MODIFICATIONS TO STUTTERERS' RESPIRATORY, LARYNGEAL, AND SUPRALARYNGEAL KINEMATICS FOLLOWING SUCCESSFUL FLUENCY THERAPY

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ABSTRACT

Within-subject comparisons of respiratory, laryngeal, and supralaryngeal kinematics of severe stutterers immediately before and after successful completion of intensive fluency therapy reveal that an increase in post-therapy fluency co-occurs with a number of spatial and temporal modifications within and among each of the three monitored speech systems. Some of the post-therapy modifications can be distinguished from therapy-directed clinical targets and are presumed to be natural requisites to perceptually fluent speech.

1. INTRODUCTION

It is well known that stutterers' respiratory, laryngeal, and supralaryngeal movements during moments of disfluency are radically different from those observed in normally fluent speakers. However, it is not clear whether stutterers' control of the speech mechanism is aberrant and abnormal, or whether it is abnormal only during production of speech that is perceived as fluent. Clarification of this issue would have important clinical ramifications. Thus, we have undertaken a research program that seeks to address the following three questions: 1) Are certain kinematic modifications that are observed post-therapy reflective of clinical instruction but rather are reflective of variability in speech motor control strategies that are observed in normally fluent subjects?

2. PROCEDURES

Within-subject pre- and post-therapy kinematic comparisons of the respiratory system (using Respirate inducive plethysmography), laryngeal system (using photoglottography), and supralaryngeal system (using electromyographic recording to monitor the movements of the lips and jaw) were made from eight stutterers immediately before and after completion of either one of two intensive fluency programs, Program 1, the Summer Regional Stuttering Clinic of Geneseo, New York, represents a Van Rijsbergen type of program that primarily emphasizes speech rate control, and Program 2, the Communication Reconstruction Center's (CRC) of New York City version of the Precision Shaping Fluency Program (PFSP), represents a highly structured physiologically oriented program. Kinematic measurements included traditional motor control indices, e.g. sequential order of articulator movements, and those that more directly address the achievement of the various clinical targets. Two paradigms were used: a variable-fourth period simple reaction-time (RT) task and a paradigm that assesses relatively natural speech, the production of the phrase "be see CVC again" where "C" represents various stops and fricatives and "V" represents /i,e/. Only fluent utterances, defined perceptually and physiologically, are discussed here.

3. RESULTS

1. Respiratory-Laryngeal Kinematics in Reaction-Time Tasks

In a related reaction-time study, we showed that quantitatively different respiratory and laryngeal behaviors underlie stutterers' fluency during both spontaneous and variable foreperiods. On the other hand, Figure 2 shows that a different Program 1 stutterer reduces post-therapy phonation response latency primarily by reducing the time, relative to pre-therapy performance, required to complete respiratory and laryngeal pre-phonatory maneuvers, e.g. appropriate levels of respiratory inflation and preparatory vocal fold adduction and variable phonation.

4. CONCLUSION

In summary, we have presented evidence that stutterers' post-therapy respiratory-laryngeal kinematic improvements are not entirely related to clinical target behaviors. For example, the RT data shown in Figure 1 demonstrate that this Program 1 stutterer reduces post-therapy phonation response latency primarily by reducing the time, relative to pre-therapy performance, required to complete respiratory and laryngeal pre-phonatory maneuvers, e.g. appropriate levels of respiratory inflation and preparatory vocal fold adduction and variable phonation. On the other hand, Figure 2 shows that a different Program 1 stutterer reduces post-therapy phonation latency primarily by improvement in respiratory-laryngeal temporal coordination, e.g. the moment of respiratory adduction relative to laryngeal addition to phonation. Taken together, the results indicate that post-therapy improvement in respiratory-laryngeal coordination may allow for a more efficient respiratory-laryngeal coordination relative to laryngeal adduction to phonation. Furthermore, the findings of this study provide a physiological basis for the coordination between respiratory-laryngeal improvement and perceptual fluency improvement.
laryngeal temporal coordination may make a greater contribution to improved acoustic RT than either respiratory RT or laryngeal RT in those stutterers who demonstrate either 1) relatively short pre-therapy response latencies, and/or 2) appropriate levels of lung volume inflation for speech, and/or 3) appropriate laryngeal abductory/adductive gestures for normal phonation.

The data for two stutterers, shown on the left, represent two different sessions about six weeks apart and are consistant with the results obtained from a larger group of control subjects [3], with respect to both inter-articulator relative-timing and sequence patterns. The stutterers' data, shown on the right, are quite different. Recall that these stutterers were classified as severe pre-therapy and mild post-therapy. Considering inter-articulator latencies first, note that pre-therapy latencies for stutterer AB (specifically lower lip lag of the upper lip) and for stutterer PC (specifically jaw and upper lip lag of lower lip) are much greater than the corresponding control subject latencies. For both of these subjects, post-therapy latencies are significantly reduced relative to their pre-therapy latencies, even though their post-therapy speech rate was significantly reduced compared to their pre-therapy rate. Turning next to sequential order, note that two of the stutterers, KH and PC, do not show the expected upper lip, lower lip, and jaw sequence in either the pre- or post-treatment condition. Also note that for stutterer KH, the pre- and post-treatment comparison shows a complete sequence reversal. Similar results were obtained for pet, fit, and fe/ and, less frequently, by alteration of the sequence patterns, although the reversed sequence may not be like that of the controls. The lip and jaw sequence patterns observed in normally fluent speakers most likely is related to neural and biomechanical interactions [2] and thus reflects differences in both neural control and biomechanical processes between stutterers and controls.

4. DISCUSSION
In conclusion, the results we have obtained thus far suggest that post-therapy increase in fluency co-occurs with spatial and temporal adjustments of the respiratory, laryngeal, and supralaryngeal systems. For example, we have observed 1) an increase in inspiratory and expiratory lung volume exchange, duration, and flow, all of which approach values exhibited by normally fluent subjects during phrase length utterances, 2) an increase in the duration of laryngeal abduction and adduction gestures although speech rate decreases post-therapy, 3) a reduction in the frequency of inaudible and phase-locked respiratory-laryngeal kinetic abnormalities, and 4) a reduction in the displacement, peak velocity, and duration of lip and jaw movements in target ob-struent-vowel sequences. In addition, certain intra- and inter-system spatial and temporal coordinative adjustments co-occur with post-therapy increase in fluency. Some of the kinematic modifications we observe appear related to the clinical strategies associated with specific therapy programs while others do not. The latter modifications may be manifestations of post-therapy adoptions of certain normal motor control strategies that are requisite to fluent speech production. Our plan is to compare the kinematic modifications of stutterers who successfully complete a variety of different therapy programs, the notion being that the most important modifications leading to fluency will be shared by all successful stutterers even though the clinical instructions to the different groups can differ. In this way, we hope to identify those kinematic strategies that are requisite to the production of perceptually fluent speech.

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6. REFERENCES