# Phonetic Context in Disfluencies of Children with Stuttering

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**Abstract**

An extensive research data has been accumulated since decades on the phonetic determinants of stuttering. However, most of the work has focused on adults rather than children, using oral reading than spontaneous speech.

The current study investigated the phonetic context in children with stuttering (CWS). 10 monolingual children with stuttering in the age range of 6-8 years exposed to only Kannada language were considered for the study. Analysis of stuttering was made with respect to place and manner of articulation of consonants and vowels.

The results indicated that children with stuttering were more disfluent on consonants than vowels in general. There was also a significant difference between the median percentage scores of long and short vowels. The rank order of the phonetic contexts of disfluency with respect to place and manner of articulation of consonants included /T/, /d/, /r/, /v/, /p/, /j/, /g/, /D/, /sh/, /c/, /s/, /y/, /k/, /l/, /n/, /t/, /m/, /b/ and /h/. Among the long vowels, the rank order included /oo/ & /uu/, /ee/, /aa/ and /ii/, and on the short vowels similar trend was present except /u/.

The results suggest that plosives, fricatives and high back vowels are frequently disfluent compared to other phonemes. Voiced and voiceless sound classification seems to have little effect on the formulation of the general ranking of difficulty of stuttering in children. CWS did not exhibit a consistent pattern for the presence of disfluencies with regard to the distribution of phonetic loci of instances. The analysis showed that although a ranking of sounds with difficulty is suggested, the individual variations are far more pronounced than the group tendency toward formulation of such ranking. The rate of phonetic loci of disfluency appears to be a dynamic phenomenon which appears to be varying across CWS. The findings support the fact that the variability of stuttering is one of the hallmarks of

developmental stuttering. Further, the problem of stuttering should be viewed in association with linguistic and physiological substrata of language/speech production.

**Key words:** *Phonetic context, children with stuttering, Monolinguals, Consonants, Vowels*

## Stuttering – A Speech Motor Control Deficit

Stuttering is reported to be a speech disorder involving a motor control deficit, and not a language disorder (Bloodstein, 2006). In describing the developmental stuttering, Olander, Smith and Zelaznik (2010) explained that "during the disfluencies that characterize stuttering, the speech motor system fails to generate and/or send the motor commands to muscles that are necessary for fluent speech to continue". Similarly, as argued by Packman, Code, and Onslow (2007) developmental stuttering is a problem in syllable initiation in which the child is unable to move forward in speech because the speech planning system is compromised. Further, they explained that this difficulty is first noticed when the child attempts to produce multisyllabic utterances requiring complex sequential movements and varied linguistic stress patterns across syllables to communicate the intended meaning. According to Packman et al (2007) children do not stutter when babbling or producing first words because these additional speech motor demands are not yet present.

Wingate (1988) regards stuttering as a deficit in the language production system, a defect that extends beyond the level of motor execution and that the defect is not simply one of motor control or coordination but involves more central functions of the language production system.

## Linguistic Variability in Stuttering

Several recent models of stuttering hypothesize that the linguistic characteristics of the word being attempted can increase the occurrence of stuttering (e.g. Au-Yeung & Howell, 1998; Packman, Onslow, Richard & van Doorn, 1996). The influence of linguistic and language variables on stuttering have been studied from the time of Brown (1938, 1945) and by many authors subsequently. Johnson and Brown (1935) studied stuttering in relation to various speech sounds. It was found that more stuttering occurred on initial sounds of words.

In a further study by Brown (1938), adults with stuttering (AWS) read a list of 1000 words. For the group as a whole and in the great majority they had more difficulty on consonants than vowels. More stuttering was found on the first few words of an utterance.

Brown (1945) also reported that stuttering tended to occur on consonants other than /t/, /h/, /w/ and /ð/. Another study by Hahn (1942) found a marked difference between consonants and vowels with only 2.9% of the stuttering occurring on words beginning with a vowel. The five sounds associated with greatest amount of stuttering were /g/, /d/, /t̪/, /l/ and /tʃ/. Though a general ranking exists for a group, individual person with stuttering (PWS) varied widely on sounds associated with stuttering and amount of stuttering on a specific sound.

Hejna (1955) studied the role of initial phonemes in the stuttering of spontaneous speech and concluded that the consonants tended to be associated with more stuttering. However, no significant trend among the various consonants was noted. Mann (1955) found that in general, consonants /s/, /v/, /m/, /l/ were stuttered more than vowels in word lists and essays, in 29 CWS with the mean age of 10 years, although there were exceptions. Soderberg (1962) investigated the frequency and duration of stuttering instances that were associated with vowels, voiced consonants and voiceless consonants. Different lists were taken up which was almost similar in terms of word frequency, readability, word length, position of the words, its accent and the grammatical function of words. The results showed no evidence of differences among vowels, voiced consonants and voiceless consonants with respect to mean frequency of stuttering instances.

Soderberg's design was criticized by Taylor (1966), and according to her, stuttering tends to occur on consonants other than /t/, /h/, /w/ and /d/. Stuttering occurred more on plosives and in initial position than on continuants, but the particular consonantal contexts were not consistent and was attributed to individual variability. Hunt (1967) regarded stuttering to occur not on consonants alone but that it may extend to all sounds including vowels. He classified stuttering as vowel stuttering and consonantal stuttering. The vowels u (as in 'rude') and 'O' seemed to offer greater difficulty than 'e' (as in 'ebb') or I (as in 'it'). In the consonantal stuttering, disfluencies were chiefly found to occur on the utterance of mute and explosive consonants as /p/, /t/, / k/, / b/, /d/ and /m/. The aspirated and continuant sounds as /f/, /w/ and /s / offered much less difficulty, as the oral cavity was not so completely closed as in the explosives.

Williams, Silverman, and Kools (1969) analyzed the verbal imitations and oral reading performance of elementary school aged children with stuttering. Fifty nine percent had more disfluency on words beginning with vowels and on /t/, /w/, /h/, /Ø/. In spite of the trend favoring Brown's consonant-vowel factor, this difference was not statistically significant.

Wall, Starkweather and Harris (1981) studied the influence of voicing adjustments during instances of stuttering in the spontaneous speech of young children with stuttering. Stuttering occurred significantly on words for which voice was initiated after a pause. In running speech, the voicing feature of the sounds surrounding the stuttered phone also played a role with reference to the frequency of stuttering.

In the Indian context, Geetha (1979) studied some linguistic aspects of stuttering in Kannada in the age range 5 to 20 years. The results revealed that in general consonants were stuttered more than vowels. The order of hierarchy with reference to the distribution of stuttering was /a/, /k/, /m/, /n/, /h/ and /b/. Jayaram (1983) studied phonetic influences on stuttering in monolingual and bilingual adults with respect to two modes of speaking (oral reading versus spontaneous speech). Results indicated that the initial nasals, voiceless fricatives and voiceless plosives were stuttered more than other sounds. Soumya and Sangeetha (2011) compared the phonetic influences in bilingual children with stuttering across two languages (Kannada and English). The results indicated a rank order for Kannada language as /c/, /b/, /k/, /s/, /g/, /sh/, /r/, /m/, /j/, /n/, /t/, /p/, /D/, /h/, /T/, /v/, /d/ and /l/. Also, the rank order of disfluent vowels as /e/, /a/, /o/, /i/ and /u/ for short vowels and considering long vowels the order were /aa/, /ai/, /oo/, /au/ and /ii/.

The role of phonetic factors as determinants of stuttering has also been investigated by Throneburg, Yairi, and Paden (1994). The data showed that none of the three factors such as, (1) developmentally late emerging consonants (Sander, 1972) which are /r/,/l/,/s/,/z/,/ʤ/,/v/,/tʃ/,/h/,/θ/,/ð/,/ʃ/,/ʒ/, (2) consonant strings and (3) multiple-syllables occurred significantly more often among stuttered words. However, contrary to their results, Logan and Conture (1997) found that the stuttered utterances of children contained more syllables than fluent utterances.

Howell, Au-Yeung, and Sackin (2000) also studied the influence of phonological difficulty of a word on stuttering and the results indicated that children (3-11 years) stuttered more on words starting with late emerging consonants than on those starting with early emerging consonants. Dworzynski and Howell (2004) found that words ending in consonants are more likely to be stuttered than words ending in a vowel for German people who stutter (PWS). Similar effect was present for both adults and children over the age of six. However, such effect was not found for English speakers (Howell & Au-Yeung, 2007), although as the authors contended, English consists of more words ending in consonants than in German.

**Need for the Study**

An extensive research has taken place since decades on the phonetic determinants of stuttering. Most of the work has been done on adults rather on children, using oral reading than spontaneous speech. The language planning that must go on concurrently in spontaneous speech might be expected to influence stuttering. Thus, a more detailed study on stuttering considering spontaneous speech is necessary. Literature mentioned above implies that the evidence is convincing to show that CWS, as a group, are more likely to stutter on specific phonemes compared to other phonemes.

Majority of the studies suggest that CWS are more likely stutter on consonants than vowels. However, there is no consensus with regard to ranking of the phonological context. It is important to address a specific question related to the stuttering–phonology connection, such as "Are CWS, as a group, more likely to have disfluencies on specific phonemes?" The cross linguistic studies across different population are required to validate the results. The phonetic loci of disfluencies in children with stuttering may throw more light on the nature of intriguing disorder of speech. There are very limited number of studies among children with stuttering in the Indian context. Hence, the present study was planned with the following aim.

**Aim of the Study**

The aim of the study was to analyze the relative occurrence of individual phonemes according to place and manner of articulation in the disfluencies of phonemes in Kannada speaking children with stuttering.

The specific objectives of the study were to answer the research questions as:

(1) Are the disfluencies of children with stuttering influenced by the phonological context and if so, (2) what are the possible rank ordering of phonological contexts of such disfluencies?

## Method

**Participants:** The study included 10 monolingual children with stuttering in the age range of 6-8 years, who spoke Kannada as their mother tongue (4 girls & 6 boys; 2 first graders, 3 second graders & 5 third graders). Stuttering Severity Instrument (SSI) revealed moderate to severe degree of stuttering for all the participants. They were selected based on the inclusionary criteria such as being diagnosed as having developmental stuttering, native Kannada speakers, studying in Kannada medium schools and not having any history of hearing, neurological, visual, language and /or psychological impairments.

## Materials

1. Stuttering Severity Instrument-3 (Riley, 1994)
2. Ten common questions
3. Pictures related to common topics
4. Picture stories
5. Re-standardized version of Kannada Articulation Test (Deepa & Savithri, 2010)
6. Audio video recording equipment.

**Procedure:** Conversation, topic narration, story narration, picture description tasks were carried out in Kannada language using the above test materials. Spontaneous speech was selected as stimuli as it forms a naturalistic data that provide insight into the language patterns that children actually use in day to day life.

Standardized version of Kannada Articulation Test (Deepa & Savithri, 2010) was used to elicit the speech sample with all phonemes of Kannada language. The picture stimuli were presented via computer one at a time. Children were instructed to name the target picture and talk about the picture in two sentences by placing the target word in initial position. This test was used for the purpose of including every phoneme of the Kannada language and thereby to control for the occurrence of phonemes in the study. The child had every chance to utter the phoneme occurring in Kannada language at word and sentence level in initial position. The tasks were carried out approximately for two hours.

The speech samples obtained across tasks were recorded using audio video equipment. Greater than 1000 words speech samples were elicited across all the tasks in Kannada language. The recorded samples were transcribed using the IPA for speech disorders and analyzed. The relative difficulty of individual phonemes for each participant was calculated using the following formula:

$$\frac{\text{Total no. of disfluencies for each phoneme}}{\text{Total frequency of occurrence of phonemes}} \text{ X } 100 = \text{Total \% of disfluent phoneme}$$

A total of 29 phonemes on which disfluencies occurred were considered in the study. The phonemes were categorized according to voicing, place and manner of articulation for Kannada language as proposed by Upadhyaya (1972). The consonants were classified according to place as bilabial, retroflex, dental, alveolar, velar, labio-dentals, palatal and glottal. Also, the consonants were classified according to manner of articulation as plosives, fricatives, affricates, flaps, laterals and nasals. They were further classified as voiced and unvoiced. Vowels were classified as short, long, mid, front and back vowels.

The frequency of occurrence of disfluencies was mostly in the initial position hence only the initial instances of stuttering were considered for analysis. The relative difficulty of individual phonemes for each participant was calculated. The mean, standard deviation and median values were calculated using SPSS software. Wilcoxon signed ranks test was used to determine significant differences between and within disfluent consonants and vowels. Data on mean, standard deviation and median suggested high variability among the participants and hence the median scores were used for comparisons. 10% of the video recorded speech samples across the tasks were analyzed by two speech language pathologists independently to check for reliability. Cronbach's alpha reliability coefficient was above 0.95 suggesting the data to be reliable between the ratings of examiner and speech language pathologists.

**Results and Discussion**

The results of the study are discussed in the following sections as to the disfluent phonemes, disfluent phonemes in the consonant and vowel groups and distribution of disfluencies across individual participants.

***a) Disfluent Phonemes***

Loci of disfluency among consonants and vowels in Kannada language were analyzed and are depicted in table 1 and 2. The IPA symbols for Kannada used in the study are as suggested by Schiffman (1979). Median percentage scores for disfluent consonants was 32 and for disfluent vowels the score was 13.5. There was significant difference (z=-2.70, p<0.05 level) between the median scores for the consonants and vowels.

*Table 1: Mean, SD and Median percentage of disfluent consonants*

| **Disfluent consonants** | **Mean** | **SD** | **Median** | **Rank of difficulty** |
|---|---|---|---|---|
| /T/ | 64.10 | 29.34 | 58.50 | 1 |
| /d/ | 49.7 | 21.03 | 55.00 | 2 |
| /r/ | 49.0 | 25.13 | 50.00 | 3 |
| /v/ | 61.00 | 28.97 | 50.00 | 3 |
| /p/ | 53.70 | 28.17 | 47.50 | 4 |
| /j/ | 51.4 | 28.31 | 44.00 | 5 |
| /g/ | 39.40 | 16.91 | 43.50 | 6 |
| /D/ | 47.40 | 43.46 | 39.50 | 7 |
| /sh/ | 42.70 | 42.57 | 36.50 | 8 |
| /c/ | 39.70 | 31.75 | 35.50 | 9 |
| /s/ | 47.00 | 25.90 | 34.50 | 10 |
| /y/ | 31.90 | 32.93 | 34.50 | 10 |
| /k/ | 37.80 | 19.58 | 33.50 | 11 |
| /n/ | 28.20 | 16.79 | 27.00 | 12 |
| /t/ | 35.2 | 25.53 | 26.00 | 13 |
| /m/ | 29.30 | 12.15 | 25.50 | 14 |
| /b/ | 33.10 | 16.96 | 25.00 | 15 |
| /h/ | 13.40 | 13.58 | 10.50 | 16 |
| **Total voiced** | **33.00** | **13.75** | **32.00** | |
| **Total voiceless** | **36.10** | **14.79** | **29.50** | |
| **Total consonants** | **34.70** | **14.18** | **32.00** | |

The results suggested that CWS have more difficulty with consonants compared to vowels. The present study supports the findings of earlier studies (Griggs & Still, 1979; Geetha, 1979), who also reported more difficulty with consonants compared to vowels.

Consonants involve a greater degree of articulatory tension and it is more likely that they are more susceptible to stuttering (Lehiste & Peterson, 1959). Bloodstein (1958) also reported that the production of consonants is complex compared to vowels and suggested a degree of stoppage or impedance of airstream, involving greater articulatory tension during the production of consonants compared to a vowel. The consonants are also relatively more important for clarity and distinctness and they lend themselves more readily to the suggestion that they are difficult to articulate. Perhaps these are the possible reasons for increased stuttering on consonants than on vowels.

In contrast, Wingate (1988) pointed out that "these differences between the consonants and vowels are misleading and that it is an artefact undoubtedly occasioned by the structure of words. In fact, analysis of word structure clearly refutes the belief that consonants are more difficult than vowels". He argued that most words begin with consonants and significantly, initial position is where stuttering occurs the most and hence the position of stuttering instances emerges as critical.

*Table 2: Mean, SD and Median percentage of disfluent vowels*

| Disfluent vowels | Mean | SD | Median | Rank of difficulty |
|---|---|---|---|---|
| /oo/ | 38.40 | 27.64 | 29.50 | 1 |
| /uu/ | 25.30 | 28.27 | 19.00 | 2 |
| /ee/ | 23.90 | 26.64 | 14.50 | 3 |
| /aa/ | 13.70 | 15.46 | 9.00 | 4 |
| /ii/ | 21.60 | 30.68 | 8.50 | 5 |
| **Total long vowels** | **30.90** | **27.05** | **24.00** | |
| /o/ | 33.50 | 34.40 | 18.50 | 1 |
| /e/ | 20.2 | 19.05 | 14.00 | 2 |
| /a/ | 17.30 | 20.91 | 10.00 | 3 |
| /i/ | 9.30 | 7.27 | 7.50 | 4 |
| **Total short vowels** | **15.50** | **12.54** | **12.00** | |
| **Total vowels** | **18.00** | **12.78** | **13.50** | |

***b) Disfluent Phonemes within Consonant Group***

Consonants were classified according to voicing, place and manner of articulation. Loci of disfluency among voiced and voiceless consonants were analyzed and are depicted in table 1. Median percentage score for disfluent voiced consonants was 32 and for disfluent voiceless consonants the score was 29.5. There was no significant difference ($z=-1.0$, $p>0.05$ level) between the median scores of disfluent voiced and voiceless consonants. Figures 1 and 2 represent the ranking of difficulty for the disfluent consonants.

The results suggested that CWS might present similar type of difficulty in both the consonant groups. There is no evidence of differences among voiced consonants and voiceless consonants with respect to frequency of stuttering instances. The results of the present study are in consonance with other researchers (Hahn, 1942; Hejna, 1955; Soderberg, 1962) who also reported no such differences.

The rank order of the phonetic disfluency with respect to place and manner of articulation of consonants included retroflex plosive /T/, dental plosive /d/, alveolar flap /r/, labiodental continuant /v/, bilabial plosive /p/, palatal affricate /j/, velar plosive /g/, retroflex plosive /D/, palatal fricative /sh/, palatal affricate /c/, alveolar fricative /s/, palatal approximant /y/, velar plosive /k/, alveolar lateral /l/, dental nasal /n/, dental plosive /t/, bilabial nasal /m/, bilabial plosive /b/ and glottal fricative /h/. The descriptive analysis of consonants with regard to place of articulation revealed no consistent pattern of phonetic difficulty. However, while considering the manner of articulation of consonants, plosives and fricatives exhibited more frequency of disfluencies compared to other consonants though not significant.

A recent study by Soumya and Sangeetha (2011) investigated phonetic influences in CWS in the age range 8-12 years for reading and narration task. The authors observed a rank order for Kannada language as /c/, /b/, /k/, /s/, /g/, /sh/, /r/, /m/, /j/, /n/, /t/, /p/, /D/, /h/, /T/, /v/, /dh/ and /l/. Comparison of both the studies indicated consistency with respect to manner of articulation in that plosives are affected most of the times. However, a consistent pattern with regard to type of phoneme did not exist across the studies in Kannada language. Although the plosive /T/ and /d/ gets higher ranking, the remaining plosives do not follow subsequently.

Jayaram (1983) while investigating the phonetic influences on stuttering in monolingual and bilingual adults concluded that the nasals (voiced), voiceless fricatives and voiceless plosives were stuttered more than other sounds.The results of the present study are in consensus with Jayaram (1983) that fricatives and plosives had the higher rank of difficulty. But, the data on voicing feature and nasals were not consistent in our study. However, the group of participants in the present study included only children, unlike in Jayaram's study where it was only adults.

The present study supports the findings of Hunt (1967) who concluded that the aspirated and continuant sounds as /f/, /w/ and /s/ were less difficult as the oral canal was not so completely closed as in the explosives. Hahn (1942) reported ranking of difficulty of consonants as G, D, L, TH , CH and M in larger percentages and the S, F, SH, WH, DH in the smaller percentages. Plosive consonants require complete closure of the articulatory pathway unlike the continuous consonants which require a free pathway. Fricatives require some intermediate position between these two extremes. This intermediate position involves certain balance between these two extremes and perhaps more effort is involved in maintaining such a balance. Consequent to the effort required and the difficulty in maintaining such a balance, the production of fricatives become more difficult. This may be the reason for higher stuttering frequency on these sounds.

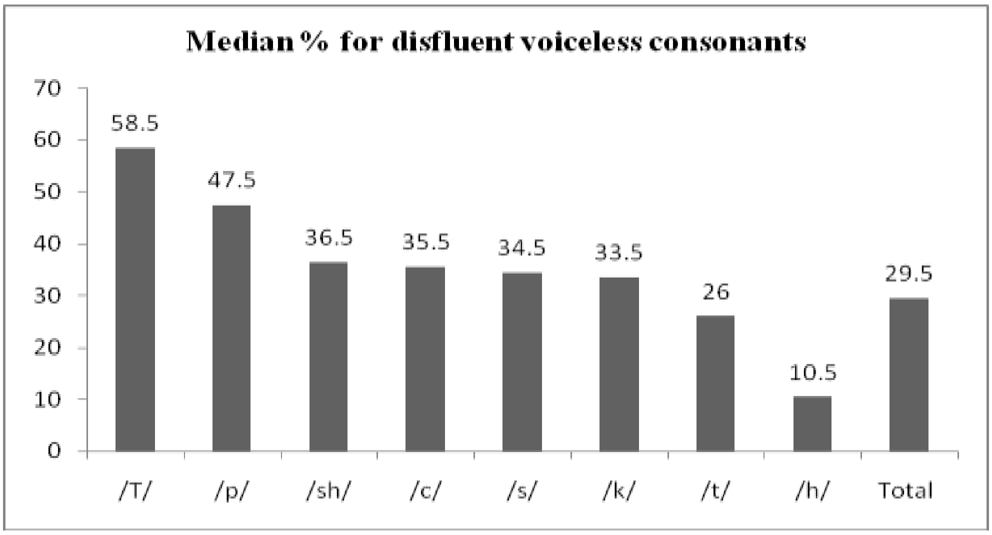


Figure1: Median percentage scores for disfluent voiceless consonants

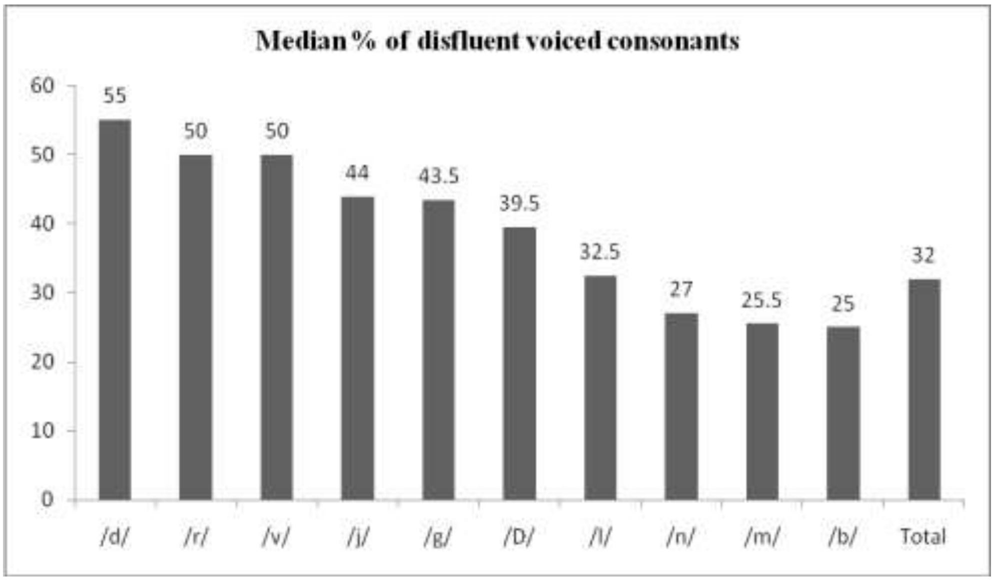


Figure 2: Median percentage scores for disfluent voiced consonants

### *c) Disfluent Phonemes within vowel Group*

Vowels were classified as short, long, mid, front and back vowels. Median percentage score for disfluent long vowels was 24 and for disfluent short vowels, the score was 12. There was significant difference ($z=-2.49$, $p<0.05$ level) between the median scores for long and short vowel. Figures 3 and 4 represent the ranking of difficulty for the disfluent vowels. The results suggested that CWS had more difficulty with long vowels compared to short vowels. The rank order of the phonetic disfluency with respect to long vowels included high back vowels /oo/ & /uu/, high front /ee/, low back /aa/ and high front vowel /ii/. The results revealed most difficulty with high back vowels and least difficulty with high front vowel /ii/. The rank order of the phonetic disfluency with respect to short vowels included high back vowel /o/, high front /e/, low back /a/ and high front vowel /i/. The results revealed most difficulty with /o/ and least difficulty with /i/. On comparison of long and short vowels the rank order of difficulty almost showed a consistent pattern. Considering the place of articulation, high back vowels had greater errors in both short and long vowel instances. The data suggests that probably children exhibit more difficulty during the production of high back vowels.

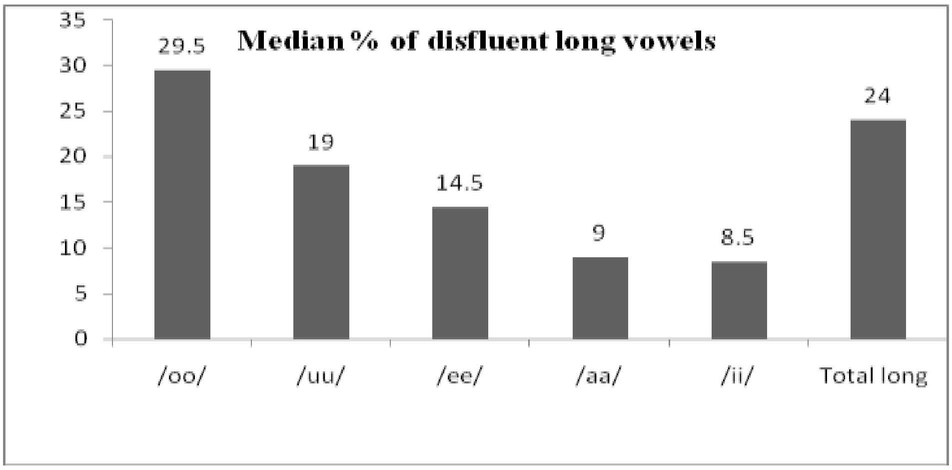


Figure 3: Median percentage for disfluent long vowels

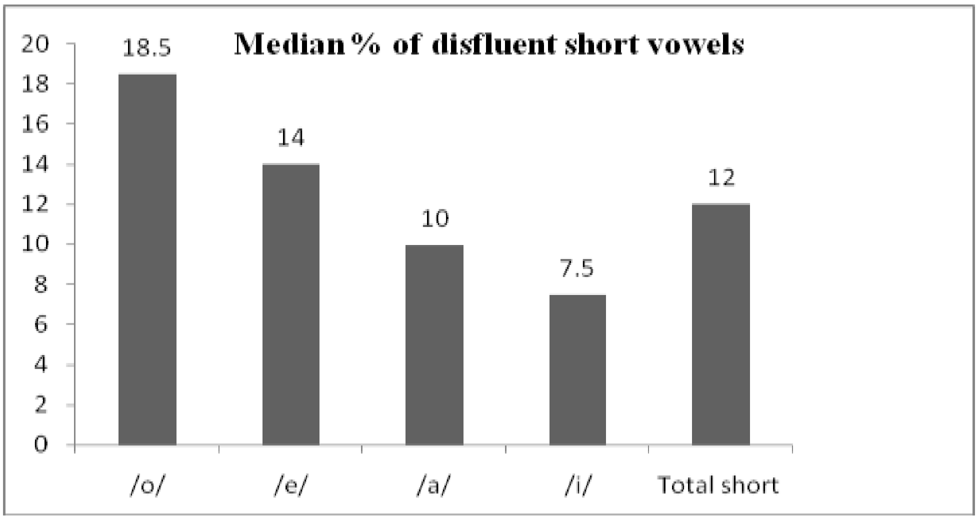


Figure 4: Median percentage for disfluent short vowels

The results of the present study also support earlier studies (Hunt, 1967; Van Riper, 1971) that stuttering not only occurs on consonants but that it may extend to all sounds including vowels. Results suggest the probability of a group of CWS in the present study in whom the back vowels were more affected than other vowels. Geetha (1979) noted higher disfluency rate on low back vowel /a/. However in the current study high back vowels were more frequently disfluent.

A recent study by Soumya and Sangeetha (2011) on Kannada speaking children noted the rank order of disfluent vowels as /e/, /a/, /o/, /i/ and /u/ for short vowels and considering long vowels the order was /aa/, /ai/, /oo/, /au/ and /ii/. The results of the present study, though do not correlate for every vowel, some pattern exists for few vowels (eg., short and long vowel /i/). The rank order for /i/ was same in both the studies. Further, our results are in agreement with Jayaram's (1977) study who stated that the long vowels are more affected than short vowels.

***d)Distribution of Disfluencies across Individual Participants***

The CWS did not exhibit a consistent pattern for the presence of disfluencies. In spite of the fact that a ranking of difficulty of sounds related to stuttering occurrence is offered, the data of individual participants showed a marked difference. Each child exhibited relative difference both on the sound disfluent and in the amount of difficulty with specific sounds.

The rate of phonetic loci of disfluency appears to be a dynamic phenomenon which appears to be varying across CWS. For example, among the consonants participant 1 had more difficulty with /p/ and /v/ whereas participant 5 had more difficulty with /T/, /D/ and /sh/.

Among the vowels, participant 1 had more difficulty with /ii/ whereas participant 5 had more difficulty with /oo/. Tables 3 and 4 present the ranking of difficulty of phonemes across the ten participants. Results of the present study support the difference hypothesis within consonant and vowel group. Nwokah (1988) proposed the possibility of stuttering to vary from one language to another and termed as "difference hypothesis". Similarly, the results of the present study related to voicing, place and manner of articulation regarding disfluencies had no consistent pattern among CWS. Such pattern suggests the supporting fact to "difference hypothesis", though for the frequency of occurrence of phonetic context across participants for a language. There was a lot of individual variability among the participants while comparing the loci of phonetic difficulty.

Cullinan and Springer (1980) stated that the persons with stuttering form a heterogenous group in linguistic deficits and the same thing holds good even while looking into the phonetic loci of disfluencies. Johnson and Brown (1935) observed that the more severe the stuttering is, the more likely one to be consistent in stuttering on certain sounds. The analysis showed that although a ranking of sounds with difficulty is suggested, the individual variations are far more pronounced than the group tendency toward formulation of such a ranking.

Table 3: *Rank order of difficulty for consonants across participants*

| **Disfluent consonants** | **Rank of difficulty** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | *P10 |
| /T/ | 6 | 4 | 5 | 1 | 1 | 3 | 1 | 3 | 6 | 2 |
| /d/ | 4 | 5 | 12 | 6 | 3 | 2 | 5 | 2 | 4 | 11 |
| /r/ | 5 | 2 | 10 | 9 | 4 | 5 | 2 | 3 | 0 | 1 |
| /v/ | 1 | 10 | 1 | 7 | 7 | 1 | 4 | 3 | 4 | 6 |
| /p/ | 1 | 3 | 9 | 5 | 2 | 7 | 7 | 10 | 3 | 5 |
| /j/ | 3 | 15 | 2 | 11 | 6 | 1 | 6 | 8 | 12 | 5 |
| /g/ | 7 | 12 | 8 | 4 | 13 | 3 | 3 | 4 | 9 | 1 |
| /D/ | 10 | 1 | 0 | 2 | 1 | 0 | 4 | 1 | 0 | 9 |
| /sh/ | 0 | 6 | 1 | 3 | 1 | 0 | 0 | 0 | 2 | 4 |
| /c/ | 0 | 2 | 1 | 9 | 10 | 11 | 8 | 11 | 8 | 3 |
| /s/ | 10 | 8 | 4 | 8 | 11 | 1 | 9 | 5 | 5 | 7 |
| /k/ | 9 | 13 | 3 | 11 | 12 | 4 | 10 | 6 | 1 | 14 |
| /n/ | 8 | 9 | 13 | 11 | 9 | 9 | 13 | 7 | 11 | 12 |
| /t/ | 2 | 11 | 6 | 12 | 8 | 10 | 11 | 12 | 10 | 11 |
| /m/ | 11 | 16 | 11 | 8 | 5 | 8 | 14 | 9 | 8 | 8 |
| /b/ | 12 | 14 | 7 | 10 | 6 | 6 | 12 | 9 | 7 | 11 |
| /h/ | 7 | 0 | 0 | 0 | 14 | 8 | 11 | 13 | 13 | 5 |
| /y/ | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 1 |

(*P1 to P10 are the participants)

Table 4: *Rank order of difficulty for vowels across participants*

| **Disfluent vowels** | **Rank of difficulty** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | *P10 |
| /oo/ | 3 | 2 | 4 | 4 | 1 | 2 | 1 | 3 | 1 | 4 |
| /uu/ | 2 | 3 | 4 | 1 | 0 | 0 | 4 | 6 | 0 | 0 |
| /ee/ | 0 | 7 | 1 | 3 | 0 | 0 | 4 | 1 | 3 | 0 |
| /aa/ | 4 | 6 | 7 | 7 | 3 | 0 | 5 | 7 | 5 | 6 |
| /ii/ | 1 | 0 | 2 | 0 | 0 | 0 | 3 | 4 | 2 | 0 |
| /o/ | 5 | 1 | 5 | 5 | 0 | 1 | 4 | 2 | 2 | 2 |
| /e/ | 0 | 5 | 3 | 2 | 2 | 4 | 2 | 9 | 6 | 1 |
| /a/ | 0 | 4 | 8 | 6 | 2 | 3 | 6 | 5 | 4 | 3 |
| /i/ | 6 | 8 | 6 | 7 | 3 | 5 | 7 | 8 | 7 | 5 |

(*P1 to P10 are the participants)

Henke (1967) proposed a model which stated that speech units are organized as 'bundles of independent articulatory features'. Motor commands to speech muscles are encoded in the central nervous system, primarily in terms of idealized articulatory 'targets' which may or may not correspond to linguistic units such as phonemes (Mac Neilage, 1970). However, if we accept Henke's (1967) contention, then features of the language also become important. Also, the extent to which a given 'target movement' is fulfilled will depend largely on such external factors as overall speed of utterance, those targets which precede or follow it and the prosodic features of the language (Dalton & Hardcastle, 1977). Assuming that sequences of movements for an entire syllable are triggered off as a whole at the beginning of that syllable, then failure in such a sequence results in the fixation of target movements of the current neurolinguistic program being processed, which is probably what is happening in speech of PWS. Probably because there is fixation of the target movement of the first sound and somehow the speech organs have not received the motor schema for the succeeding sound or syllable in time, PWS repeat the sound or syllables many times or prolong or fixate on them before going on to the next sound (Van Riper, 1971).

Olander, Smith, and Zelaznik, (2010) explained that "during the disfluencies that characterize stuttering, the speech motor system fails to generate and/or send the motor commands to muscles that are necessary for fluent speech to continue". Watkins, Smith, Davis, and Howell (2008) stated that "stuttering is a disorder related primarily to disruption in the cortical and subcortical neural systems supporting the selection, initiation and execution of motor sequences necessary for fluent speech production".

Similarly, as argued by Packman et al. (2007), developmental stuttering is a problem in syllable initiation in which the child is unable to move forward in speech because the speech planning system is compromised. Further, they explained that this difficulty is first noticed when the child attempts to produce multisyllabic utterances requiring complex sequential movements and varied linguistic stress patterns across syllables to communicate the intended meaning. According to Packman et al., children do not stutter when babbling or producing first words because these additional speech motor demands are not yet present.

According to Levelt’s model (1989) “word errors could occur at the lemma level and sub-word level that involve phonemic and syllabic transmutations. The generated phonemic plan allows the first part of the word to be available before the rest of it”. Majority of PWS present the fluency failures at word onset or in the initial position. This suggests that the speakers find it difficult to span from word onset to the subsequent part of the word during fluency failures.

The EXPLAN model (Howell & Au-Yeung, 2002) "stresses that motor levels are as important as the linguistic planning levels in leading to fluency failure". As literature suggests, instances of stuttering is a complex phenomenon. The deficit probably may not be only at motor execution level but may be beyond that involves the central functions of speech production system. In the present study CWS had phonetic difficulty which was highly variable within and across participants. The ranking of difficulty of sounds does not clearly indicate the influence of physical factors in sound formation. Voiced and voiceless, plosive and continuant sound classification seems to have little effect on the formulation of the general ranking of difficulty of stuttering in children.

The study analyzed the relative difficulty of individual phonemes according to place and manner of articulation of phonemes in Kannada speaking children with stuttering. In addition to theoretical implications our results may also have clinical implications. Our findings support the notion that persons with stuttering require a detailed assessment both in terms of depth and breadth. The findings based on Kannada language reported here may be useful in providing cross linguistic evidence on phonetic influences on the disfluencies of CWS. However, future research should examine the role of word frequency in spontaneous speech and analysis of succeeding phonemes for better understanding on phonetic factors.

**Conclusion**

This paper addressed the phonetic context of disfluencies in children with stuttering to understand more fully the occurrence of disfluencies at phonetic level. Our findings suggested greater frequency of occurrence among consonants compared to vowels. Long vowels had more stuttering instances compared to short vowels.

The results of the present study related to voicing, place and manner of articulation regarding disfluencies had no consistent pattern among CWS. The findings support the fact that the variability of stuttering is one of the hallmarks of developmental stuttering. Stuttering is a problem with the mystery as it is difficult to understand why persons with stuttering speak fluently in one moment and then a moment later struggle dramatically as they attempt to say the same sound. It is difficult for the speaker to compensate for the problem that is so inconsistent and unpredictable. The problem of stuttering should be viewed in association with linguistic and physiological substrata of language/speech production.

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