CVCV word.
5. Concatenating this transition to the initial position of the VCV word of the same pair.

Synthesis of these five tokens were performed for all six set of paired words. Each token was iterated ten times and arranged randomly.

Thus, totally 300 synthetic tokens were prepared (Appendix - 1). These tokens were Audio-recorded using the Batch play program on to a metallic cassette with an interstimulus interval of 1 second and inter-iteration interval of 5 seconds. These audio recorded synthetic stimuli formed the material.

METHOD:

The subjects were tested individually and were audio presented with the stimulus through W - 7 7 0 headphone. The subjects were instructed to respond to a forced choice within form.

ANALYSIS:

The responses of the subjects were tabulated and the percent of response for all the five tokens were computed by the formula,

$$\frac{\text{No. of Correct Responses}}{\text{No. of Total Tokens}} \times 100$$

Principle component analysis was performed to find out the trading relationship between burst and transition and the canonical space was identified. Also Two - way ANOVA was used to find out the significant difference between males and females.

RESULTS AND DISCUSSION

The results reveal significant difference between the token with truncated burst & concatenated transition and truncated transition & concatenated burst indicating no trading relationship between burst & transition. Figs 1 - 6 show the % response for all the six word pairs.

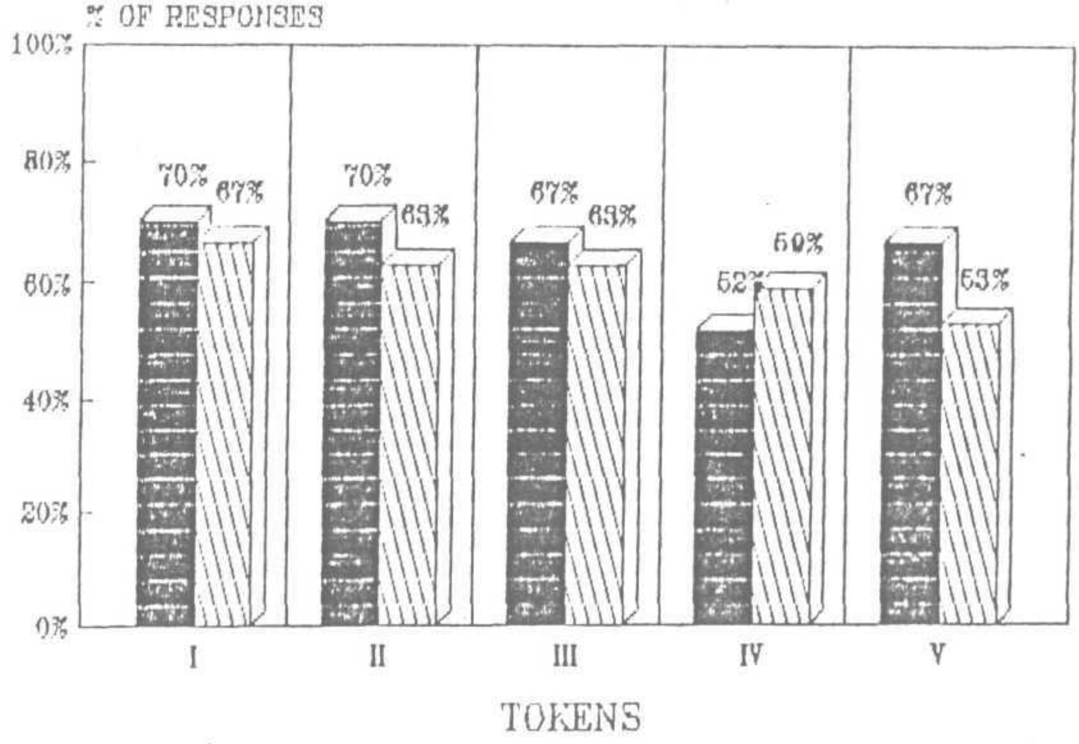

FIG: 1 SUBJECT RESPONSES OF MALES AND FEMALES

TIRU (SET I)

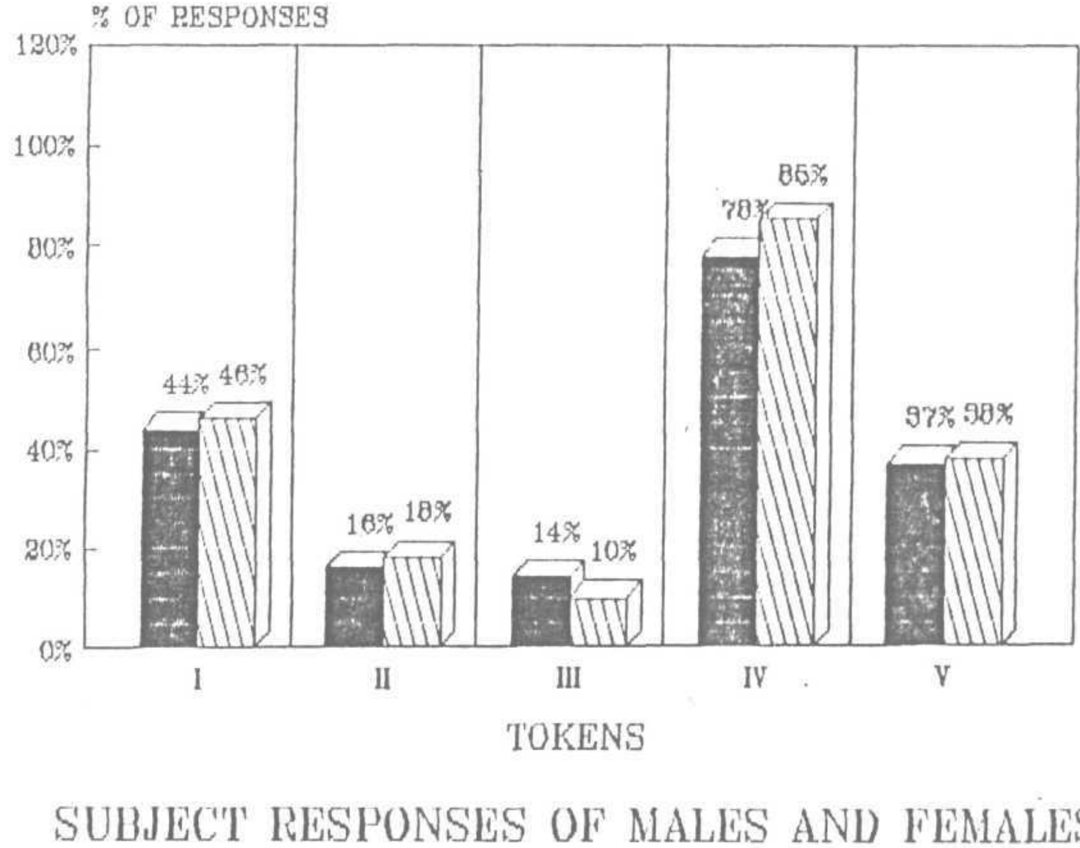

FIG: 2 SUBJECT RESPONSES OF MALES AND FEMALES

PARI (SET II)

MALES FEMALES

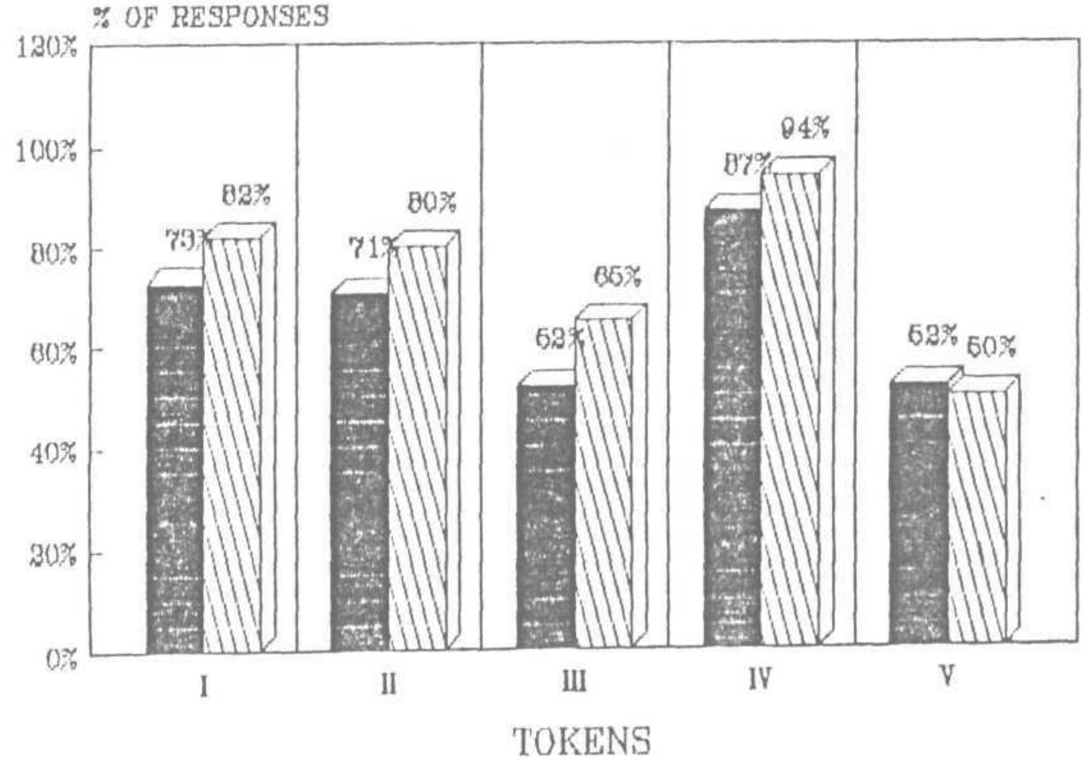

FIG:3 SUBJECT RESPONSES OF MALES AND FEMALES

PIḌI (SET III)

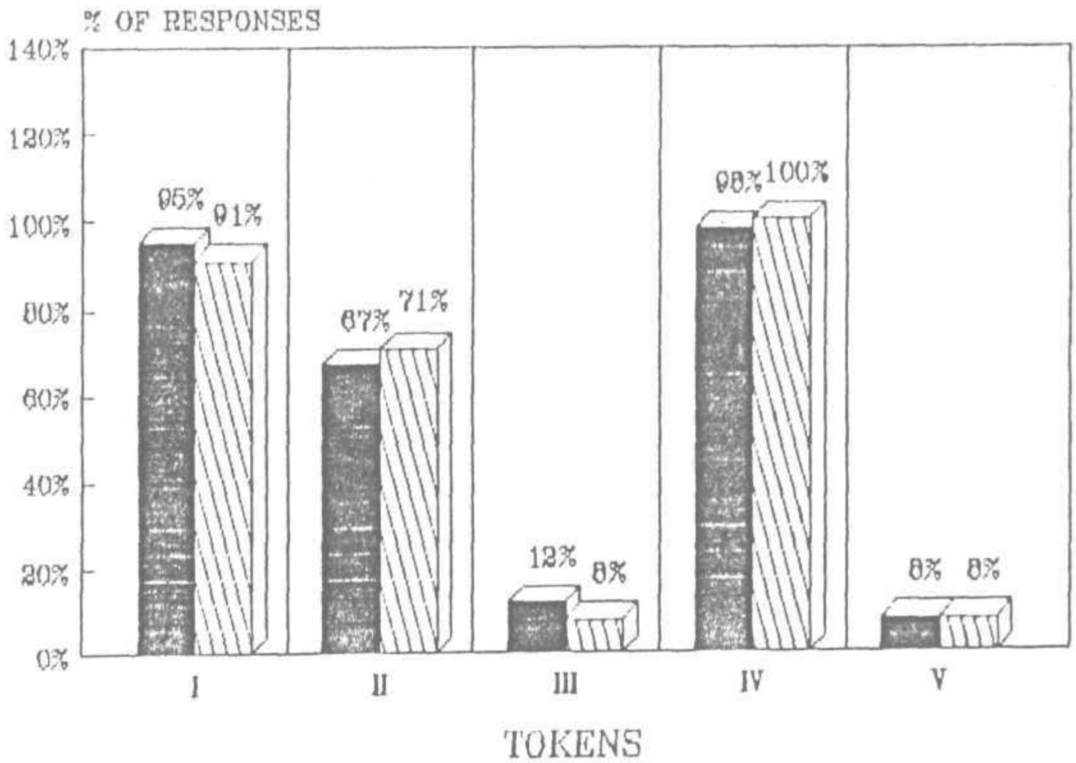

FIG:4 SUBJECT RESPONSES OF MALES AND FEMALES

KALE (SET IV)

MALES FEMALES

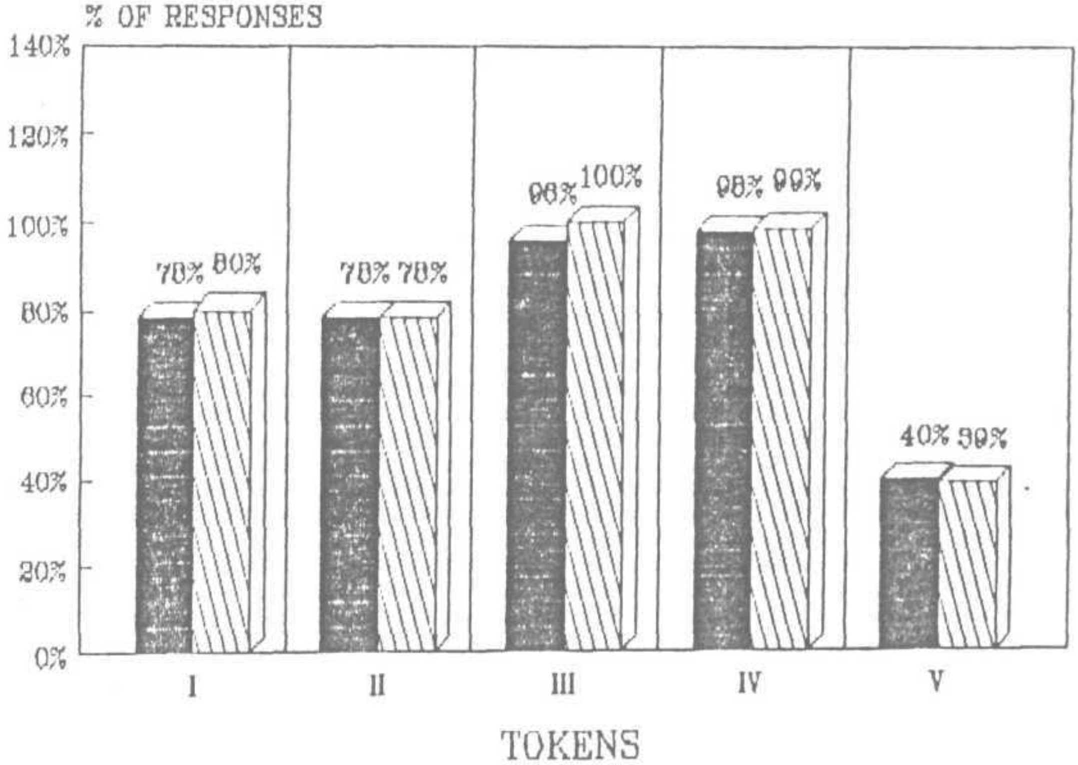

FIG: 5 SUBJECT RESPONSES OF MALES AND FEMALES
KIRU (SET V)

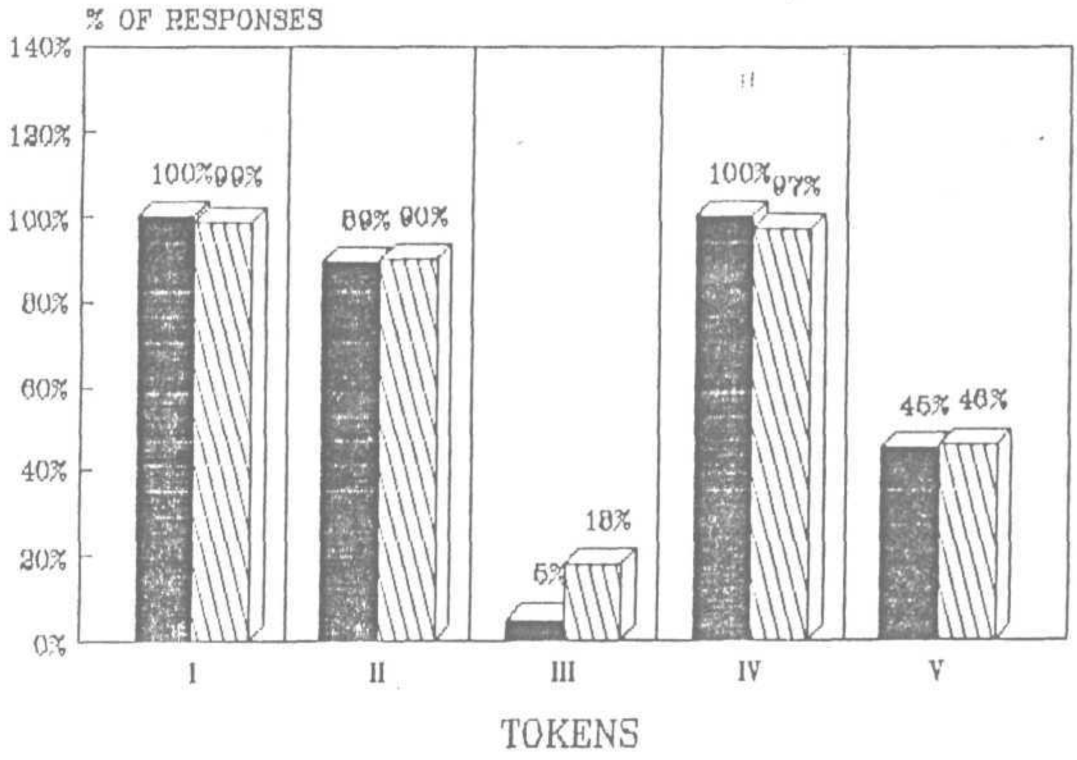

FIG: 6 SUBJECT RESPONSES OF MALES AND FEMALES
TALE (SET VI)

MALES FEMALES

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The canonical spacing for these tokens were also wide indicating no trading relationship between burst & transition. Fig. 7. shows the canonical space for all the tokens.

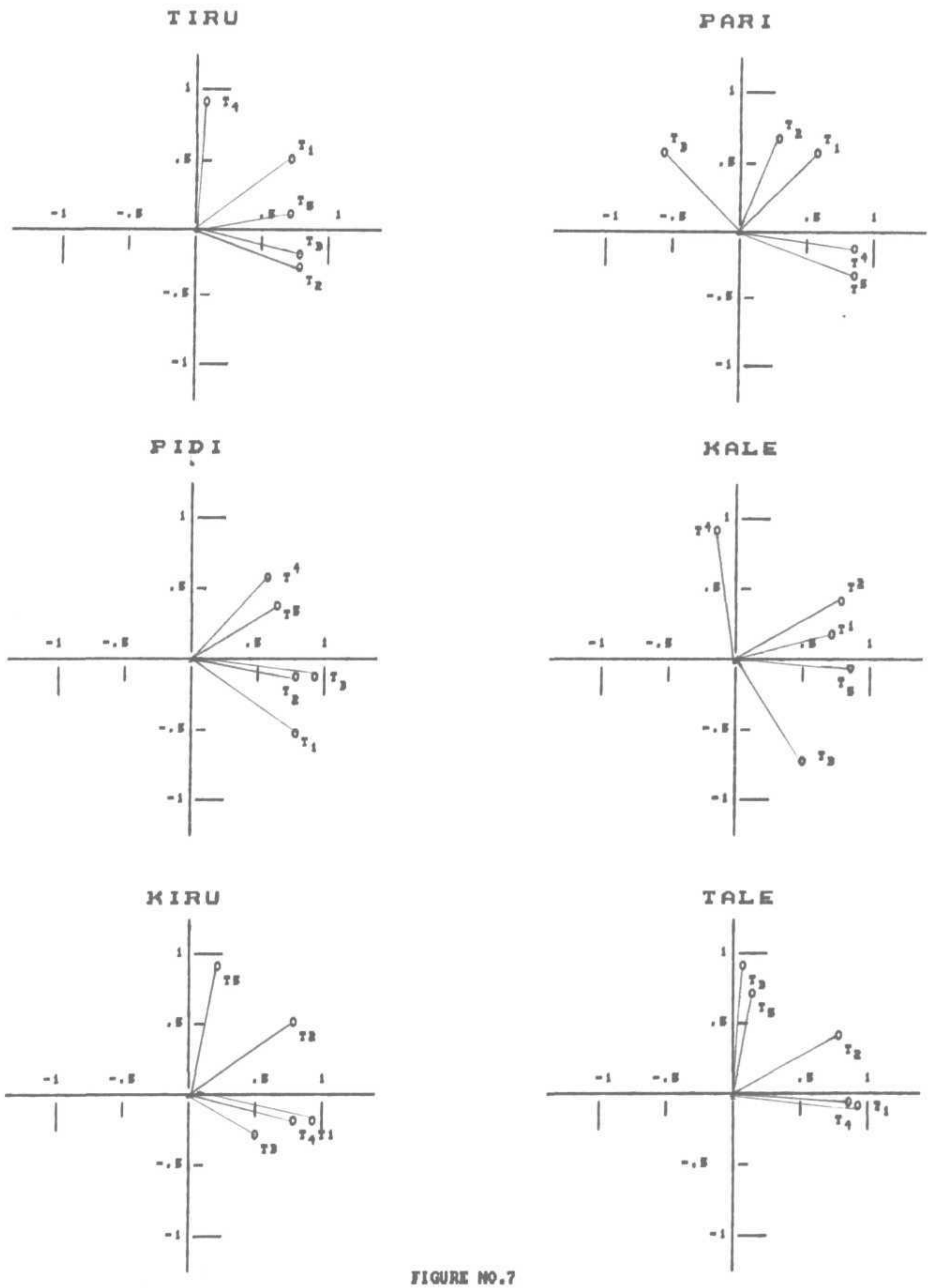

FIGURE NO.7

FACTOR PATTERN - GRAPH

PRINCIPAL COMPONENTS ANALYSIS (CONONICAL SPACE)

Table 1. shows the factor patterns for all the six tokens which again reveals no trading relationship between burst & transition.

TOKEN	TIRU/ IRU	PARI/ ARI	Pipi/ IDI	KALE/ ALE	KIRU/ IRU	TALE/ ALE
1	0.731	0.595	0.823	0.758	0.934	0.945
2	0.861	0.314	0.875	0.814	0.785	0.763
3	0.881	0.592	0.946	0.539	0.559	0.076
4	0.046	0.849	0.532	0.166	0.886	0.916
5	0.787	0.836	0.626	0.839	0.185	0.189

Table 1. COMPOSITE - 1. of Factor Pattern.

Further the corelation matrix table (table 2) of principle component analysis indicates that the transition cues contributed to the perception of stop more than burst. Also, positive corelation between token 2 & 5 (truncating transition and concetenating burst) was found for the word pairs with velars (Kale/ale, Kiru/iru). However, correlation was not high. On the contrary negative correlation existed between token 3 (truncating burst) and token 4 (concentrating burst) for all the word pairs except Pidi/idi.

TOKEN	TIRU/ IRU	PARI/ ARI	PIDI/ IDI	KALE/ ALE	KIRU/ IRU	TALE/ ALE
Trans-ition 2 Vs 5	0.578	0.072	0.408	0.646	0.609	0.019
Burst 3 Vs 4	-0.139	-0.415	-0.424	-0.645	-0.367	-0.090

Table 2.

Correlation matrix among transition (2 vs 5)

& Burst (3 vs 4) TOKENS

ANOVA indicated no significant differences between the performance of males and females except for the word pair (set 1) Tiru/iru. However, it appeared that the females in general performed better than males except for the word pair Tiru/iru. Figures 3-6 shows that the % response of males & females for all the word pairs.

Table 3 shows the varying performance of vowel /a/ & /i/. It was observed that the vowel /i/ contributed for the better perception of the stop consonants, when compared to vowel /a/.

CONSONANT & VOWEL COMBINATION	BURST	TRANSITION
Pa	-0.415	0.072
Pi	0.424	0.408
ta	-0.090	0.019
ti	-0.139	0.578
Ka	0.645	0.646
Ki	0.367	0.609

TABLE 3

Table 3. Corelation matrix of principle component analysis for burst and transition for all six word pairs comprising of vowel /a/ & /i/.

The maximum score obtained for each of the token of all the six word pair are indicated in Table (4).

TOKENS	Tiru	Pari	Pidi	Kale	Kiru	Tale
	M F	M F	M F	M F	M F	M F
1	70%,67%	44%,46%	73%,82%	95%,91%	78%,80%	100%,99%
2	70%,63%	10%,18%	71%,80%	67%,71%	78%,78%	89%,90%
3	67%,63%	14%,10%	52%,65%	12%,8%	96%,100%	5%,18%
4	52%,59%	78%,85%	87%,94%	98%,100%	98%, 99%	100%,97%
5	67%,53%	37%,88%	52%,50%		40%,39%	45%,54%

Table 4 Percent response of males & females

The results of the response score does not indicate any trend followed by the tokens for the word pairs. However the individual responses indicated that subjects 1 & 3 among males and subject 6,9 among females have performed better than others and subject 7 among males & 4 among females performed poorly. The individual responses of the subjects are shown in Fig 8 (a) & (b).

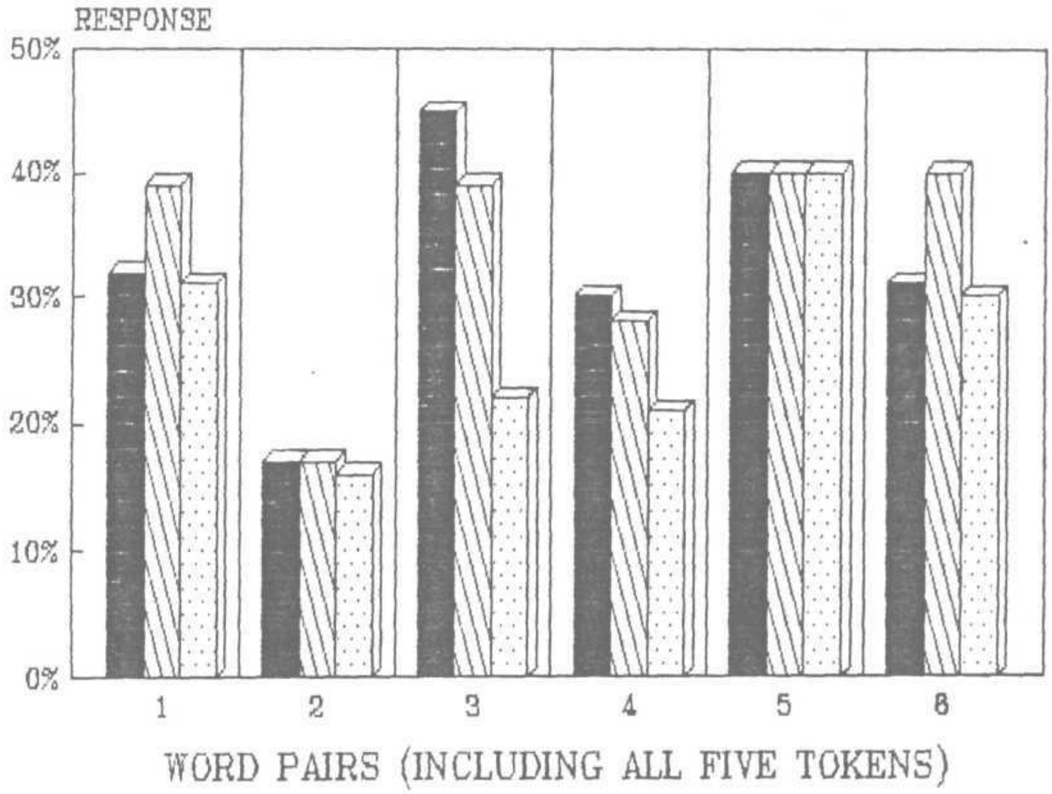

FIG: 8(a). INDIVIDUAL SUBJECT RESPONSES
MALES

GOOD PERFORMANCE: SUBJECT 1 SUBJECT 3
POOR PERFORMANCE SUBJECT 7

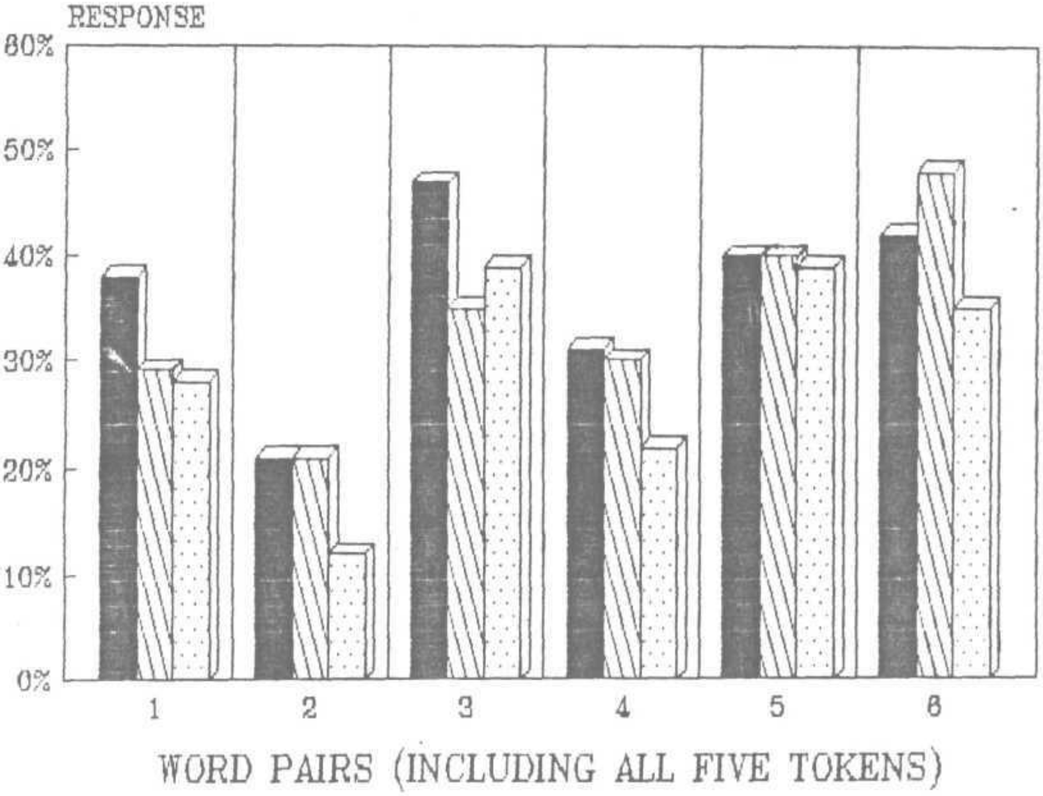

FIG: 8(b). INDIVIDUAL SUBJECT RESPONSES
FEMALES

GOOD PERFORMANCE — SUBJECT 6, SUBJECT 4

POOR PERFORMANCE — SUBJECT 9

The results of the present study indicate that the burst & the transition do not trade with each other. This contradicts the results of the studies by Dorman, et al The results indicated that the burst were largely invariant in the effect.

This might be attributed to the language differences. It appears that the transition provides a better cue than the burst. However, in the absence of burst or transition the perception of stop consonant becomes very poor, indicating that the sudden release of air and the movement of the tongue from consonant position to vowel position are important cues for the perception of the stop.

SUMMARY & CONCLUSIONS

Speech perception is an area studied since several decades and still remains an unresolved issue. The advancement in the technology and refinement in the approach statergies have helped in gaining more knowledge in this field.

Speech signa1 consist of multi - dimensional cues. This distinct aspect of the speech enable the listeners to distinguish between the speech sounds. Whenever two acoustic cues contribute to the same phonetic distinction/ unitary percept, they can be traded off against each other, with in certain range ie, in the absence of one cue, the other cue takes over and contribute to the perception of the phoneme. This is termed trading relationship.

The present study is aimed at investigating the trading relatioship between the burst and transition for the voiceless stop consonants in Kannada.

Six pairs of meaningful Kannada words (Tiru/iru, Pari/ari, Pidi/idi, Kale/ale, Kiru/iru, Tale/ale) were chosen for the experiment. The test stimuli were synthesized by cut & splice method. Alteration in the signal were made to form five stimuli of each word.

1. Original CVCV word.
2. Removal of burst from the initial consonant of the word.
3. Addition of burst to the initial part of the word VCV.
4. Removing transition from the initial consonant of CVCV word.
5. Addition of transition to the initial part of the VCV word.

This proceedure was followed for all the six word pairs. Each stimuli was iterated ten times which were randomly arranged. A total of three hunded such stimuli with inter iteration interval of one second and inter stimulus interval of five seconds was presented.

Twenty normal Kannada speakers (ten males and ten females) served as judges for a perceptual task. They were to listen to the audio-presented stimulus and respond to a forced-choice format. These responses were tabulated and discriminant analysis and ANOVA were performed.

The results of the present study indicate that there was no trading relationship exists between burst and transition. Also, it appears that Transition served as a better cue than the burst for the perception of stop consonants. However there was a low corelation for all the six words, except for the word pair Pidi/idi. Further, there existed no significant difference between males and females, except for word pair Tiru/iru. Vowel /i/ contributed more to the perception of stop consonants than vowel /a/.

It appears that there is no trading relationship between burst and transition. This is not in consonance with the results of previous study by Dorman et al (1977).

Thus it appears that the burst and transition are not equivalent with each other. The differences in the results might be due to language differences.

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APPENDIX. 1

ORDER OF PRESENTATION OF TOKENS.

TIRU.O	1	10	14	17	23	29	33	36	42	50
TIRU.b	4	6	12	18	25	26	34	37	45	48
IRU.2b	2	9	13	20	21	27	35	39	43	46
IRU.2t	3	7	15	16	24	28	31	40	44	47
TIRU.t	5	8	11	19	22	30	32	38	41	49

PARI & All THE OTHER WORDS ARE PRESENTED IN THE SAME ORDER

PARI.O	1	10	14	16	21	26	35	39	41	46
PARI.b	4	9	11	19	22	29	34	36	44	47
PARI.1b	2	7	12	18	24	27	32	37	43	49
ARI 1t	3	8	13	17	23	28	33	38	42	48
PARI.t	5	6	15	20	25	30	31	40	45	50