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The Effects of Pantomime Speech & Silent Reading in Varied Syllable Positions Throughout a Phrase on Stuttering Frequency

by

Christian M. Keil

A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in the Department of Speech and Language Pathology

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Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Christian Keil find it satisfactory and recommend that it be accepted.

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March 18, 2014

Daniel Hudock, PhD
MS 8116
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RE: Your application dated 3/18/2014 regarding study number 3820M2: Inhibition of stuttering via pantomime speech

Dear Dr. Hudock:

I have reviewed your request to reopen the study listed above by expedited review. This type of study qualifies for expedited review under FDA and DHHS (OHRP) regulations.

The request to reopen the study included This is to confirm that I have approved your request to reopen the study. The protocol is now approved through 3/18/2015.

The study is subject to continuing review on or before 9/18/2014, unless closed before that date.

As with the initial approval, changes to the study must be promptly reported and approved. Contact Thomas Bailey (208-282-2179; fax 208-282-4723; email: humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

Phone: (208) 282-3592 • Fax: (208) 282-4723 • www.isu.edu/research

Acknowledgements

I would like to thank my thesis advisor Dr. Daniel Hudock for his continual patience and support in completing this thesis. I would also like to thank my parents for their love and encouragement that they have provided me in every aspect of my life. Finally I wish to acknowledge my soon to be wife, Ana for more love, support, respect and reassurance then I could ever ask for.

Table of Contents

List of Abbreviations

PWS: People who stutter

P: Pantomime

SR: Silent Reading

SRI: Silent Reading Initial

SRM: Silent Reading Medial

SRF: Silent Reading Final

PI: Pantomime Initial

PM: Pantomime Medial

PF: Pantomime Final

The Effects of Pantomime Speech & Silent Reading in Varied Syllable Positions Throughout a Phrase on Stuttering Frequency

Thesis Abstract-Idaho State University-2014

The current study sought to explore the relationship between speech initiations using altered forms of fluency enhancement and stuttering frequency. Nine participants who stutter read seven, 300 syllable length passages, under seven conditions: Baseline, pantomime initial, pantomime medial, pantomime final, silent reading initial, silent reading medial, and silent reading final. It was hypothesized that stuttering frequency would decrease during imagined and pantomimed speech initiation conditions thus leading to need for people who stutter (PWS) to use feed-forward processing to a greater extent as explained by Guenther (1994).

Chapter 1: Introduction

Stuttering is defined as part-word repetitions, part-word prolongations, and inaudible postural fixations (i.e., "silent blocks"; Armson & Stuart, 1998). Stuttering can occur at any time during a person's utterance, but typically the greatest frequency of stuttering occurs during phrase initiations (Taylor, 1966). Most stuttering therapies targeted at reducing overt stuttering teach altered forms of speech production. Some of these speech alterations include pausing between words and syllabic repetitions, each of which is successful at reducing stuttering by up to 73% (Reitzes, 2006; Saltuklaroglu & Kalinowski, 2011). Other stuttering reduction strategies such as prolongations (temporally expanding speech) and easy onsets of syllable initiations, share a paradoxical relationship with stuttering. That is, when people who stutter (PWS) stutter on a voluntary basis, their stuttering is substantially reduced (Curlee & Perkins, 1969; Perkins, Rudas, Johnson & Bell, 1976).

Additionally, stuttering has been found to have a marked reduction during whispered speech and a complete elimination during pantomime speech (Perkins et al., 1976). Pantomime speech, also known as silent articulation, occurs when a speaker mouths (i.e., no auditory output) a portion of their utterance instead of verbally producing the chosen section. Van Riper (1971) hypothesized that a reduction in stuttering during whispered and pantomime speech was in part due to PWS focusing on the articulation of specific speech sounds at a slower speech rate. This allows for synchronization to occur between the varying motor sequences. It has been shown that slower speech is sufficient for the reduction of stuttering (Andrews, Howie, Dozsa & Guitar, 1982) via experimentation on forms of altered auditory feedback that have demonstrated equivalent

reductions at fast and normal speech rates (Hargrave, Kalinowski, Stuart, Armson & Jones, 1994; Hudock et al., 2010; Kalinowski, Armson, Stuart, Roland-Mieszkowski & Gracco, 1993; Macleaod, Kalinowski, Stuart & Armson, 1995).

Van Riper (1971) studied the effects of pantomime speech on stuttering and reported complete fluency amelioration while pantomime speech was being used. Additionally, Perkins et al. (1976) found that when pantomime speech was used throughout an entire utterance, it was able to reduce stuttering at a rate greater than any of the other tested reduction techniques; voiced and whispered. In Perkin's study, 30 PWS were tested under the following conditions: pantomime, whispered and voiced, each used through an entire utterance. Interestingly, 27 of the participants experiencing a reduction in stuttering from voiced to whispered and all 30 participants seeing a reduction from whispered to silent articulation, with stuttering episodes only occurring in 1-.05% of participants. Although these speech alteration strategies were used throughout an utterance it likely required some degree of preparatory anticipation with conscious control over production mechanisms.

As PWS can anticipate stuttered events, many fluency-enhancing strategies use this anticipation to their advantage by having PWS primarily use techniques prior to anticipated stuttering. For example, if a prolongation is used in the initial position of an utterance, the speaker would have a heighten level of awareness to produce the prolongation as it is contrary to how they would normally speak. This expectancy of a change in production was examined by Brutten and Janssen (1979) who conducted a study where PWS were given a list of words and asked to underline which words they expected would be the most difficult to produce. The designated words were inserted into

passages and participants read the assigned readings silently. Frame by frame eye-gaze analysis revealed that PWS look ahead searching for words on which stuttering may occur, and displaying greater fixations on words in which fluency failure had been anticipated (Brutten & Janssen, 1979). The data suggest that PWS search 3-4 words ahead of where they are reading and sort out those words on which stuttering is anticipated (Bakker, Brutten, Janssen & Van Der Meulen, 1984; Brutten & Janssen, 1979). The expectancy of stuttering experienced by the participants altered how they normally perceived and produced speech, and in doing so, altered their motor execution. The shift in eye-gaze that occurred is an effect of the anticipation of stuttering, with the expectancy of stuttering altering the PWS behavioral execution. Interestingly, Roland (1972) theorized there would be a significant difference in the number of fixations and retraces of the eyes for PWS compared to fluent speakers while silently reading, reading out loud, and using choral speech (*choral speech* occurs when two or more speakers recite the same passage in approximate simultaneity). He found that PWS have more retraces and fixations than non-stutters during the mentioned conditions. However, despite the fact that choral speech increased fluency almost to the point of making stuttering nonexistent; PWS actually exhibited an increased number of retraces when using choral speech then when reading independently (Roland, 1972).

Some commonality shared between choral speech, pantomime speech and silent reading is activation of the same areas of the brain including the premotor, speech motor, and cortical sensorimotor areas (Callan, Callan, Gamez, Sato & Kawato, 2010; Decety et al., 1997; Ingham, Fox, Ingham & Zamarripa, 2000). However, unlike silent reading and pantomime speech, the choral speech process is reliant on the PWS hearing an outside

speech signal as they are producing their own utterance. Choral speech used in isolation has been found to reduce stuttering by nearly 100% (Saltuklaroglu, Kalinowski, Robbins, Crawcour & Bowers 2009). The ability of choral speech to almost entirely eliminate stuttering lends evidence to a distinct relationship between speech perception and speech production. Saltuklaroglu and colleagues presented a study where stuttering was decreased by 40% prior to speaking by having PWS watch and listen to another person produce easy syllabic repetitions (Saltuklaroglu, Kalinowski, Dayalu, Stuart & Rastatter 2004). The findings in this study, as well as in more recent studies, support the existence of a centralized inhibitory mechanism responsible for the associated speech perception and production system (Saltuklaroglu & Kalinowski, 2011).

Feed-forward and Feedback Models

Guenther (1994) described an integrative internal mechanism of speech production and perception for stuttering that utilizes two processes: feed-forward and feedback systems. The feed-forward system uses motor commands that are prepared in the premotor and speech motor areas before the initiation of movements (Max et al., 2004; Ingham et al., 2000). The feedback system utilizes no preparation prior to the action; rather motor commands are generated at the same time as the execution of an action with adjustments occurring in real time. Additionally, as different afferent and efferent signals are received, the brain makes adjustments and modifies the internal model of speech (Max et al., 2004).

Max's model of the perception and production of speech integrates both the feedforward and feedback systems, stating that the actual internal model of speech (how speech is processed and produced) is composed of motor commands that are prepared

beforehand, with real-time adjustments occurring as needed (Max et al., 2004). Specific to stuttering, Max and colleagues suggest an over-reliance on the feedback system as a possible cause of stuttered events. If stuttering reduction strategies such as pantomime speech or silent reading are employed, it may lead to an increased activation of pre-planning (i.e., the feed-forward system) which may change the persons internal model of speech and lead to enhanced fluency.

A possible representation of the internal model of speech is the mirror system hypothesis (Callan et al., 2010). This theory provides an explanation of the speech production and speech perception relationship mentioned previously. Mirror systems are circuits of sensorimotor neurons activated when an action is executed, observed, or even imagined (Roglasky, Love, Driscoll, Anderson & Hickok, 2011). Therefore, as speech is perceived, so too are the mirror neuron circuits as if speech was produced. One study presented this distinct relationship by using fMRI and MEG imaging to display that when speech is produced the same areas of the brain are activated as when speech is perceived (Callan et al., 2010). The mirror system serves as a catalyst for the production and perception mechanisms, assisting in speech production and speech perception.

Justification for this study was that as speech alteration strategies are designed to increase fluency, such as pantomime speech and silent reading, portions of an utterance have previously been tested; however varied syllable use had yet to be studied. If one applies Max's model, stuttering results from an over-reliance on sensory feedback. As supported from the use of fluency enhancing techniques that can be used intermittently in anticipation of stuttered events, PWS are able to reduce their overt stuttering behavior by altering their pre-programming for speech motor execution. In other words, previous

research has shown that using fluency enhancing strategies when one anticipates stuttering will increase fluency, but may not directly act on the feedback mechanisms. Applying speech alterations to various syllable positions throughout an utterance requires one to alter their pre-programming of speech which may result in increased fluency. This study's aims were to determine the effects of pantomime speech and silent reading in various syllable positions throughout an utterance.

Chapter 2: Methods

Participants

Nine adolescent and adults who stutter with no self-reported history of concomitant speech, language, cognitive, visual reading or hearing deficits participated in the study. All participants signed informed consent documents (approved by Idaho State University's Human Subject Committee) prior to experimental conditions.

Instrumentation

A 13-inch widescreen Macbook pro or 13-inch hp pavilion laptop was positioned 24 inches directly in front of participants who read predetermined utterances via PowerPoint 2011. An Aiptek AHD H23 video recorder was positioned 27 inches directly in front of participants at eye level with an orientation of 0 azimuth.

Stimuli

Participants were presented utterances of 8-12 syllable length, retrieved from Biographies Skill-Based Story Cards, reading level 3-4 (Remedia Publications, 2006). The 8-12 syllable length passages were written in black font with a white background at 28-point Calibri font. Each participant was tested under seven speech conditions: 1) Baseline, their normal speech with no strategies; 2) Silent reading (SR) in initial phrase position (SRI); 3) SR in medial phrase position (SRM); 4) SR in the final phrase position (SRF); 5) Pantomime (P) in initial phrase position (PI); 6) P in medial phrase position (PM) and 7) P in final phrase position (PF). In order to notify the participants of what syllables should be silently read, the designated syllable was grey colored and underlined and for pantomime speech, the appointed syllable was grey colored only (Hudock, unpublished work). Passages and condition sequences were randomly assigned to

participants using numeric sequences on www.randomize.com. Participants completed a total condition prior to beginning the next condition.

Procedure

Researchers verbally briefed participants about procedures prior to experimental conditions. After verbal briefing, participants were asked to read and then sign informed consent documents prior to participating in the experiment. The researcher demonstrated the procedures of verbally reciting the utterance under the specific conditions, which was then repeated by the participants. Trial phases lasted until participants were comfortable with experimental procedures, typically 4-6 sentences per condition. Each phrase was read only once per participant. Participants verbally read each utterance from the computer screen using the experimental procedures.

Chapter 3: Results

Stuttering was defined as syllable repetitions, phoneme prolongations, and postural fixations (i.e., "silent blocks"; Armson & Stuart, 1998). After an initial analysis, we/I performed an intra-rater reliability test on a randomized 10% of the data. A student researcher trained on identifying instances of stuttering also performed reliability testing on a randomized 10% of the data. Cohen's Kappa (SPSS 21.0 for Mac) syllable-by-syllable agreement (Cohen & Cohen, 1983) revealed a Kappa value of 0.860 for the intra-rater and 0.691 for the inter-rater testing. Values above 0.41 represented moderate agreement and values greater than 0.75 represented excellent agreement (Viera & Garrett, 2005). We then calculated proportional values by dividing the number of stuttered syllables by the amount of total syllables (i.e., syllable length per passage). Stuttering episodes were then transformed into arcsine units to reduce end point weighting of proportion values during inferential statistical analysis (Viera & Garrett, 2005).

A one-factor repeated measures analysis of variance was conducted to examine the effect of each condition on stuttering frequency. A significant main effect for the conditions was revealed [$F(3.237, 26.188) = 3.475$, *Greenhouse-Geisser* $p = 0.027$) η_{p2},.303]. Post-hoc comparisons with Bonferroni adjustments revealed a difference between baseline and initial pantomime conditions ($p = 0.005$), but no other significant differences between conditions were revealed. Researchers then used contrast comparisons, which revealed differences between P to Baseline ($p = .008$), SR to Baseline ($p = .017$), initial position to Baseline ($p = .004$), and final position to Baseline ($p = .010$). No significant differences were revealed between medial position to Baseline ($p = .10$), or P to SR ($p = .746$). Interestingly, contrast comparisons also resulted in

nonsignificant differences between any syllable positions ($p = 0.111$) initial to medial position; ($p = 0.319$) medial to final position; and ($p = 0.56$) initial to final position.

Stuttering was significantly reduced during both P and SR conditions as compared to baseline values and was reduced to the greatest extent during the initial pantomime condition. Additionally, when P and SR strategies were used during initial and final syllable productions a significant reduction in stuttering frequency was revealed. When comparing experimental conditions to the Baseline, participants exhibited the following percent reductions in stuttering: 8% P, 8% SR, 7% initial syllable position, 8% medial syllable position and 7% final syllable position. See *Table 1* for mean proportions of stuttered syllables and standard errors by condition. As indicated by the percent stuttered syllables in *table 1*, participants in the current study exhibited mild overt disfluencies leading to smaller than expected effect sizes and potentially less reduction in stuttering. Hudock et al. (unpublished work) reported approximately 60% reductions in stuttering frequency during pantomime speech and 40% reductions from silent reading in the initial positions. Similarly, Sun et al. (unpublished work) also reported approximately 50% reductions in stuttering frequency during pantomime and silent reading in the initial phrase position.

Finally, both P and SR strategies revealed equivocal reductions in stuttering frequency when compared to Baseline. Although less reduction in stuttering frequency was noted during the current study, findings support previous research that P and SR produced on the first syllable of a phrase significantly reduce stuttering frequency throughout the phrase (Hudock, et al., unpublished work; Sun et al., unpublished work). Similarly, although nonsignificant differences, a slight increase in percent reduction, with

a larger effect size and less variability was revealed from P to SR in the initial position. This finding, although to a lesser degree, is consistent with previous work (Hudock, et al., unpublished work; Sun et al., unpublished work). In the current study, P in the initial position was the only condition that revealed a significant difference during post-hoc comparisons with Bonferoni adjustments. As this is the first study to examine the use of P and SR in varied syllable positions throughout an utterance, there are not such comparisons for a lack of findings in the medial position, or significant contrast findings in the final position when compared to Baseline.

Chapter 4: Discussion

Studies by Van Riper (1971) and Perkins et al. (1976) reported decreases in stuttered frequency when participants used pantomime speech and whispering throughout an entire utterance; with Perkins reporting a 100% reduction in stuttering frequency. Perkins et al. (1976) and Van Riper (1971) proposed that if stuttering was affected by alterations in phonation and respiration, stuttering was then a result of tension and fragmentation in PWS ability to accurately execute a motor plan for some element of speech (Perkins et al., 1976). While these studies demonstrated that pantomime speech reduced stuttering frequency when used for the duration of an utterance, the current study and a similar study by other researchers (Hudock et al., unpublished work; Sun et al., unpublished work), examined P speech and SR effectiveness at reducing stuttering when used only on a single syllable of a selected phrase.

As the majority of stuttering occurs at the onset of speech (Yairi & Seery, 2011), implementing a reduction strategy such as P speech or SR during the phrase onset may decrease stuttering during the position when it occurs most often. Once fluent speech is produced during phrase initiation it is likely that more fluent speech will follow. Most fluency enhancing strategies are used during phrase onsets, however, until this study alteration strategies in varied syllable positions had not been tested. Interestingly, the amelioration of fluency with P and SR was also revealed in the final syllable position. Finding a reduction during the final syllable position condition was unexpected, as typically speech initiation creates the greatest amount of disfluency, leading to the belief that usage of a stuttering reduction strategy at the end of a phrase might have little influence on fluency. Self-reported information from participants in the study described a

sense of relief during final position conditions. The neighborhood density model may shed additional light on why P and SR were successful in the final position (Arnold, Conture & Ohde, 2005). The model states that within a lexical construct there are lexically similar words (cab, cat, etc…) and the more similar the words are the greater difficulty PWS have at producing the intended utterance in which they are contained, regardless of the amount of space between the lexically associated words (Arnold, Conture & Ohde, 2005). By having P and SR occur at the end of a phrase, no additional computations for productions had to be planned, thereby possibly eliminating the requirement for additional motor speech planning or predictive feedback comparisons to planned templates.

Although there was a trend towards significance, differences were non-significant for the medial position, which may be a result of the spatio-temporal relationship of the condition being too far removed from the actual planning of the specific motor-movement. Motor speech is typically planned in 4-6 syllable segments (Friederici, 2011). For the current study, if the participants planned the alteration in the middle of the 8-12 syllable length phrases, it would occur in the middle or at the end of their planned motor speech segment. As the segment was being produced, the participants reinitiated the planning phase for the following segment. The techniques being used may have occurred too late in the PWS utterance to be able to reduce stuttering frequency.

Results from the current study support the notion that stuttering is a result of interference in feed-forward processing of efferent plans for motor-speech (Max, et al., 2004). Max and colleagues presented a model for speech production where plans for speech are prepared beforehand (feed-forward system) with adjustments to those motor-

plans occurring in real-time (feed-back). The model argues that PWS rely too much on the feed-forward mechanism for speech, which then results in stuttering. Using P speech and SR may utilize the feed-forward system, allowing a fluent-motor plan to replace the previous plan. While both P and SR displayed a reduction in stuttering frequency, P alters the motor-plan for speech to a greater extent than does SR (Hudock, unpublished). P speech in the initial position displayed the most marked and greatest reduction in stuttering than all other conditions. Additionally, P is a motor-movement that alters the pervious motor-movement plan, while SR is a manipulation of neural constructs not dealing directly with physical motor-movements. Alteration of the first syllable of speech by using an actual or imagined motor-production may create changes in the trajectory of typical motor-productions for PWS and thereby access the feed-forward or planning system. Modification during the initial motor-plan may shift the original blueprint for speech production to a more fluent form increasing the accuracy of the feed-forward process, altering how participants would normally produce speech.

Clinical Application

Findings from the current study can be clinically applied to PWS by using P and SR to reduce stuttering frequency. P or SR used at the initial onset of an utterance by a PWS can expect to see a greater amount of fluency throughout their entire utterance. These strategies may also be used on an injection word such as “um”, thus not affecting the target message, as occasional exclamatory remarks preceding a statement are normal and accepted. As there was a significant reduction in the initial position, it is likely that most motor-speech fluency strategies used in the initial syllable position will have a similar effect. The significant change that was exhibited by P and SR in the initial

position could be extrapolated to be applied to any stuttering reduction strategy consisting of articulatory motor-movements or imagined motor-movements.

Chapter 5: Conclusion

The use of covert strategies to altered planned productions has been shown to be efficient at reducing stuttering. Findings from the current study added converging evidence to prior research demonstrating active motoric alterations or non-motor operations are effective at reducing stutter frequency. Our study furthered the current level of knowledge by displaying a reduction in stuttering from planned alterations of motor and non-motor strategies across syllable positions throughout an utterance. These behavioral findings support current models of stuttering inhibition and can further be extrapolated to other motor and non-motor strategies for fluency enhancement. Future studies should examine similar motor and non-motor strategies (i.e., SR or sensory feedback) and their effect on enhancing fluency across syllable position. Clinicians may find it useful to apply techniques such as P in their therapy sessions to assist clients in creating fluent productions at the onset of speech.

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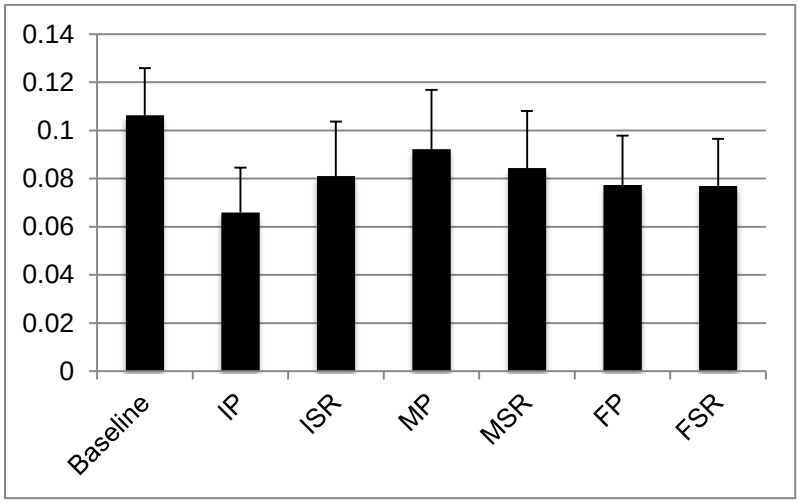
APPENDIX A

Figure 1: Average proportion of stuttering by condition. Error bars represent +1 standard error of the mean.



APPENDIX B

Table 1.

	Mean	Std. Error
Baseline	.101	.059
Initial Pantomime	.066	.056
Initial Silent Reading	.081	.068
Medial Pantomime	.092	.072
Medial Silent Reading	.084	.071
Final Pantomime	.077	.061
Final Silent Reading	.077	.059

***Summary of descriptive variable statistics based on averages from 9 participants**