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Some Effects of Metronome Modality on Speech Rate

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Some Effects of Metronome Modality on Speech Rate

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Applied Behavior Analysis
Department of Child and Family Studies
College of Behavioral and Community Sciences
University of South Florida

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DEDICATION

I dedicate this manuscript to my parents, Patricia and Joel. Thank you for the constant love, support, and patience you always give me. To Emily, your unwavering support means everything.

ACKNOWLEDGMENTS

I would like to acknowledge and thank my thesis advisor, Dr. Sarah Bloom for her guidance and support throughout this thesis process. I would also like to thank Dr. Andrew Samaha and Dr. Raymond Miltenberger for their knowledge and feedback in support of my research. What I have learned from each of you is invaluable.

Additionally, I would like to thank and acknowledge J Turner Braren and Olivia Mulligan, for their assistance with data collection and providing support throughout this process. Thank you Karie John for your supporting me from start to finish.

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ABSTRACT

Effects of three metronome modalities on speech rate were examined for three college students. Five conditions were tested for comparison of the effects of each modality. In the first phase of the multielement evaluation none of the modalities succeeded at decreasing the speech rate of the subjects to the target range. During the second phase, a modeling plus feedback component was implemented which successfully decreased the speech rate to the target range for each subject. In the post assessment the effects of the model and feedback component maintained for each subject. These findings may suggest that the use of a model and feedback may help speakers achieve an ideal speaking rate.

CHAPTER ONE:

INTRODUCTION

Public speaking is an important part of many careers yet, public speaking is ranked as one of the most common fears (Friman, 2014). Individuals report feeling anxious (Speiler & Miltenberger, 2017) which may result in nervous behavior, such as quickened speech (Azrin & Nunn, 1974). Addressing these nervous behaviors is important because vocal delivery of information may affect how the listener receives the information (Friman, 2014). Being able to express ideas effectively in individual and group situations is an important aspect of communication (Shohr, 2009). If an individual speaks too quickly information may be overlooked, and if the individual speaks too slowly the importance of the conversation may never come across for the listener. Speech rate is important for the above reasons and also, listeners have limited amount of time and their time should be valued (Kiefer, 2010).

Rate of Speech

Rate of speech refers to how fast or slow an individual speaks, which may vary depending on upbringing and circumstances, and is calculated by dividing the number of words spoken by a specified amount of time. According to Stucky (2015), an auctioneer may speak as fast as 400 words per minute (wpm), but an audiobook or podcast will typically be recorded in the 150-160 wpm range. Conversational speech typically falls between 120-200 wpm but anything over that threshold is considered fast and may be difficult for the listener to process (Stucky, 2015). In order to be effective, the individual should strive for a rate of speech even

slower than their conversational pace when speaking to an audience (Stucky, 2015). Additionally, popular Ted Talk speakers (i.e. Al Gore, Steve Jobs, Dan Pink) averaged 153 wpm during their presentations (Snippe, 2017).

Metronome Effect

There are numerous speech pathology articles on the effects of metronome and speech, particularly with individuals who engage in stuttering (Boutsen, Brutten, & Watts, 2000). Although the metronome effect has been well researched within the field of speech pathology, little research has been conducted to evaluate if beneficial effects may be observed in individuals who do not engage in stuttering. Several studies have examined the metronome and rhythmic movements in the body (Varlet, Williams, Bouvet, & Keller, 2018). For example, Nittono, Tsuda, Akai, and Nakajima (2000) examined the effect of tempo of background sound on line-tracing speed. Participants traced lines on paper while background sounds and metronome tones played through speakers. The results indicated a change only in the fast tempo (i.e., 120 beats per minute) conditions of the music and metronome tones. The slow tempo conditions did not influence line-tracing speed. Therefore, a metronome set to a fast tempo have an effect on behavior. This finding supports the claim that an external stimulus may influence rate of speech. The authors suggested that the effects may have been due to another factor in the music such as, rhythm or melody. Although it is difficult to identify exactly what an individual may be focusing on while listening to music, providing a steady metronomic tone instead of a layered piece of music and then measuring a behavior may provide clarification. If the metronomic tone influences the response in the same way as the music, we would know at least that the metronomic tone was sufficient.

Brady (1969) found that individuals who stutter made fewer dysfluencies when pacing their speech to a metronome. Brady tested two conditions: first, the participants performed a secondary task while reading with a metronome playing in the background. Second, only a metronome was playing while the participant was reading. This study showed that an auditory stimulus provided by an external source was enough to influence the number of dysfluencies individuals with a stutter. Brady (1969) suggested that certain individuals who stutter may perform better with different modality of metronomes.

Additionally, Greenberg (1970) evaluated the effects of a metronome on stuttering and dysfluencies stuttering with children and found that the presence of the metronome decreased the number of dysfluencies. Greenberg (1970), found it was easy to tell when the participant "fell in rhythm" with the metronome. The researcher measured syllables and words per minute, and frequency of dysfluencies. Brady (1969) suggested that certain individuals who stutter may perform better with different modality of metronomes.

Although the metronome effect on stuttering has been well researched within the field of speech pathology, very little research has been conducted to evaluate if similar effects may be observed in individuals who do not engage in stuttering. A notable exception is, Bousten, Brutten, and Watts (2000), who found that metronomic stimulation effected the rate of speech in individuals with and without a stutter. During the study the participants were instructed to read four sentences in a trial, for a total of five trials. A metronome tone was delivered through headphones approximately every 10 s. The authors suggested that the slower metronome rate may have increased variability among individuals with and without a stutter. Future research should evaluate if altering the modality of a metronome may lead to performance variations

during experimental conditions. The use of a visual stimulus in the form of a flash, audible click, and vibrating pulse are alternative stimuli that may provide options for future areas of research.

Therefore, the purpose of this study is to evaluate some effects of metronome modality on speech rate and frequency of disfluencies with adults who do not engage in stuttering, and to examine if effects observed maintain after the removal of the metronome

CHAPTER 2:

METHOD

Subjects, Setting, and Materials

Four adult females between 19 and 21 years-of-age who were enrolled at the University of South Florida participated in this study. Each subject wanted to improve their public speaking skills and develop a practice method for preparing presentations. Subjects were recruited through recruitment flyers that were distributed at the primary investigator's (PI) place of employment and PI's contact list. Once contacted, the PI provided the consent forms for the student to agree to participate and explained that the student may withdraw from the study at any time.

Criteria for participating in this study included speaking below 145 wpm or above 160 wpm. To determine if the subject met the inclusion criteria three to seven pre-assessment sessions was conducted to identify speech rate. Sessions were conducted in conference rooms at the University of South Florida in front of a small audience. An English passage was provided for the subject to read for 5 min before the start of the pre-assessment. The pre-assessment consisted of the PI setting a timer for 2 min and the subject reading from the beginning of the English passage until the timer sounded. The Lexile Scale was used to identify an English passage at an eighth-grade reading level.

Materials included the PI's cell phone, a metronome application, PI's computer, headphones, data sheets, pencil, a timer application, the passage printed on multiple colored sheets paper, and a recorded model of the passage in the target range. The voice memo

application was used to record the session each session. The Tempo™ application was used for each metronome modality.

Dependent Measure and Response Measurement

The primary target behavior for the study was speech rate. Speech rate was assessed during an initial pre-assessment, the multielement evaluation, the multielement evaluation including a modeling plus feedback condition, the choice assessment, and the post assessment. Speech rate was calculated by dividing the total number of words spoken by the session length (2 min). Additionally, data were collected on the frequency of disfluencies and reading errors (e.g., omitting or adding words) across phases and conditions. The target range of words per minute (wpm) was 145-160, and the metronome was set to 150 beats per minute (bpm) across conditions.

Interobserver Agreement and Treatment Integrity

Interobserver agreement (IOA) and treatment integrity were measured for 34% (33-36%) of sessions by trained observers that independently reviewed and scored the audio recordings of the sessions. The PI and trained observers listened to the audio recordings while reading the English passage to score the average number of wpm and frequency of disfluencies. IOA was collected using total count for the average wpm and frequency of disfluencies. This method involved counting the number of words in each minute, adding the total of each minute together and dividing by 2 to get the average. The IOA for all participants for wpm was 99% and the mean frequency of disfluencies across participants was 82% (76-88%). The mean number of audience members for each subject across phases was 5 (5-6).

Data on treatment integrity were collected by using a checklist (Appendix C). The checklist specified the steps necessary for the primary investigator complete during each session. Treatment integrity was calculated by the number of steps completed correctly, divided by the total number of steps, and multiplying by 100. The mean treatment integrity was 100%.

Social Validity Assessment

Each subject was asked to complete a social validity questionnaire upon competition of the post assessment (Table 1). Additionally, the choice assessment served as a social validity measure.

Experimental Design

This study used a nonconcurrent multiple baseline design with a multielement evaluation embedded across subjects.

Pre-Assessment

During the pre-assessment the subject was asked to read the English passage for 2 min in front of a small audience while standing. No feedback was provided while data on rate of speech and frequency of disfluencies were collected. The audience consisted of a minimum of five individuals. The purpose of this assessment was to determine if the subject is eligible to participate in the study. In order to participate the individual had to speak a rate below 145 wpm or above 160 wpm. This assessment is identical to the control condition of the multielement evaluation.

Multielement Evaluation

A multielement evaluation was initially conducted to evaluate some effects of three metronome modalities on speech rate compared to a control condition, and in a second phase, a modeling plus feedback condition as well. The names of each condition correspond to each metronome modality. The test conditions in the first phase were: pulse, with the subject holding the PI's phone in the palm of her hand to ensure contact; audio, in which the subject was provided with headphones and only the subject was able to hear the metronome; and visual, with a flashing screen in view of the subject. These were compared to a control condition, which was identical to pre-assessment. In the second phase of the multi-element evaluation, an additional test condition was added: modeling plus feedback, in which a model reading the same passage at the target rate was provided immediately prior to the session start and statement 1 (Appendix D) was read to the subject. Statement 1 was provided if the subject spoke above the target range. If the subject fell below the target range statement 2 (Appendix D) was read to the subject. The modeling plus feedback condition was compared to the most effective metronome condition from the previous multielement evaluation, and control. To further distinguish the conditions, five copies of the English passage were attached to different colored sheets of paper. The colored sheets of paper were consistent across phases and conditions. The sessions were conducted in a conference room at the University of South Florida and the subjects were asked to stand and read the English passage with whatever additional programmed stimuli were included in that condition. Data were collected on speech rate and frequency of disfluencies until clear differentiation between the control and at least one experimental condition was observed through visual analysis**.** If no differentiation was observed, a modeling plus feedback component was implemented. The length of each session was 2 min with any active metronome set at 150 bpm

during the metronome conditions. Each metronome modality was transmitted through the primary investigators phone using the Tempo™ application.

Choice Assessment

A 2-min choice assessment was conducted to evaluate the preferred modality of each subject. Each subject was asked to choose their most-preferred metronome modality. The procedures were identical to those described in the condition of the modality chosen. The criteria for moving to the post assessment included selecting the same modality three times consecutively or reaching ten sessions.

Post Assessment

The post assessment consisted of one session of each of the conditions from the multielement evaluation including the feedback condition, however the metronome associated with the condition was not used. Just as in the pre-assessment, the subject was asked to read the English passage associated in front of a small audience for 2 min while standing. The purpose of this assessment was to evaluate if effects observed during the multielement evaluation maintained after the removal of the intervention. It should be noted that an additional choice and post assessment were conducted with Charlotte due to the absence of the feedback condition when selecting a preferred modality and in the initial post assessment.

CHAPTER THREE:

RESULTS

The top panel in Figure 1 depicts Charlotte's data for average number of wpm. Before the pre-assessment, Charlotte specified that she wanted to improve her presentation skills because she had a difficult time adhering to time requirements during presentations. Pre-assessment consisted of 3 sessions to determine if she spoke above or below the target range. In the multielement evaluation, Charlotte showed minor variability between conditions with the Pulse and Auditory modalities showing lower rates. Because no clear differentiation between the control condition and one metronome modality was observed, a modeling plus feedback condition was implemented. The pulse modality was the lowest in the last series and was selected to be used for the feedback condition. In the modeling plus feedback phase, Charlotte showed an immediate level change across conditions. During the third and fourth series of the condition, Charlotte's speech rate fell below the target range and she was provided additional feedback. Thereafter, Charlotte's speech rate increased to the target range. In the choice assessment Charlotte chose the pulse modality three times consecutively. She stated that out of the three modalities it was the least distracting. During the post assessment Charlotte's speech rate stayed within the target range for each condition. It is likely that feedback was effective for decreasing Charlotte's speech rate and keeping it in the target range.

The middle panel in Figure 1 depicts the average number of wpm for Maeve. Pre-assessment for Maeve consisted of 5 sessions with her speech rate increasing until the last

session. During the multielement evaluation, Maeve showed variability between conditions with the control condition consistently averaging higher than the other conditions. This indicates that the metronome modalities had a minor effect on her speech rate. In the modeling plus feedback phase, Maeve's speech rate decreased to the target range for the first and second modeling plus feedback condition showing differentiation when compared to the control. The audio modality decreased Maeve's speech rate to the target range during one session but increased above the target range for the remaining series. Maeve's speech rate fell below the target range during the third modeling plus feedback phase and was subsequently provided the same feedback as Charlotte. Differentiation can be observed in the last two series of the modeling plus feedback phase with the feedback condition consistently in the target range. During the choice assessment Maeve chose the feedback condition three times consecutively. Maeve stated that she either did not attend to the other modalities or they were distracting. In the post assessment Maeve's speech rate stayed within the target range for each for each condition. It may be concluded that the feedback condition may have had carryover effects for the following conditions. The intervention was successful at decreasing Maeve's speech rate.

The bottom panel in Figure 1 displays Elsie's average number of wpm. Pre-assessment for Elsie consisted of 7 sessions before moving onto the multielement evaluation. Elsie showed variability between conditions but no differentiation between the control and one modality. The lowest average of wpm was observed in the audio condition and therefore was implemented during the modeling plus feedback phase. In the modeling plus feedback phase, Elsie's speech rate was comparable to those found in the multielement evaluation until feedback was introduced. Elsie's speech rate fell below the target range for the first modeling plus feedback session and so received feedback. For the following three series each modeling plus feedback

condition stayed within the target range. During the choice assessment, Elsie initially chose the audio modality and then the pulse modality. Elsie stated that she chose the pulse modality for the second session because "I (she) hadn't used it in a while". Elsie then chose the audio modality three times consecutively. In the post assessment Elsie's speech rate stayed within the target range for each condition.

Figure 2 displays the frequency of disfluencies for each subject. All subjects engaged in high levels of disfluencies during pre-assessment and steadily decreased during the multielement evaluation. A level change was observed for Charlotte and Maeve during the multielement evaluation. Charlotte showed a variability and then showed stability before moving in to modeling plus feedback. Maeve showed variability and an increasing trend with the exception of the last two sessions in the multielement evaluation. Elsie's frequency of disfluencies during pre-assessment shows a decreasing trend although, the frequency of disfluencies is greater than or equal to the other subjects with the exception of the last session. Each subject's frequency of disfluencies was lower than in the pre-assessment but more variable. Only when modeling plus feedback was implemented disfluencies decreased to 0 for all subjects. These results could suggest that the feedback condition may have had an effect at reducing disfluencies or the number of exposures to the English passage each subject had was enough to decrease disfluencies.

Table 1 shows the results of the of the social validity questionnaire. All three subjects indicated that their participation in this study improved their public speaking skills.

Charlotte and Elsie indicated that they would likely use a metronome while preparing for a presentation while Maeve was not likely to use a metronome. Maeve and Elsie indicated that

they liked the audio modality best and the visual modality the lease while Charlotte liked the pulse modality best and the audio modality the least. Table 2 shows the results of the demographic questionnaire.

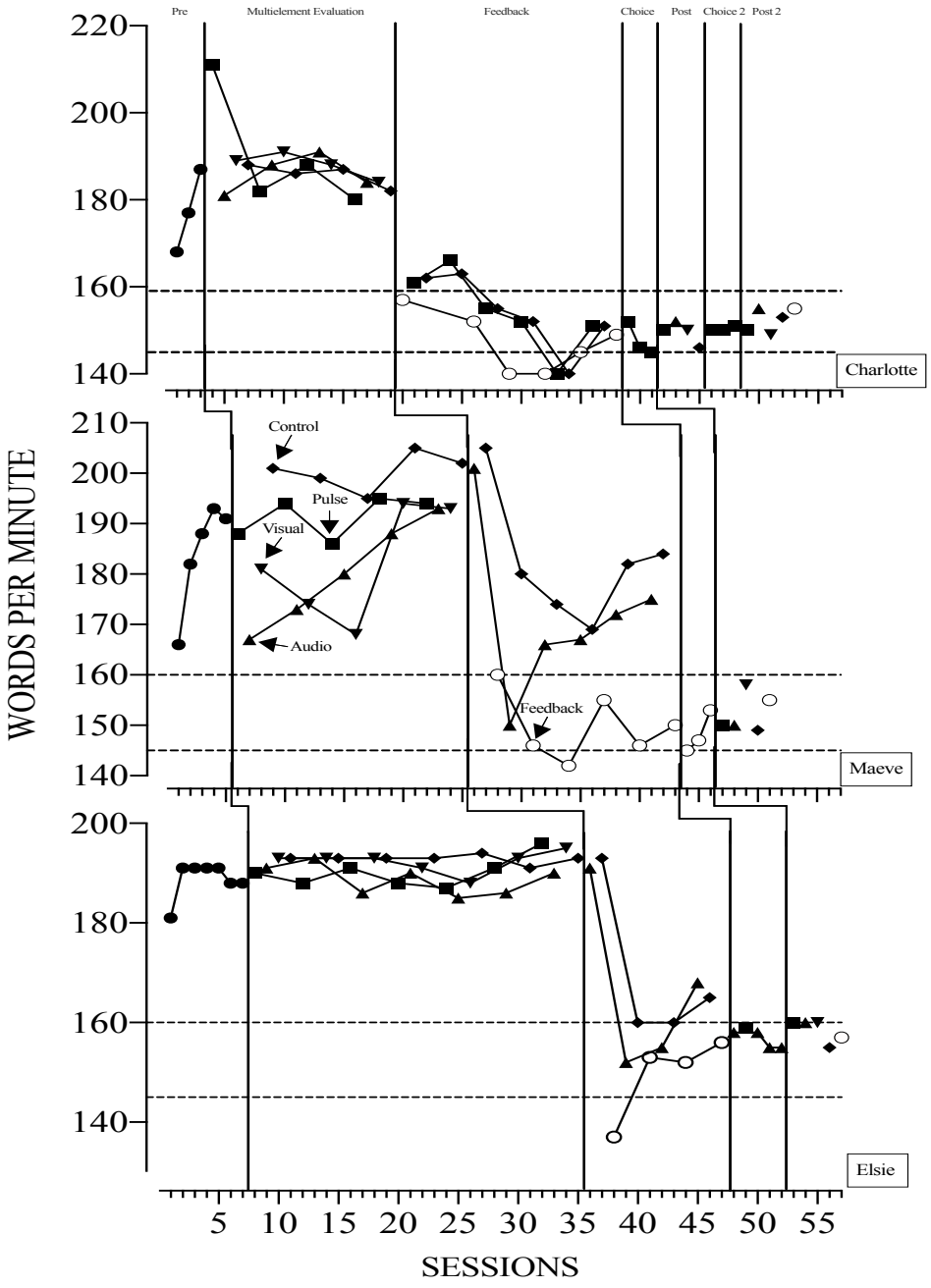

Figure 1. Average number of words per minute during 2 min sessions for each subject.

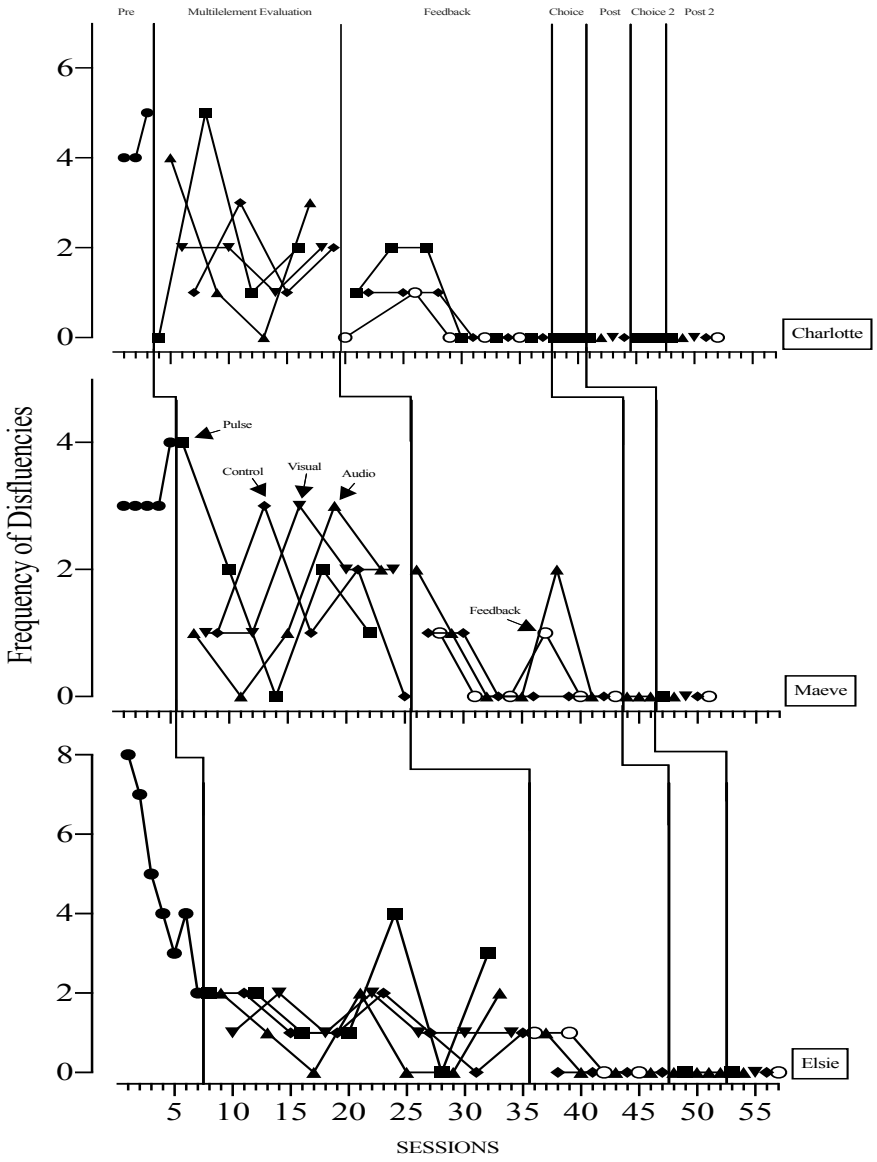

Figure 2. Frequency of disfluencies for each subject.

Table 1

Results of the Social Validity Questionnaire

Question	Charlotte	Maeve	Elsie
Did participating in this study improve your public speaking skills?	Yes	Yes	Yes
Which metronome modality did you like best?	Pulse	Audio	Audio
Which metronome modality did you like least?	Audio	Visual	Visual
How likely are you to use a metronome when preparing for a presentation?	Likely	Not Likely	Likely

Table 2

Results from the Demographic Questionnaire

Question	*Charlotte*	*Maeve*	*Elsie*
What is your gender?	Female	Female	Female
What is your age?	18-24	18-24	18-24
Would you describe yourself as Hispanic or Latino?	No	No	No
What is your racial background?	White	Black or African American	White
What is your major?	Pre-Nursing	ABA	ABA
What is you minor/concentration?	Public Health	N/A	N/A

CHAPTER 4

DISCUSSION

This study evaluated the effects of metronome modality on speech rate. In this study, all three participants successfully decreased their speech rate to within the target range once the modeling plus feedback condition was introduced and all participants decreased below the target range during the modeling plus feedback phase, requiring additional feedback to reach the target range.

This study extends the literature on public speaking in several ways. First, this appears to be the first study to specifically target speech rate in college students using metronome modalities for use during presentations. Developing a practical practice method may improve student's presentation skills. Second, this study used multiple metronome modalities (similar to Brady, 1969) to test whether or not an effect could be observed when speaking at a typical speech rate. Research has shown that a metronome alters speech rate when speaking with each tick of the metronome (Brady, 1969) and decreases the rate of disfluencies (Greenberg 1970). The literature has not targeted speech rate for typically developed individuals. Third, this study set a target range for the participants to reach for each minute. Stucky (2015) suggested that conversational speech ranged from 120 wpm- 150 wpm. Additional differences between the current study and previous studies are that social validity and demographic questionnaire data were collected. The subjects indicated whether they would use this intervention as a practice method for future presentations.

There were several limitations to the current study. First, because a multielement design was used, the results may have been influenced by potential carry-over effects during the modeling plus feedback phase. In the modeling plus feedback phase an immediate level change was not observed as was with Charlotte. This was perhaps due to the order of conditions with the feedback condition being run last in each series. Second, the number of exposures to the passage was over 50 for each subject. It can be argued that the number of disfluencies may have decreased due to the number of exposures to the passage. Third, each subject's participation ranged from 5 days to approximately 7 weeks. This was due to the PI's and subject's availability. Charlotte was completed over approximately 7 weeks in a total of 5 days. Maeve was completed approximately in 6 weeks over 5 days and Elsie was completed in 1 week over 3 days. Fourth, the subject was not instructed to attend to the audience at any point while reading. Also, the audience did not attend to the subject. To simulate a formal presentation setting future research could have the speaker and listener attend to each other. Fifth, the passage contained a couple of non-English words that may have been unfamiliar to the subject and could have served as a poor measure of their fluency. This passage was selected because it met the predetermined reading level. The non-English words were geographical locations and all subjects were expected to be familiar with the names. Future research could select a passage based on specific criteria.

Procedures used in this study differed from those used in previous research. For instance, typically developed college-aged individuals participated in this study, Greenberg (1970) and Brady (1969) targeted individuals with a stutter. In Brady (1969) the metronome was set to 93 bpm and the participants were asked speak with each tick of the metronome. In the current study, the subjects were not told to speak in time with the any metronome modality.

Future research should limit the number of exposures each subject has to the reading material and include multiple passages for the subject to read to test generalization of the modeling plus feedback condition. This study was conducted in front of a small audience and neither the audience nor the speaker were required to attend to each other. Future research should include attending to the audience to simulate presentation conditions. As previously discussed, public speaking is considered an important skill within many job fields. Although society values speaking well, many individuals report being poor public speakers and even avoiding such situations. Additionally, very little behavioral research has been conducted on how to assist individuals in improving public speaking skills, particularly speech rate

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APPENDICIES

Appendix A: Social Validity Questionnaire

Social Validity Questionnaire

Researcher:

Participant:

Date:

1) Did participating in this study improve your public speaking skills?

_____

_____

2) Which metronome modality did you like best? Why?

_____

_____

3) Which metronome modality did you like least? Why?

_____

_____

4) Will you use this form of practice in the future?

_____

_____

5) Any other comments or suggestions?

_____

_____

Appendix B: Demographic Questionnaire

Demographic Questionnaire

Please answer the questions below. All answers will be kept confidential and will not affect study participation. Declining to answer a question will not affect study participation.

1. What is your gender?
    a. Male
    b. Female
    c. Nonbinary
    d. Prefer not to answer
    e.
2. What is your age?
    a. Under 18
    b. 18-24
    c. 25-35
    d. 36-46
    e. 47-57
    f. Over 58
    g. Prefer not to answer

3. Would you describe yourself as Hispanic or Latino?
    a. Yes
    b. No
    c. Prefer not to answer

4. What is your racial background? (Circle as many as apply)
    a. Native American or Alaska Native
    b. Asian
    c. Black or African American
    d. Native Hawaiian or other Pacific Islander
    e. White
    f. Other _____
    g. Prefer not to answer

5. What is your major? _____

6. What is your minor/ concentration? _____

Appendix C: Treatment Fidelity Checklist

Treatment Fidelity Checklist

Subject:

Date:

Data Collector:

Did the researcher provide the subject with the reading associated with the condition?	Yes	No	N/A
Was the metronome associated with the condition provided to the subject?	Yes	No	N/A
Did the researcher start a timer at the beginning of the session?	Yes	No	N/A
Did the researcher end the session when 2 min elapsed?	Yes	No	N/A
Did the researcher record the session?	Yes	No	N/A

Appendix D: Feedback Statements

Feedback Statements

1. Read the passage how to the model reads it.
2. Last time you had longer pauses between sentences when you listened to the model. This time I want you to listen to how she pauses after each sentence and do your best to mimic it. Speed up a little bit.

Appendix E: IRB Approved Letters

APPROVAL

February 13, 2020

Zachary Hand
534 11th Ave. N
St. Petersburg , FL 33701

Dear Mr. Hand:

On 2/12/2020, the IRB reviewed and approved the following protocol:

Application Type:	Modification / Update
IRB ID:	STUDY000009_MOD000001
Review Type:	Expedited 6 & 7
Title:	Some Effects of Metronome Modality on Speech Rate
Funding:	None
IND, IDE, or HDE:	None
Approved Protocol and Consent(s)/Assent(s):	• Protocol Version #2 1.28.20 Clean.docx • Adult Consent #2, 2.11.20 Clean.pdf Attached are stamped approved consent documents. Use copies of these documents to document consent.

The modifications, as described by the study team below, have been approved:

Feedback and modeling will be provided to the subjects before continuing with the multielement evaluation if no differentiation is observed between the experimental and control conditions. The subjects will be notified of these changes in person before the start of their next session.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Re-consent is not needed.

Sincerely,

Various Menzel
IRB Research Compliance Administrator

A PREEMINENT RESEARCH UNIVERSITY

Institutional Review Boards / Research Integrity & Compliance
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