Phonatory Vocal Tract Stability in Stuttering Children before and after Fluency – Enhancing Therapy

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ABSTRACT

Background
Stuttering is a complex disorder. Essentially, it is a neuromuscular disorder whose core consists of tiny lags and disruptions in the timing of the complicated movements required for speech.

Objective
The purpose of the current study was to collect and compare jitters and shimmer values in children who stutter before and after fluency – enhancing therapy.

Methods
Subjects consisted of 15 Iranian preschool girls with stuttering, and 15 Iranian preschool girls without afflictions, matched according to age. Vocal jittering and shimmer measurements of the phonation of the children were compared before and after therapy. Each subject phonated vowels nine times in a random order. Each phonation was sustained for at least five seconds and was recorded. The middle three-second portion of each recorded vowel phonation was subjected to jitter and shimmer analysis.

Results
On shimmer measures between pre-treatment and post treatment, significant differences were found in all sustained vowels of persons who stutter group and means of shimmer in post therapy were significantly lower than pre-treatment. Differences in jitter measurements were not significant between pre-treatment and post-treatment statuses and this parameter did not change after therapy.

Conclusion
The findings showed that therapy resulted in decreased irregularity in the amplitude of vibrations (shimmer). In other words, the therapy increases the steady-state of the laryngeal system. Moreover, this parameter may be used as an index for the effectiveness of therapy.

Key Words
children, jitter, phonation, shimmer, stuttering, voice
INTRODUCTION

Stuttering is a complex disorder and essentially it is a neuromuscular disorder whose core consists of tiny lags and disruptions in the timing of the complicated movements required for speech. Obvious disturbances in the speech production system of stuttering individuals might be related to generalized temporal incoordination between respiration, phonation, and articulation. Alarge body of literature has accumulated in support of this view that individuals who stutter differ from individuals who do not stutter in at least some of the neuromuscular processes involved in speech production. Several authors have proposed incoordination of these actions as a specific version of the “general hypothesis that stuttering is a disorder of timing.”

One of the most important factors that predict high precision temporal coordination is phonatory vocal tract stability. Vocal perturbation measures are short-term indices of the stability of the phonatory system and both may be associated with poor laryngeal control.

Irregularity of the fundamental frequency of the period of subsequent glottal cycles is called jittering. Shimmer is the relative overlapping of the fundamental frequency of the voice with noise, which leads to amplitude irregularities. Several studies that examined speech acoustics of persons who stutter (PWS) and persons who do not stutter (PWDS) have found that PWS, as a group, show longer voice onset times (VOTs), vowel durations, stop gap durations, and consonant-vowel transition durations. Baer (1979) considered that stuttering children have weaker laryngeal neuromuscular control and greater disturbances in integrating respiratory and laryngeal control which justifies measurements of voice disturbances.

On the other hand, few studies have examined the differences in vocal tract stability during speech production between (WS) and (PDS). Klich and May (1982) suggested that the stutterers were producing vowels using a neutral vocal tract posture as a means of controlling speech fluency. Most researchers have examined the differences in oral-laryngeal coordination between stuttering and non-stuttering individuals. Pesák and Urbánek (1993) studied incoordination of the phonation start in individuals with stuttering and found that in the group of children and adolescents with stuttering only less than 4% of the cases showed undisturbed regular phonation, whereas in the control group it was almost as much as 90 percent. Falck, Lawler, and Yonovitz (1985) found that adults who stutter exhibited measurable cycle-to-cycle temporal changes in proportion of the same speaker. Newman, Harris, and Hilton (1989) found that PWS as a group showed higher amplitude irregularities during sustained vowel productions and their findings showed differences between stutterers and non-stutterers in the laryngeal behavior (i.e., F0 perturbation). This finding was interpreted as maintaining a fixed laryngeal posture during vowel steady-state production. Bamberg, Hanley, and Hillenbrand (1990) also reported significantly higher vocal shimmer values in the fluent speech of PWS than their fluent peers. Hall and Yairi (1992) examined acoustic correlates of phonatory control in the speech of 10 preschool-aged boys who were stutterers and in the speech of 10 boys who were non-stutterers. Significant differences were found between the two groups for shimmer measures. Robb, Blomgren, and Chen (1998) found that PWS enrolled in fluency-shaping therapy displayed the least formant frequency fluctuation (FFF) (most vocal tract stability) and the untreated PWS displayed the most FFF (least stability). Salihovic et al. (2009) compared the speech of 67 children who stutter with the speech of 46 fluent speakers and concluded that there were significant differences between the two groups for jitter and shimmer measures.

Unfortunately, research addressing laryngeal functioning in people who stutter has been primarily focused on adults. When children mature, they exhibit greater control over laryngeal adjustments that is reflected in the increasing stability of vocal fold vibration. Similarly, data has shown that vocal jitter and shimmer decreases as age increases, as it is interpreted to having greater control. A lower index of magnitude on either jitter or shimmer indicate less vocal perturbation and greater stability in the motor control of phonate behavior. If there is no support that the magnitude of jitter or shimmer indicates less vocal perturbation and greater stability in the motor control of phonatory behavior, we should consider this as a significant greater than of PWNS, this it would provide additional support to the hypothesis that PWS may demonstrate less competence in neurophysiological regulation. Moreover, research has not documented the acoustic measures of jitter or shimmer in the fluent phonatory behaviors of PWS (either jitter or shimmer) was shown to be significantly greater than of PWNS. In this study, we provide an additional support to the hypothesis that PWS may demonstrate less competence in neurophysiological regulation. Moreover, the current study was designed to provide a better understanding about the phonatory motor function. The results of this study can be used as an index of the progression of therapy.
METHODS

Subjects: Subjects of fifteen 15ss and fifteen 15 non-stutterers matched according to age and sex. The age range of the stutterers was from 67 to 79 months of the non-stutterers was ranged from 66 to 79 months with a mean age of 72.6 for both groups. All subjects were female.

The study design was a quasi-experimental that was done conducted at the rehabilitation clinic of Zahedan University of Medical Sciences, study was carried out over eight months.

Several criteria were employed for subject classification to be regarded were observed by both parents and two speech therapists as exhibiting a stuttering problem and had to demonstrate at least six stuttering-like behaviors (SLDs) per 100 words during a 300-word sample of conversation with their mothers, and, or (if people in their environments had expressed concern regarding their speech fluency).

The presence and magnitude of stuttering at the time of testing was verified using the Stuttering Severity Instrument. All were moderate level in SSI-3 Scale. All subjects were perceptually assessed for normality of their voices with the GRBAS scale. By means of sound reproduction of each vocal sample, the following items were graded: conjunctly by two professionals experienced in vocal pathology; from 0 to 3 using the GRBAS method: (0 = normal, 1 = slight, 2 = moderate, 3 = severe); (G) Grade, the global grade of vocal afflication; (R) Roughness, the quality of the voice related to the impression of irregular glottic pulses from a noise component of low frequency, of roughness or vocal fry; (B) Breathiness, the voice-related tohoienoisethat originiates with the turbulence created by an incompetent glottis; (A) Asthenia, the auditory impression of weaknessness in spontaneous phonation; (H) Hypo kineticor hypofunctional voice; (S) Strain, vocal tension, the auditory impression of excessive effort and tension associated with spontaneous phonation.

 Those with ratings higher than 0, even if it was on one measure, were excluded. The rating was performed on a voice sample of one minute of spontaneous speech. Subjects were also screened for former problems with breathing, their voice, neurological diseases, and structural abnormalities in the larynx, mouth, or throat with a questionnaire. The second author checked their vocal folds with a flexible laryngoscopy to confirm that no neohad organiclesions of the vocal folds.

The acoustic examination was performed in a soundproof room with the subjects in a sitting position. Subjects attended fluency reinforcement plus corrective feedback. The criterion of treatment success was less than 2% stuttering rate in all stages.

The number of sessions of therapy depended on the individual child and varied from 26-90 hours. Data collection was performed before starting treatment protocols, using the Dr. Speech 4.0 software (subprogramme: vocal assessment version 4.0 from Tiger Electronics, USA) at the speech therapy clinic. The microphone (type: ECM-717 condenser microphone, Sony Corporation) was placed at a standard position that was 1 distance from the front of the mouth. The same samples were recorded after termination of therapy. Voices were taken in a comfortable and habitual way, and each subject phonated vowel samples in the randomized order. Each phonation was sustained for at least five seconds and was recorded. The mid-3-second portion of each recorded vowel phonation was subjected to jitter and shimmer analyzes.

Statistics data were analyzed with the statistic software SPSS 18.0. Data and measures were subjected to a two-way analysis of variance (ANOVA) with repeated measures.

RESULTS

Means and standard deviations of jitter of PWS and normal peers showed in the Table 1 and 2 for pre-treatment and post-treatment statuses. On the jitter measures in pre-treatment and post-treatment conditions of both groups, there were not significant differences. Means and standard deviations of shimmer of PWS and normal peers were presented in Table 4, respectively. On shimmer measures between pre- and post-treatment, significant differences were found in all sustained vowels of PWS group and means of shimmer in post-therapy were significantly lower than pre-treatment (p < 0.05). As noted in Table 4, shimmer was not significantly different from shimmer measures in the control group.

DISCUSSION

A significant difference was found between pre-treatment and post-treatment statuses on measures of shimmer. However, the differences of jitter between the two statuses were not statistically significant. The means of shimmer into falloff of the vowels in the pre-treatment statuses were larger than the shimmer measures in post-treatment status, indicating that shimmer increased from pre-treatment to post-treatment status and the changes were significant. On the other hand, for shimmer measures, there was no significant difference in the control group that we can conclude that the changes in shimmer measures in the post-treatment status results from therapy and it is not dependent on growing. Although the specific neuromuscular components of vocal jitter and shimmer have not been...
identified, it is possible that shimmer is the greater faculty of with integrating respiratory, laryngeal, and cortical control than jitter. Although, it is difficult to compare our acoustic data with the findings of other studies because past various research has used the variety of methodologies that it limits comparisons across studies. However, it is interesting to note similarities between the present results and acoustic data from literature for children and adults who stutter. The direction of our finding differences were obtained, suggest that stutterers have less stable neuromuscular control over the events regulating the aerodynamics of the laryngeal and respiratory system during sustained fluent vowel articulations and fluency therapy increase steady-state in laryngeal and respiratory system and led to decrease irregularity in the amplitude of vibration (i.e., shimmer). The steady state, sustained phonation involves even maintenance of such forces as vocal fold tension, mass, length, and subglottic pressures, while it also maintains the supralaryngeal articulatory adjustments required for production of the vowel. On the other hand, it was determined that stuttering individuals have variable, sometimes even chaotic subglottal pressure. It is thought that this is caused by musculotension coordination of the tract. However, differences have been observed, however, between the two statuses which suggest that children are better able to control these forces after the termination of therapy. Therefore on the basis of the current study findings, measurement of amplitude perturbation of voice such as formant frequency fluctuation measures can be used as an index of vocal tract stability, as it has also been used in research. Also, the study will also allow clinicians to stop the process of therapy and can then be used as an index of effec. It must be acknowledged that the study is presented with certain limitations, such as the number of participants which were used, and the narrow age group, thus, it is recommended that this study be replicated in older or wide age range samples of stuttering speakers. stuttering adults.

CONCLUSION

The findings from the present study showed that there aren’t significant differences on the jitter measures between pre-reament and post-treatment conditions but on the other hand, there is significant differences on shimmer measures between pre-reament and post-treatment conditions. So, the latter parameter or shimmer has an important role in the therapeutic process and can be used as an index of progression of therapy.

REFERENCES


