

**TEMPORAL DYNAMICS IN SOUND / SYLLABLE REPETITIONS  
OF STUTTERERS AND NORMAL NON-FLUENT CHILDREN:  
A PILOT INVESTIGATION IN TAMIL<sup>1</sup>.**

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**ABSTRACT**

*Attempts to differentially diagnose stuttering from normal non fluent children acoustically have received central, theoretical and practical attention in recent years. However, temporal aspects of acoustic analysis of speech in dys / disfluent children has been relatively neglected, and this is the focus of the present study. The study investigated durational aspects of the silent intervals (IID), spoken repetition units (ITD), fluent portions (FTD), total duration (TD) and the number of iterations within sound /syllable repetitions in the speech of stuttering and normal non fluent children who speak Tamil as their native language. The results reveal significant differences between the groups in all the parameters. The discussion focuses on the results from a theoretical (stuttering as a motor control disorder) and a clinical (differential diagnostic cue) perspective.*

**INTRODUCTION**

The crucial issue of differentiation between cases of early stuttering and normal non fluency in its incipient stage, is one that has received considerable attention from the field of research for many years. Efforts to distinguish normal non fluency from stuttering in a categorical way have focused on the identification of specific features in early disfluency, but have yielded little success. Various researchers (2,3,4,5) have considered aspects such as type of disfluency (syllable/word repetitions, prolongation, interjections etc.), frequency of occurrence and number of repetition units as some of the indicators for differential diagnosis of stuttering and normal non fluency.

More recently there has been a surge of interest in the objective analysis of disfluencies (6,7,8,9,10). Durational aspects of part word repetitions and sound prolongation have also been studied (11,12,13). But short segment repetitions and silent intervals between repetitions were not given relative importance until recently where Throneburg and Yairi (14) and Yairi, Hilchie and Hall (15), reported data on the durational characteristics of several identifiable segments within single repetitions of single syllable words. Their results indicated that the ratio of the silent interval to the total disfluency was smaller for stutterers than non stutterers. They speculated that the silent interval was a crucial factor to differentiate the speech of stutterers from normally non fluent children. Zebrowski (13) used acoustic analysis to measure the duration of part word repetitions and sound prolongation in the speech of stutterers and normally non fluent children. She found no significant differences in duration between the two groups.

Thus, no conclusive data are available on the durational characteristics of disfluencies. Studies till date have focused on single unit repetitions, however, multiple unit repetitions which may be speculated as a crucial diagnostic tool, have not been investigated adequately and this is the focus of the present study. The present study aims at evaluating the significance of durational characteristics of single and multiple unit repetitions as an important tool to differentiate between childhood stuttering and normal non fluency. It is hypothesised that there is no significant difference between the two groups on the durational parameters studied namely, Inter-iteration duration (IID), Iterated token duration (ITD), Fluent token duration (FTD) and Total duration (TD).

**METHOD**

**S u b j e c t s**

The subjects included ten Tamil speaking children in the age range of 3-8 years. They were divided into two groups. Group A consisted of five moderate stutterers, four males and one female, while Group B consisted of five normally non-fluent children, three males and two females (diagnosed by Speech-Language Pathologists). The subjects had no other speech, language or hearing deficits other than stuttering.

**P r o c e d u r e**

The children were comfortably seated in a noise free room at the Speech Science Laboratory. They were involved in two tasks:

- a task of general conversation with at least one of the investigators for a duration of 5-8 minutes, and
- a picture description task / a story narration task, using a standard Indian (Panchatantra) story.
- These were audio recorded using a stereo cassette deck on a high quality audio cassette, using a high fidelity microphone kept at a distance of 12 centimetres from the speaker. The recordings were transcribed verbatim and the dys /disfluencies were identified. These dys /disfluencies were required to meet the following criteria:
  - Dys /disfluencies other than sound / syllable repetitions were not included.
  - Dys /disfluencies having sound / syllable repetitions along with other dys / disfluencies (e.g., Prolongation, interjections etc.,) were discarded (e.g., p.p.o..t pot).
  - Tokens having iterations in the final position in a word were not included (e.g., pot....t...t).
  - Tokens selected had to be free of interfering noise (recording).

Group A yielded a total of 46 dysfluent tokens, of which 25 were single unit repetitions and 21 were multiple unit repetitions. Group B provided a total of 11 disfluent tokens, of which 9 were single unit repetitions and 2 were multiple unit repetitions. This formed the material for the acoustic analysis.

### **A c o u s t i c   a n a l y s i s**

Temporal analysis was carried out using the software programme “Vaghmi”.

The following acoustic measurements were made based on the waveform displays:

1. Inter Iteration Duration (IID): The time difference between the end of an iteration and the beginning of the next iteration / fluent utterance in milliseconds.
2. Iterated Token Duration (ITD): The time difference between initiation and termination points of an iterated token in milliseconds.
3. Fluent Token Duration (FTD): The time difference between the initiation and termination points of the iterated sound / syllable in the fluent token in milliseconds.
4. Total Duration (TD): A combination of inter-iteration duration, iterated token duration and fluent token duration in milliseconds.

On the display, the end of an iteration and the beginning of the next iteration / fluent utterance were marked using the cursors. Initiation was visually defined as the first peak (maximum amplitude in milli volts ) judged as the first sound of the disfluent episode. Termination was defined as the last consecutive peak in the waveform. Initiation and termination points were also verified auditorily. Apart from these the number of iterations, both single and multiple, were also noted.

### **S t a t i s t i c a l   a n a l y s i s**

Because of the small sample, a non parametric statistical procedure, the Walshtest (16) was used to estimate the significance of difference between the two groups on the various parameters.

## **RESULTS**

### **1. Inter-iteration duration (IID)**

**Table 1: Means (S.D) of IID (in msec) and number of tokens (single iterations) measured in Groups A and B.**

GROUP A (stuttering)			GROUP B ( normal non fluent)				
1.	S1	5	105.2(34.59)	1.	N1	1	25.0

2.	S2	3	64.3(62.94)	2.	N2	-	-
3.	S3	7	132.14(70.12)	3.	N3	4	280.5(52.26)
4.	S4	7	170.57 (163.7)	4.	N4	3	142.0(203.04)
5.	S5	3	114.0 (36.0)	5.	N5	1	594.0(167.31)
<b>Mean (S.D)</b>			<b>5(2) 117.24 (38.81)</b>	<b>Mean (S.D)</b>			<b>2.25(1.89)</b>
			<b>260.38(245.71)</b>				

The IID (single iterations) for Group A (stutterers) ranged from 64 msec to 170 msec [mean 117.24 and (S.D) 38.81], while the IID for Group B (normal non fluent) ranged from 25 msec to 280 msec [mean 260.38 and (S.D) 245.71]. There was a significant difference between the two groups at the 0.031 level. On comparison of the means of IID for single iterations (shown in table 1) it was found that IID for stutterers was shorter than for normal non fluent children.

**Table 2: Means (S.D) and number of tokens for the IID (multiple iterations) measured in groups A and B.**

GROUP A (stuttering)			GROUP B ( normal non fluent)				
1.	S1	4	213.79(63.96)	1.	N1	-	-
2.	S2	-	-	2.	N2	1	268.0(65.05)
3.	S3	9	219.96(203.6)	3.	N3	-	-
4.	S4	3	108.4(28.24)	4.	N4	1	9.8(2.97)
5.	S5	5	172.06(40.77)	5.	N5	-	-
<b>Mean (S.D)</b>			<b>4.2(3.63)</b>	<b>178.55(51.38)</b>	<b>Mean (S.D)</b>		<b>0.4(0.75) 138.9(182.6)</b>

The IID (multiple iterations) ranged from 108 to 219 msec for Group A (stutterers) [mean 178.55 and (S.D) 51.38] and from 9.8 to 268 msec for Group B (normal non fluent children) [mean 138.9 and (S.D) 182.57]. There was a significant difference between the two groups at the 0.031 level. The IID (multiple iterations) for normal non fluent children as a group was less than the stuttering children.

## 2. Number of single and multiple iterations

Tables 1 and 2 also reveal the number of single and multiple iterations in both the groups. The number of single iterations ranged from 3 to 7 [mean 5 and (S.D) 2] in Group A and between 0 to 4 [mean 2.25 and (S.D) 1.89] in Group B. The number of multiple iterations ranged from 3 to 9 in Group A [mean 4.2 and (S.D) 3.63] and between 0 to 1 in Group B [mean 0.4 and (S.D) 0.75]. Stutterers as a group had more single and multiple iterations.

## 3. Iterated Token Duration (ITD)

**Table 3: Means (S.D) for ITD of single and multiple iterations measured in Groups A and B.**

GROUP A (stuttering)			GROUP B ( normal non fluent)				
1.	S1	10.8(8.14)	20.4(12.17)	1.	N1	6.0	-
2.	S2	149(94.84)	-	2.	N2	-	71.15
3.	S3	120.6(106.5)	85.21(98.95)	3.	N3	156 (143.6)	-
4.	S4	116.28(77.7)	128.7(83.79)	4.	N4	142(47.82)	7.4
5.	S5	170.3(40.45)	233.9(127.1)	5.	N5	215	-
<b>Mean (S.D)</b>			<b>113.4(61.43)</b>	<b>117.07(89.7)</b>	<b>Mean (S.D)</b>		<b>129.9(88.4) 39.45(43.3)</b>

The ITD for single iterations for Group A (stutterers) ranged from 10.8 to 170.3msec [mean 113.40 and (S.D) 61.43], while the duration for Group B (normal non fluent) ranged from 6.0 to 215msec [ mean 129.87 and (S.D) 88.40]. The difference between the means of the two groups was statistically significant at the 0.031 level. The ITD in single iterations as a group was less for stutterers than for normal non fluent children.

The ITD for multiple iterations for Group A (stutterers) ranged from 20.4 to 233.96 msec [mean 117.07 and (S.D) 89.74]. Only two multiple iterations were measured in Group B where N2 and N4 had 71.5 and 7.4 as ITD (in msec) respectively. A significant difference was found between the means of the two groups at 0.031 level.

#### 4. Fluent token duration (FTD)

**Table 4: Means (S. D) for FTD for single and multiple iterations in Groups A and B.**

GROUP A (stuttering)			GROUP B ( normal non fluent)				
1.	S1	64.4(57.3)	62.25(39.6)	1.	N1	108.0	-
2.	S2	176.6(120.9)	-	2.	N2	-	89.0
3.	S3	101.43(70.9)	79.89(78.3)	3.	N3	126.0(78.8)	-
4.	S4	107.14(65.4)	64.67(63.0)	4.	N4	120.0(41.04)	138.0
5.	S5	121.0(79.9)	195.6(104.0)	5.	N5	104.0	-
<b>Mean (S.D)</b>		<b>114.11(40.7)</b>	<b>100.6(63.8)</b>	<b>Mean (S.D)</b>		<b>114.5(10.25)</b>	<b>113.5(34.65)</b>

The FTD for Groups A for single iterations ranged from 64.4 to 176.6 msec [mean 114.11 and (S.D) 40.72], while the same in Group B ranged from 104 to 126 msec [mean 114.5 and (S.D) 10.25]. The difference in the duration of fluent token for single iterations was found to be statistically significant at the 0.031 level.

The FTD for Group A for multiple iterations ranged from 62.25 to 195.6 msec and for Group B subjects N2 and N4 had 89 and 138 msec as FTD respectively. Other subjects revealed no multiple iterations. A significant difference was found between the two groups on the FTD for multiple iterations.

#### 5. Total duration (TD)

**Table 5: Means (S.D) for TD for single and multiple iterations in Groups A and B**

GROUP A (stuttering)			GROUP B ( normal non fluent)				
1.	S1	180.4(88.4)	756.78(245.9)	1.	N1	139.0	-
2.	S2	390(190.6)	-	2.	N2	-	768.0
3.	S3	354.14(97.2)	1366.2(697.8)	3.	N3	563(256.13)	-
4.	S4	394.6(216.1)	741.3(317.65)	4.	N4	524(167.31)	224.0
5.	S5	405.3(146.9)	1109.4(507.8)	5.	N5	594.0	-
<b>Mean (S.D)</b>		<b>344.86(90.59)</b>	<b>993.43(203.0)</b>	<b>Mean (S.D)</b>		<b>455.0(212.6)</b>	<b>496(384.7)</b>

The TD of the single iterations in Group A ranged from 180.4 to 405.33 msec [mean 344.86 and (S.D) 90.59] and the same in Group B ranged from 139.0 to 594.0 msec [mean 455 and (S.D) 212.6]. However, N2 had no single iterations. The test of significance revealed a significant difference at 0.031 level.

The TD for multiple iterations in Group A ranged from 741.3 to 1366.2 msec [mean 993.4 and (S.D) 203.0]. However, S2 had no multiple iterations. On analysing the same in Group B, three subjects viz., N1 N3 and N5 revealed no multiple iterations. Subjects N2 and N4 had 768.0 and 224.0 as their TD ( in msec) respectively. This showed multiple iterations were more likely to be seen in the stuttering group than in the normal non fluent group. On the values measured, TD was shorter for stutterers as a group when compared with the normal non fluent group.

### DISCUSSION

In concurrence with the results reported by Throneburg and Yairi (14), the present study also reveals that stutterers exhibited shorter silent intervals between spoken repetition units i.e., inter iteration duration were shorter in stuttering children than normally non fluent children in single iterations. But an opposite trend was obtained on analysing multiple iterations. However, the number of multiple iterations in Group B was small and so the result should be viewed with caution. This trend indicates that stuttering children tend to repeat faster than children who do not stutter, giving relatively lesser time for motoric self-correction.

The ITD was found to be lesser in stuttering children than normally non fluent children. Zimmermann (17), views repetitions as reflexive responses in an attempt to correct various spatial and temporal articulatory relations. Making an inference from the above, the relatively shorter time of the iterated token may reflect a

reflexive correction of movement velocities, inter articulatory relations, tensions and so on, effecting a better approximation of the intended target, which indicates a more central strategy of correcting errors.

The FTD were very similar for the two groups of children which reveals that the fluent tokens were produced in more or less the same physiological time.

The TD of the stutterers' dysfluencies were significantly shorter because of their shorter silent intervals, when compared to the disfluencies of the normal non fluent children. This finding concurs with that of Throneburg and Yairi(14).

Finally, the number of single and multiple repetition units in stuttering children were more than normally non fluent children. Yairi and Hall (18) suggested a heavier reflexologic role in stutterers as a reason for faster repetition rate. Based on this notion, it may be concluded that in normal children the system allows sufficient time to make necessary adjustments between one attempt and the next. The result is a net reduction in the number of repeated units in the normal group. However, in stutterers, corrective responses may be reflexively rigid, allowing only brief intervals for readjusting. Thus the corrections may not accurately match the target, requiring more corrective attempts. This may account for the fact that the stuttering children exhibited more number of iterations within a dysfluent episode.

## **CONCLUSION**

According to Yairi and Hall (18), 'Data on subtle temporal characteristics of segments within disfluencies provide information that is not detected when instances of disfluency are treated as a whole'. The results of the study strongly affirm this statement, and highlights the need to probe into subtle temporal dynamics in routine evaluation for a better differential diagnosis. However, further research with a larger sample, and refined temporal parameters (multiple iterations) in greater numbers is warranted to throw more light on this area.

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