

Initial Syllable Vowel Duration as a Temporal Measure in Persons with Stuttering: Implications for Speech Motor Control

Abirami. S¹, Balambigai N²

¹Speech Language Pathologist, Kare therapy Center, Chennai

² Assistant Professor, Dept. of SHC, NIEPMD (D), Chennai

Abstract

Stuttering is a fluency disorder characterized by involuntary repetitions, prolongations and hesitation. “Relational Speech Timing Task (RST)” refers to a phenomenon where in, when a set of words with a common base word, is used with progressively increasing length of suffixes it results in progressive reduction in the duration of vowel of the initial syllable. Since individuals with stuttering are reported to have difficulties in the temporal aspects of speech, this study aimed to assess and compare the Initial Syllable Vowel Shortening (ISVS) among individuals with stuttering and Fluent age matched controls. Eight males with stuttering and eight age and gender matched fluent adults served as subjects. Eight sets of meaningful Tamil words were developed for the RST tasks. The subjects were asked to repeat the modelled stimuli and only the stutter free responses were taken for the analysis. The duration of the initial vowel in the words were measured and compared between the two groups. Results revealed that individuals with stuttering exhibited difficulties for multisyllabic words, demonstrating the subtle timing difficulties in individuals with stuttering.

Keywords: ISVS, Relational Speech Timing Task, Stuttering

Introduction

Speech is governed by many factors, of which motor control forms an important component. Stuttering is a disorder of fluency marked by involuntary repetition, hesitation, and prolongation [1]. Reduced capacity to generate and control plans for motor control of speech was postulated to be one of the causes for initial dysfluencies produced by children who stutter [2]. Stuttering has been described as a disorder of “movement” [3]. Individuals with Stuttering have been reported to show a great variability in sequencing the articulators across trials [4]. Individuals with stuttering exhibit difficulty with the timing of speech movement due to poor programming of the required movements [5]. Segmental and temporal components of a speech signal may be reduced or lost as a result of an impairment in the ability to control movements of speech articulators. Thus, the earlier studies suggest that individuals with stuttering appear to differ from controls in certain neuromotor processes underlying the programming of speech and non-speech articulatory movements and thus exhibit temporal difficulties in speech.

The temporal dimension of speech refers to chaining the sequences of phonemes, and smoothly coordinating movements which in turn results in accurately articulated speech. Some of the temporal parameters of speech that has been investigated in individuals with stuttering include Voice Onset Time,

Vowel duration and consonant-Vowel(CV) transition. The results have indicated longer VOT's [6,7], longer vowel duration, and longer CV transitions [8-10] among individuals with stuttering as compared to non-stutterers both among adults and children.

Another measure of the temporal dimension of speech is the "Relational speech timing (RST)" [11]. When a set of words with a common base word, along with progressively increasing length of suffixes are presented, there is a progressive reduction in the duration of vowel of the initial syllable, and this is referred to as "Initial syllable vowel shortening". Initial syllable vowel shortening (ISVS) in the "Relational Speech Timing Tasks" has been reported as the sensitive measure of speech praxis control, in individuals with apraxia of speech [12]. It has been reported that in the sequential production of the words, words- strings and sentences, individuals with apraxia exhibit significantly longer vowel and between word segment duration, both in word and sentence context [13]. An earlier study suggested that relational timing task could be sensitive in inferring on the central control mechanisms for praxis control in children [14].

The speech motor control specifically the speech praxis control is important for the production of fluent speech, and hence it would be interesting to study if and how the ISVS occurs in adult with stuttering. Attempts to understand if ISVS is evidenced in relational speech timing tasks when administered on adult stutterers would be an important measure of temporal speech motor control. Individuals with Stuttering tend to have temporal difficulties in speech and hence the study aims to find if ISVS can effectively tap the temporal difficulties in their speech.

Aim of the study

To assess and compare the ISVS among individuals with stuttering and age matched controls.

Method

Eight male individuals with stuttering and 8 age matched fluent individuals served as subjects. The individuals with stuttering were clinically diagnosed to have moderate to severe stuttering, as assessed using SSI (Stuttering Severity Instrument-4) by a Speech Language Pathologist. The native language of all the subjects was Tamil. Oral Peripheral mechanism examination was carried out to rule out structural and functional anomalies. Subjects were screened to rule out articulation errors using Test of Articulation in Tamil. The subjects were selected from Chennai city subsequent to the diagnosis and prior to attending stuttering treatment program.

Eight sets of meaningful Tamil words were developed for the Relational Speech Timing tasks. Each set had a base word (BW= Stimuli1) and this base word was extended by adding a suffix 1 to it in the first level (BW + suffix 1= Stimuli 2) and by adding suffix 1 and suffix 2 in the second level (BW + suffix 1 + suffix 2= Stimuli 3). The familiarity of the word were rated by three Speech Language Pathologist (native speakers of Tamil) using a three point rating scale, (1- Least familiar, 2- Familiar, 3- Most familiar). The words having high familiarity scores (2 or 3) in all three levels were selected as the stimuli.

The task was administered in quiet environment and subjects were seated comfortably. The stimuli were spoken clearly by the experimenter (native Tamil speaker). The responses were elicited by asking the subjects to repeat the modelled stimuli word. In the individuals with stuttering only the stutter free responses were considered for the analysis.

The target responses were stored in the form of wave files and were analysed. The acoustic analysis was done using the Praat software (version 6.4.01). To study the initial syllable vowel duration (ISVS), the

duration of the initial vowel of the first syllable of the target words, across all three conditions were computed. For example, the duration of initial vowel, ‘/a/’ was measured in the words, ‘/va:/’ (Stimuli 1), ‘/va:l/’ (Stimuli 2), ‘/va:lmiki/’ (Stimuli 3) respectively. The duration of the initial vowel in the words was measured by isolating it from the neighbouring phonemes.

Results

The ISVS across the three stimulus conditions (BW, BW+I, BW+II) for both, controls and stutters seemed to follow a similar trend, ie the duration of the vowel shortened with increase in word length as can be seen in Table 1.

Table 1: Group mean and standard deviation of ISVS (in milliseconds) on three stimulus conditions (BW, BW+I, BW+II) for controls and individuals with stuttering.

GROUP	BW (ms)		BW+I (ms)		BW+II (ms)	
	MEAN	SD	MEAN	SD	MEAN	SD
Controls	0.2095	0.04457	0.1414	0.04674	0.0999	0.03145
Individuals with Stuttering	0.2369	0.05393	0.1625	0.05184	0.1186	0.05751

The mean value for controls and individuals with stuttering across the three stimulus conditions shows that the duration of the vowel shortened with increase in word length. It was found that the vowel duration was higher in individuals with stuttering as compared to the controls in all the 3 three set of words (BW, BW+I, BW+II).

The effect of vowel duration on word length was compared between controls and stutters using independent ‘t’ test. Though there were difference in ISVS in BW, BW+I conditions between controls and the individuals with stuttering , only BW +II condition reached statistical significance(Table 2).

Table 2: Comparison of the two groups on t test

Parameters	‘t’ value	Significance (p)
BW	-1.107	.788
BW+I	-.856	.639
BW+II	-.806	.033

Discussion

Vowel shortening is phenomenon exhibited due to the co-articulatory effect in a speaker, to maintain the accuracy in the articulation. ISVS is a measure which reflects on the intrinsic timing of speech motor control. Being a measure which is sensitive in reflecting the intrinsic temporal dimension of speech, the current results show that, individuals with stuttering exhibit a difficulty in the intricate timing control mechanism of the central process of the speech. In the present study, though both groups exhibit the co-articulatory effect, individuals with stuttering tend to have temporal difficulties in their speech for multisyllabic words (BW+stimuli II). When the word length increases, the complexity of the word thus increases and the subtle timing difficulties seen in individuals with stuttering become evident.

Results of the current study are in line with the findings of an earlier study which has also reported of brief, subtle differences in the temporal characteristics in stutters’ fluent speech, and not marked differences from normal adults [15].

Fluent speech requires rapid and sequential motor control, produced in milliseconds, requiring a high temporal resolution. Individuals with Stuttering show difficulties in sequencing the articulator due to the impairment in the temporal parameter. Thus, this study concludes that individuals with stuttering exhibit subtle temporal difficulties in speech that affects their speech motor control. This may have significance in the treatment program of the stutterers to achieve a fluent speech. Results also reveal that ISVS in Relational Speech Timing is a sensitive measure of the timing control for speech among individuals with stuttering. Future research can focus on the ISVS measure on a larger group of individuals with stuttering and also in children.

Conclusion

In conclusion, the initial syllable vowel shortening effect is evident in relational speech timing tasks in individuals with stuttering and they tend to have longer vowel duration for multisyllabic words. ISVS is a sensitive component to examine the temporal parameter of speech among individuals with stuttering.

References

1. Bloodstein O., "A handbook on stuttering", 1987, Chicago: The National Easter Seal Society.
2. Guitar., "Stuttering an Integrated Approach to its Nature and Treatment", 2006, Lippincott William and Wilkins.
3. Zimmerman G, Stuttering: A disorder of movement, *Journal of Speech and Hearing Research*, 1980, 23, 122-136.
4. Caruso A.J., Conture E.G., Colton R.H., "Selected temporal parameters of coordination associated with stuttering in children", *Journal of Fluency Disorders*, 1988, 13, 57-82.
5. Van Riper C., "The Nature of Stuttering", 1982, Englewood Cliffs, New Jersey: Prentice-Hall Inc.
6. Bakker K., Brutten G.J., Speech-related reaction times of stutterers and nonstutterers: Diagnostic implications, *Journal of Speech and Hearing Disorders*, 1990, 55, 295-299.
7. Hillman R. E., Gilbert H. R., "Voice onset time for voiceless stop consonants in the fluent reading of stutterers and nonstutterers", *The Journal of the Acoustical Society of America*, 1977, 61, 610-611.
8. Adams MR, Voice onsets and segment durations of normal speakers and beginning stutterers, *Journal of Fluency Disorders*, 1987, 12, 133-139.
9. Sim H., Zebrowski P., "Acoustical analysis of children's fluent speech: Pre- and Post therapy", Preliminary observations. NCVS Status and Progress Report, 1994, 6, 81-88.
10. Caruso A. J., Chodzko-Zajko W. J., Bidinger D. A., Sommers, R. K., "Adults who stutter: Responses to cognitive stress", *Journal of Speech and Hearing Research*, 1994, 37, 746-754.
11. Lehiste I., "The timing of utterances and linguistic boundaries", *The Journal of the Acoustical Society of America*, 1972, 51, 2018-2024.
12. Collins M., Rosenbek J., Wertz J., "Spectrographic analysis of vowel and word duration in apraxia of speech", *Journal of Speech and Hearing Research*, 1983, 26, 224-230.
13. Edythe A. Strand., Malcolm R. McNeil., "Effects of length and Linguistic complexity on temporal acoustic measures in apraxia of speech", *Journal of Speech and Hearing Research*, 1996, 39, 1018-1033.
14. Davis B., Jacks A., Marquardt T., "Vowel patterns in developmental apraxia of speech: Three longitudinal case studies", *Clinical Linguistics & Phonetics*, 2005, 19, 249-274.

15. Conture E. G., Colton R. H., Gleason J. R., “Selected temporal aspects of coordination during fluent speech of young stutterers”, *Journal of Speech and Hearing Research*, 1988, 31, 640-653.

Acknowledgement

We would like to extend our thanks to all the participants in the study.