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The Effect of Attention to Self-Regulation of Speech Sound Productions on Speech Fluency in Oral Reading

Chana Basya Halpern
University of Wisconsin-Milwaukee

THE EFFECT OF ATTENTION TO SELF-REGULATION OF SPEECH SOUND PRODUCTIONS ON SPEECH FLUENCY IN ORAL READING

by

Chana Halpern

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ABSTRACT

THE EFFECT OF ATTENTION TO SELF-REGULATION OF SPEECH SOUND PRODUCTIONS ON SPEECH FLUENCY IN ORAL READING

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Purpose: This study ultimately sought to test whether a condition of heightened attention to speech sound production during connected speech serves to trigger increased disfluencies. Disfluencies, or disruptions in the flow of speech, are highly variable in form and location, both within and across individuals and situations. Research to identify conditions that can predictably trigger disfluencies has the potential to provide insight into their elusive nature. A review of related literature covered the cognitive-linguistic theories related to speech fluency and stuttering. This review of previous literature also served as the foundation for why it was proposed that disfluencies would be triggered by heightened self-monitoring attention to how speech sounds are made during connected speech.

Methods: Participants included 10 male and 10 female normally fluent adult college students. Their tasks included a baseline oral reading of a 330-word passage, learning of two new speech sounds, followed by an experimental reading of the same passage again. During the experimental reading, target sounds, which were indicated by highlighted locations within the passage, had to be replaced with the newly learned speech sounds. Participants indicated much greater attention was given to how speech sounds were produced during the experimental oral reading than in the baseline oral reading, to support and validate the nature of the task.

Results: Disfluencies and oral reading rates were examined using descriptive statistics and analyzed by means of the negative binomial distribution model. Secondary analyses of oral reading rates were conducted with the Wilcoxon's Signed Rank test. The results revealed that the experimental reading task was associated with a significant increase in Stuttering-Like Disfluency (SLD) and Other Disfluency (OD), and a significant decrease in oral reading rate. Furthermore, SLDs increased significantly more than ODs from the first to the second reading.

Discussion: Results supported the hypothesis that disfluency, especially SLD, can be triggered by a condition of increased attention to self-monitoring how speech sounds are produced during connected speech. These findings support theories explaining disfluencies as a symptom of a speaker's cognitive-linguistic speech planning processes being over-burdened. Implications are raised for specific populations that may be at risk-for more disfluencies: young children learning language, second-language learners, and children in speech therapy. Future research directions are recommended to better understand how to prevent disfluencies in at-risk populations and clarify the enigmatic relationship among attentional processes, phonological production planning, and stuttering.

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ADHD	Attention-Deficit/Hyperactivity Disorder
AV	Audio-Visual
DCM	Demands and Capacities Model
IPA	International Phonetic Alphabet
NFS	Normally Fluent Speakers
OD	Other Disfluency
PWS	People Who Stutter
R1	Reading 1
R2	Reading 2
RBANS	Repeatable Battery for the Assessment of Neuropsychological Status
SI	Segment Initial
SLD	Stuttering-Like Disfluency
UWM	University of Wisconsin-Milwaukee
WPM	Words per Minute

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INTRODUCTION

The word “disfluency” serves as the broad categorical term for all varieties of surface disruptions in the flow of speech (Yairi & Seery, 2015; Lickley, 2017). All speakers experience disfluencies (Yairi, 1981; Yairi & Seery, 2015) but not enough is known about what triggers these speech disruptions. Individuals who are learning speech appear to be particularly vulnerable to fluency disruptions. For example, the disorder of stuttering begins in early childhood during speech learning, and those who are learning a second language do not produce speech smoothly at first. More knowledge is needed about the nature of conditions that trigger speech disruptions during speech learning.

Disfluencies are a highly variable phenomenon. Their frequency varies with the person, with the situation, and with the words spoken (Ambrose & Yairi, 1999; Chon, Kraft; Zhang, Loucks, & Ambrose, 2013). In the production of spontaneous speech by normally fluent individuals, disfluency can be expected to occur at a frequency of approximately 6% of the total number of words sampled (Bortfeld, Leon, Bloom, Schober & Brennan, 2001; Eklund, 2004; Fox Tree, 1995; Shriberg, 1994). The form of disfluencies also varies from moment to moment. The reasons for this variability are not fully understood. Research is needed to reveal those conditions that may predictably trigger disfluencies to improve understanding of their variability.

Types of Disfluencies

Types of speech disruptions were first classified by Johnson and Associates (1959) into eight subcategories. Later, Williams, Silverman, and Kools (1968) and other researchers (Yairi & Seery, 2015; Yairi & Ambrose, 1992) adapted these disfluency categories to include the following types: single-syllable whole-word repetitions, part-word repetitions, disrhythmic phonations (i.e. sound prolongation, blocks, and tense pauses), phrase repetitions, interjections (also called “filled pauses”), revisions/incomplete phrases. Others also added types such as unfilled pauses and other hesitancies (Guitar, 2014; Goldman-Eisler, 1968; Boomer, 1965; O'Connell & Kowal, 1983; Butcher, 1981).

All speakers, both Normally Fluent Speakers (NFS) and People Who Stutter (PWS), experience disfluencies in all the types just listed (Bjerkan, 1980; Hubbard & Yairi, 1988; Johnson & Associates, 1959; Yairi, 1972; Yairi & Lewis, 1984; Zebrowski, 1991; Kelly & Conture, 1992). Onslow, Gardner, Bryant, Stuckings, and Knight (1992, p. 83) observed in adults that with few exceptions “the full range of eight disfluency categories was used by listeners to describe both stuttered and normal disfluencies.” Yairi and Lewis (1984) found that normally fluent children exhibited disfluencies in all the disfluency categories that occurred in the speech of children who stuttered.

In contrast to normal disfluencies, stuttering instances are speech disruptions experienced by PWS. The speech of PWS is characterized by abnormally high frequencies and/or durations of stuttering blockages (Guitar, 2014), particularly taking the form of “elemental repetitions and prolongations” (Wingate, 1988, p. 9). Moreover, stuttering instances are usually experienced as a "loss of control of the ability to voluntarily continue the disrupted utterance" (Perkins, 1990, p. 376).

Despite the reality that all types of disfluencies occur in all speakers, research has found that certain disfluency categories occur more often in PWS than in NFS (Bjerkan, 1980; Meyers, 1986, 1989; Yairi, 1972; Yairi & Lewis, 1984). Not only are certain types of disfluencies more prevalent in *quantity* in PWS, but they also occur for longer durations or with increased tension, impacting their *quality* in PWS, when compared to NFS (Boey, Wuyts, Van de Heyning, De

Bodt, & Heylen, 2007). Probably because certain types of disfluencies occur more often and with more severity in PWS, researchers have found that those disfluency types are associated with and more often perceived as stuttering, while other types of disfluencies are more often perceived as normal disfluency (Zebrowski & Conture, 1989; Boehmler, 1958; Williams & Kent, 1958).

The disfluency types prevalent to a greater extent in PWS are: part-word (i.e. sound or syllable) repetitions (e.g. ca-ca-cat), single-syllable (i.e. monosyllabic) whole-word repetitions (e.g. you-you-you), and dysrhythmic phonations (i.e. sound prolongations, broken words, blocks and tense pauses) (e.g. tommmmorrow, tomo—rrow, or –tomorrow) (Yairi & Seery, 2015; Guitar, 2006). Yairi and Ambrose (1992) named the category that includes these disfluency types S*tuttering-Like Disfluency (SLD)*. The types of disfluency that were not distinctively characteristic of PWS, were deemed *Other Disfluency (OD)* (Yairi & Ambrose, 1992). These consist of multisyllabic whole-word repetitions (e.g. spaghetti spaghetti), phrase repetitions (e.g. that looks really that looks really), interjections (e.g. um, uh), revisions (e.g. I want – I mean), and abandoned utterances (my brother – yesterday I saw) (Ambrose & Yairi, 1999).

Although the frequency of SLDs differ significantly between stuttering and fluent speakers, the frequency of ODs do not (Ambrose & Yairi, 1999; Pellowski & Conture, 2002; Juste & Andrade, 2011). The question regarding why SLDs are more prevalent in the speech of PWS has yet to be answered. Knowledge of the conditions that trigger SLDs as opposed to ODs would help to shed light on the nature of the stuttering disorder. Having discussed the various kinds of disfluencies, as well as how and why they have been categorized, it is now important to relate what is known about the conditions that may trigger instances of disfluencies. Although researchers have speculated that these two groups of speech disruptions (i.e. SLDs and ODs) occur for different reasons, this assumption has yet to be substantiated.

Reasons for Disfluencies

To produce well-developed language, people conceptualize words to represent intended meanings and then grammatically structure those words into meaningful sentences. Research suggests that ODs tend to result in response to increased demands or difficulties that arise during the processes involved in applying meaning to words or placing words into grammatical sentences. Thus, a speaker's uncertainty at these levels of constructing a message has been shown to induce a higher frequency of ODs in NFS. Smith and Clark (1993), as well as Brennan and Williams (1995), found that interjections occurred more often when participants were unsure of answers to questions as compared to when the answers were known. Krahmer and Swerts (2005) also found speaker uncertainty related to the content of one-word responses to result in increased interjections and delays.

Just as a speaker's uncertainty about the content of a message can result in more ODs, uncertainty regarding how to structure a message can also induce more ODs. For instance, when the degree of structure imposed on a discourse task is decreased, ODs tend to increase (Oviatt, 1994; Schachter, Rauscher, Christenfeld, & Tyson Crone, 1994). Conversely, providing a speaker with the structure for a discourse simplifies the speaker's formulative task of speaking and thus tends to promote fluency. The differences between these tasks may account for the differences in fluency. In a structured discourse, a speaker is given prompts to guide the nature of the information to be exchanged while in an unstructured discourse, a speaker must initiate and self-structure the content to a much greater degree.

In her research with human-computer and human-human spoken interactions, Oviatt (1994) found that the unstructured format of human-human dialogue resulted in twice the number of disfluencies than those exhibited during human-computer interaction. Perhaps this relationship between self-structuring language content and increased moments of disfluency can explain Goldman-Eisler's (1968) finding of increased disfluencies by participants when speakers interpreted the meaning of a cartoon as opposed to when they simply described the content. Similar research revealed that when people have more options to choose from regarding what to talk about or different words to say, such as when lecturing on subjects that are less formal, less structured and less factual, they tend to use more interjections (Schachter, Christenfeld, Ravina, & Bilous, 1991; Schachter et al., 1994).

Biber, Johansson, Leech, Conrad, and Finegan (1999) suggested that disfluencies, such as filled pauses (i.e. interjections, e.g. "um, uh"), unfilled pauses (silences) and repetitions are sometimes used during speech to reduce planning pressures. Biber et al. (1999) proposed that revisions result from reformulations that are due to a speaker's desire to change the wording, increase precision, or correct a grammatical error of what he/she previously said. Finally, Biber et al. (1999) describe different possibilities as to why unfinished utterances might occur. These include the desire to start a new utterance rather than finish the previous one, the speaker's loss of the thread of what he/she was saying, inattention, and interruptions by other speakers. In summary, ODs appear to result mostly from the propensity of speakers, regardless of whether they are PWS or NFS, to monitor or formulate the language aspects of their speech.

Several authors have attempted to summarize and encapsulate research regarding the reason for ODs. Lickley (2017) opined that ODs are often triggered by momentary delays in the planning or formulation of speech. Yairi and Seery (2015) seem to generally agree as they maintain that ODs in NFS occur for recognizable reasons such as a speaker's reconsideration of message content, a delay due to word-finding or a sentence-formulation decision, or even an external distraction. Andrade (2004) similarly posits that ODs result from linguistic imprecision, uncertainty, or an attempt to enhance the comprehension of a message.

The common factor in all these causes of OD is that they are identifiable. Yairi and Seery (2015, p. 27) stated that “When the speaker recognizes the reason for the speech disruption, he or she is apt to acknowledge it as a ‘normal disfluency.’” Arnold, Kam, and Tanenhaus (2007) concluded that even listeners could make inferences based on the situation about the causes of ODs, such as difficulty with planning, or word finding.

Conversely, the reasons underlying SLDs, especially in PWS, are not clear. Regarding the cause of SLDs in PWS, Yairi and Seery (2015, p. 27) noticed that “when the word(s) to be said is fully decided and the speaker is intent to engage in speaking, but the production becomes ‘stuck’ for what seems to be no apparent reason, it is then that the experience by the speaker is apt to fit the label of stuttering.” While it has been suggested that the reasons for ODs appear to be related to the process of language formulation and other recognizable causes, SLDs are believed to be more motorically-based (Smith, Goffman, Sasisekaran, & Weber-Fox, 2012). Juste and Andrade (2011) observed that NFS frequently prolonged the last syllable of words in a manner that appeared to serve a motor programming purpose to facilitate the co-articulatory transition between words. Thus, even for NFS, SLDs may be triggered mainly by motor-driven processes in speech production. Other potential triggers of SLDs will be discussed later in the section on cognitive-linguistic load as a factor in disfluency.

Theoretical Explanations for Conditions of Increased Disfluencies

Multiple researchers have explained conditions of increased disfluency with the Demands and Capacities (DCM) Model (Adams, 1990; Starkweather, 1987; Starkweather & Gottwald, 1990). According to this model, disfluencies can arise when "demands" on the speech production surpass a person's "capacity" to speak fluently. Demands can be environmental and/or self-imposed (e.g. rushing) and their types may span the gamut to increase the load on many dimensions, including a person's cognitive, linguistic, motoric, and social-emotional capacities (Adams, 1990; Starkweather & Gottwald, 1990). For example, disfluencies often increase when adults speak to a larger audience (Van Riper & Hull, 1955) or when young children play with adults who rush conversation and interrupt more often (Yaruss, 1997).

Wingate (1988) proposed a psycholinguistic explanation of the breakdown in speech fluency, attributing the stuttering moments to the asynchronous assembly of speech sounds within a word. Disfluencies in PWS most frequently occur in the syllable-initial position and almost never occur in the word-final position (Bluemel, 1913; Emerick, 1963, Froeschels, 1961; Hahn, 1942). Even though initial consonants, as compared to initial vowels are more frequently stuttered (Johnson & Brown, 1935; Taylor, 1966), no specific consonants have been consistently associated with increased moments of disfluency among groups of PWS (Hahn, 1942). Based on these factors, Wingate (1988) hypothesized that the breakdown in fluency occurs at the transition between the initial consonant and vowel in a syllable. Wingate (1988, p. 184) termed this transition of phonemes, within the production of words, the "fault line" of phonological production. Furthermore, with respect to the fact that stuttered sounds are frequently accurately articulated, Wingate (1988) explained that the difficulty that results in stuttering occurs during the transition between sounds rather than during the production of individual phonemes. He explained stuttering as the result of a lack of synchrony in the assembly of words. The speech production planning system fails to integrate and unify the sound elements into syllable structures.

Another theoretical model relating the syllabic structure of utterances to the underlying reason for the breakdown of fluency was proposed by Perkins, Kent, and Curlee (1991). They explained both stuttered and nonstuttered disfluencies serve as placeholders during a speaker's attempts to put sound segments into their syllable forms. This theory is based on the idea that segmental fillers (i.e. sounds of the syllable) and syllable frames (i.e. a syllable's structure of slots for the onset and rime of a syllable) are processed in different parts of the brain and come together for the production of speech. Not only do sounds need to be placed into their proper sequence for words, but they also need to be inserted into their proper hierarchy of onset (initial sound) and coda (final vowel and consonant) for syllables, which are subsequently hierarchically placed within a phrase to achieve appropriate suprasegmental patterns. Thus, to achieve fluent speech, each segmental filler needs to be inserted into the precise place within its corresponding syllable frame. For this to occur, the syllable frames and segmental fillers need to be integrated with appropriate synchronization. If a syllable frame reaches the point of production before its matching segmental filler or vice versa, disfluency could be the result. Perkins et al. (1991) identified time pressure, or the need to begin, continue, or quicken a spoken utterance, although the frames and fillers are not ready to be integrated, as the clincher, which results in a stuttering event. When time pressure exists, and there is dyssynchrony between a syllabic frame and segmental filler, the speaker will persist in the face of speech disruption and experience a loss of control in the form of stuttering. In sum, according to this neuropsycholinguistic theory, disfluency results from delayed integration of the slots or filler elements, until both syllabic frames and segmental fillers are prepared for production.

Whereas the theoretical explanations of disfluencies that have been introduced thus far mainly focus on cognitive-linguistic processes, Howell's (2007) EXPLAN theory also adds motor-physiological components into the speech planning failures that could interfere with fluent speech production. The EXPLAN theory (named for the interface between "EX"ecution and "PLAN"ning) supposes that overlapping factors of linguistic planning, motor programming, and execution all influence disfluency. Although planning subsequent units of speech can take place while previous units of speech are being produced, sometimes a subsequent unit is not ready to be executed immediately following the completion of the previous unit's production.

Thus, in his EXPLAN theory, Howell (2007) proposes that when a person finishes speaking a relatively easy-to-execute unit before the subsequent, more difficult unit is finished being planned, disfluency can result in one of two forms. The first form is called stalling. Howell (2007) classifies whole-word repetitions, phrase repetitions, and pauses as ways of motorically stalling on the unit of speech that was already programmed and executed while the speaker waits until the more difficult unit is ready for execution. These tend to be located on function words (i.e. pronouns, prepositions, conjunctions, articles). For example, if a person tried to say, "I split" and finished the production of "I" before the word "split" was completely planned, the speaker might repeat the word "I" or pause as a means of handling the delay in generating the content word (in this case) "split."

Howell (2007) named the other form of disfluencies advancings. Advancings include various types of SLDs, such as prolongations, part-word repetitions, and dysrhythmic phonations, and occur when a speaker tries to produce the unit of speech (in this case content words such as nouns, verbs, adjectives, adverbs) before it has finished being planned (Howell, 2007). The speaker begins to produce the word but cannot complete it and this interrupts the flow of speech. In the same example of "I split," if a speaker advances to say the /s/ sound in the word split before the rest of sounds in the word "split" (verb) have been encoded and prepared for articulation, the speaker might prolong or repeat the /s/ or produce a dysrhythmic phonation until the rest of the word is ready for production.

Thus, while stallings occur because a speaker is waiting for the completed encoding of subsequent sounds and syllables, advancings occur because a speaker began to say a word that was not completely encoded. This theory helps us to appreciate the potential role of both linguistic planning and motor execution in disfluency.

These theoretical models, which outline the underlying processes/causes of instances of disfluency, can be used to explain why conditions of speech learning may trigger more instances in which disfluency is more apt to occur. The common theme among them is the situation of an unfinished assembly of words for speech production. These theoretical explanations account for disfluencies as a result of disruptions to central psycholinguistic processes responsible for speech production. If disfluencies occur for reasons of cognitive load and psycholinguistic processes involved in the planning of speech, then an understanding of a general model of the speech production system and its regulation is important in explaining the nature of speech disruptions.

Model of Self-Monitoring in Fluent Speech Production

Levelt (1989) proposed three, chief, sequential stages of conceptualization, formulation, and articulation in his research-based model of fluent speech production. The blueprint for his monitoring system, modified by Hartsuiker and Kolk (2001) and adapted to include Kessler's and Treiman's (1997) illustration of the syllabic aspect of phonological encoding is depicted in Figure 1. In the first stage of conceptualization, a speaker connects concepts and organizes them to generate a message. According to Levelt (1989) as well as Hartsuiker and Kolk (2001) speech monitoring occurs during the processing stage of conceptualization. After a message is conceived it needs to be formulated into both grammatical and phonological representations. Thus, to assemble the components of speech, the second stage of formulation can be subdivided into phases of grammatical and phonological encoding. Grammatical encoding involves the retrieval of the semantic and syntactic (e.g. meaning and grammatical function) aspects of words. The product of the grammatical encoding process is next passed along to the next stage, the phonological encoding process. In the phonological encoding stage, words are then structured by retrieving and sequentially ordering the associated sounds and hierarchically building the syllable framework for the sounds. In other words, not only do speakers need to retrieve the sounds (phonemes) that will appear within a word, but according to the onset-rime theory (Fudge, 1969; Selkirk, 1982), speakers also need to retrieve syllabic structures and place each phoneme into its corresponding location (e.g. vowel/nucleus is grouped with final consonant/coda to form the rime) within the syllable. Levelt's (1983, 1989) perceptual loop theory, suggests that an inner monitor, which also functions as the speech comprehension system, brings the grammatical and phonological prearticulatory representations and ultimately the phonetic plan to the conceptualizer to be monitored. It is important to note here that people can begin to articulate the phonetic plan before the encoding for subsequent sounds, syllables, and words within an utterance is complete. This concept is known as the "staged and feedforward" process (Howell, 2002; Levelt, Roelofs, & Meyer, 1999). With so many co-occurring processes, it is not surprising that the speech system operates without direct conscious attention to the psycholinguistic tasks of retrieving words, grammatical structures, intonational patterns, and phonemic features. Being that these procedures usually occur automatically, articulation can occur almost instantly after a message is conceived.

In the third and final stage of speech production, which is articulation, the previously retrieved grammatical and phonological representations are motorically programmed so that articulators can shape the production of overt speech. If the phonetic plan is not immediately transformed into speech movements, it can be stored temporarily in an articulatory buffer until the formulated message is ready to be articulated. As people speak, they hear what they say and auditorily process words as phonetic strings through the speech comprehension system. The speech comprehension system sends information back to the conceptualizer where information is compared to the target message. As long as the analyzed spoken utterance matches what was intended, then no corrections need to be implemented and speech can continue to flow fluently. Levelt's (1989) model of fluent speech production involves a myriad of cognitive-linguistic processes, which play a role in how smoothly speech will be delivered.

Given these foundations of knowledge and theory related to how fluent speech is produced, attention can be turned to what is known about conditions that disrupt this flow. The next sections describe the research literature that has uncovered cognitive-linguistic factors known to increase the frequency of disfluencies.

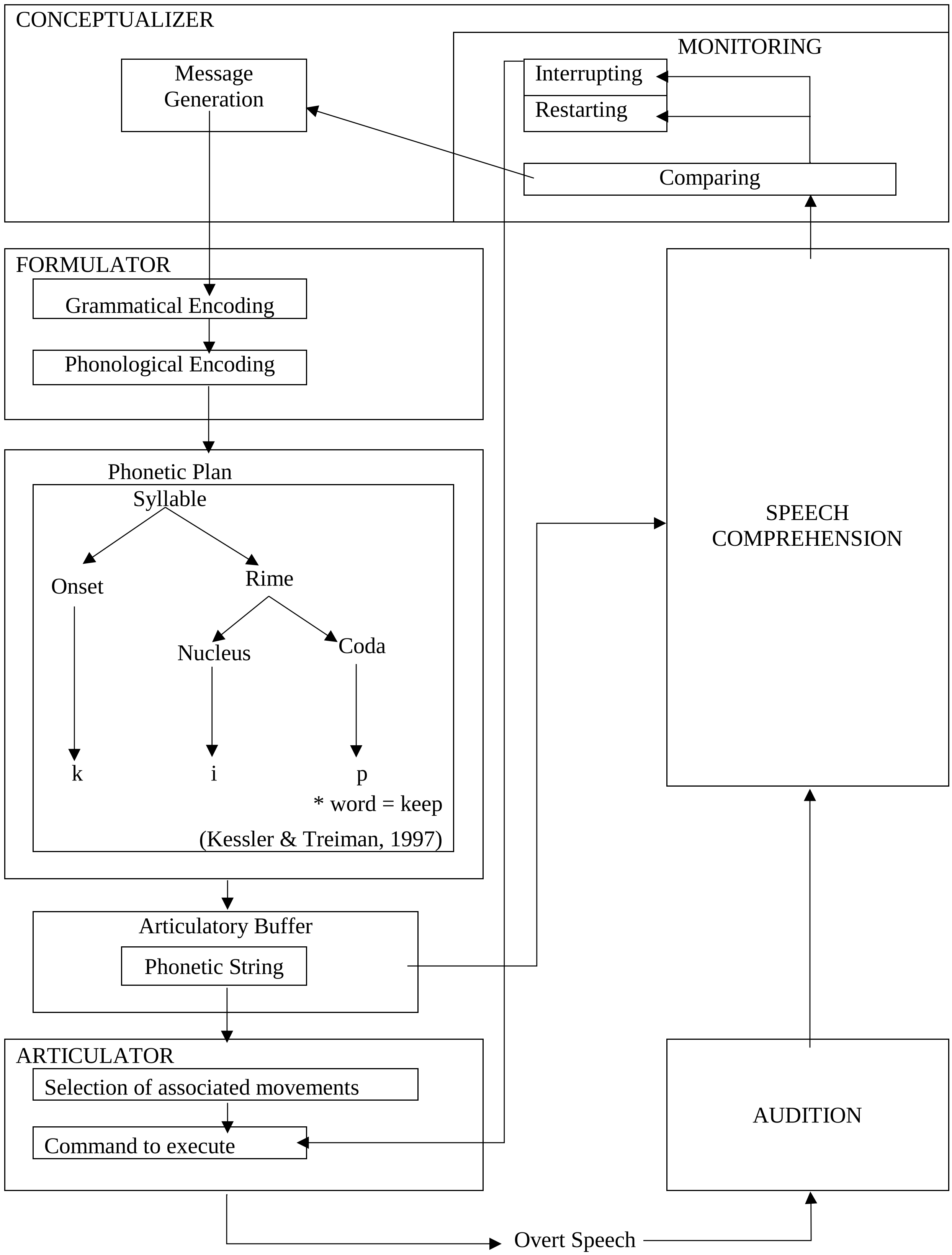

Figure 1. Self-monitoring in the production of speech, adapted from Hartsuiker & Kolk (2001)

Cognitive-Linguistic Load as a Factor in Increased Disfluency

There is a growing body of evidence to suggest that as the load on the cognitive-linguistic speech production system intensifies, disfluencies increase (Bortfield et al., 2001; Owens, Thacker & Graham, 2018; Siegman, 1979). The cognitive-linguistic load of a speaker can increase for various reasons. For instance, during language formulation or speech production, greater complexity of the semantics or syntax of an utterance will increase the cognitive-linguistic load (Hartsuiker & Notebaert, 2010). The production of unfamiliar words, as compared to familiar words, also places increased demands on a speaker's cognitive-linguistic load (Hubbard & Prins, 1994). Finally, it is not hard to understand that cognitive-linguistic demands intensify with longer and more complicated messages (Ratner & Sih, 1987). Intriguingly, each of these examples of increased cognitive-linguistic load has been shown to lead to disfluency. Thus, many triggers of disfluency appear to share a common factor in their impact on cognitive-linguistic load. These factors are examined next in more detail.

Message planning as a cognitive-linguistic load

Moments of disfluencies have been found to occur more frequently when a speaker has more decisions to make about how the succeeding speech needs to be structured and planned. Swerts (1998) found that phrase-initial filled pauses (e.g. um, uh) occurred more frequently after major breaks in the discourse. Comparably, Chafe (1987) noticed that pauses became longer than normal, and disfluencies were likely to increase in narratives during an important change in event structure, scene, time, or character configuration. Chafe (1987, p. 43) reasoned that "If such changes are costly in terms of cognitive effort, that explains the unusual amount of pausing and disfluency." In summary, at major discourse boundaries, when there are greater demands on the speaker to structure an utterance, disfluencies were found to increase.

Parallel to discourse boundaries, new utterances require structuring and planning and these extra cognitive-linguistic demands might be reflected in the higher probability for disfluency events to occur at the beginning of utterances. Swerts and Ostendorf (1997) found segment-initial (SI) utterances to be relatively more disfluent than utterances that were not in the segment-initial position of discourse segments. Brubaker (1972) similarly found that pauses between sentences were significantly longer and speech rates were substantially slower in the initial positions of paragraphs. This finding was explained with the *reduction of uncertainty hypothesis*, which supposes that rate is reduced, and pauses are more frequent at the beginning of a paragraph because the speaker is still uncertain about the content of the rest of the paragraph.

Word Characteristics as a Cognitive-Linguistic Load

The semantic roles and other features of words used by a speaker can add to the cognitive-linguistic load that bears on whether an utterance will be fluent. Hartsuiker & Notebaert (2010) observed that in conditions of increased difficulty of lexical access for naming pictures, NFS produced more pauses (both filled and silent) and self-corrections (i.e. revisions). They explained their findings with Beattie's and Butterworth's (1979) suggestion that the need to choose between words with comparable semantic characteristics leads to pauses.

Hartsuiker and Notebaert (2010) also found that when NFS participants experienced an increased cognitive burden on lexical access by using less common function words (e.g. whom vs. him) they displayed more revisions, abandoned utterances, and repetitions. Yet, the effects that low-frequency words have on disfluency are neither limited to function words nor NFS.

Content words with a low frequency of occurrence have also been associated with increased disfluency in both NFS and PWS (Hubbard & Prins, 1994) in content words (e.g. nouns, verbs, adjectives, adverbs).

Heller, Arnold, Klein, and Tanenhaus (2015) considered the difficulty of lexical retrieval to increase when a speaker plans the production of a low-frequency word. Analysis of the lexical selection process (Fromkin, 1973) and evidence regarding the increased time required to access words with low frequency (Oldfield & Wingfield, 1965; Mercer, 1976) support this supposition. Based on Monsell's (1991) model, in which more demands on the processes involved in reading aloud result in longer response times for low-frequency words, Hubbard and Prins (1994) suggested that during oral reading, unfamiliar words might slow down the phonological encoding stage of speech production. This decelerated phonological encoding could be reflected by the longer response durations and the greater number of ODs in NFS, while their effects may constitute the increased SLDs found in PWS (Hubbard & Prins, 1994).

Utterance Length and Complexity as a Cognitive-Linguistic Load

Length and complexity of utterances can also add to a speaker's cognitive-linguistic load, thus impacting the fluency with which they will be produced. Linguistic messages that are longer and/or more complex have been associated with disfluency in NFS and PWS (Zackheim & Conture, 2003; Logan & Conture, 1997; Ratner & Sih, 1987). Increased length (Oviatt, 1995; Shriberg, 1994) and complexity (Lickley, 2001; Clark & Wasow, 1998; Ferreira, 1991; Wheeldon & Lahiri, 1997) of utterances resulted in significantly more ODs and longer response times in normally fluent adults; whereas, the factors of length and grammatical complexity often led to increased SLDs in both children and adults who stutter (Gaines, Runyan, & Meyers, 1991;

Logan & Conture, 1995; Weiss & Zebrowski, 1992; Yaruss, 1999; Melnick & Conture, 2000; Bloodstein, 1995).

Multiple research studies have shown that normally fluent children display increased disfluencies on a wide variety of sentence types that are longer and/or more complex (Rispoli & Hadley, 2001; Yaruss, Newman, & Flora, 1999; Gordon & Luper, 1989, Pearl & Bernthal, 1980). Yet, in many of these studies, researchers did not differentiate the dependent variable of disfluency into SLD vs. OD categories. This reality likely stemmed from the relatively small number of SLDs produced by this population even on longer and more complex utterances. Despite this, because SLDs and ODs seem to frequently occur for different reasons, a separate analysis of SLDs and ODs would shed more light on the nature of the effects, which the conditions of length and complexity produce. One study by McLaughlin's and Cullinan (1989) did separately analyze SLDs and ODs in normally fluent children and found not only more ODs, but also more SLDs when the children repeated more linguistically complex utterances. Upon contrasting this finding with the research on the types of disfluencies present in normally fluent adults in similar conditions of linguistic complexity (which merely revealed increased ODs), it is interesting to note that normally fluent children may be more susceptible to SLDs than adults when producing more complex utterances.

Researchers have disagreed on whether utterance length vs. complexity has a stronger impact on disfluency frequency in PWS. In a few studies, length of utterance was a better predictor of disfluency than was syntactic complexity (Yaruss, 1999; Logan & Conture, 1997, Sawyer, Chon & Ambrose, 2008). However, Brundage & Ratner (1989) noticed that increases in morphemic length, when compared to the number of words or syllables, was associated most with disfluencies. Dworzynski, Howell, & Natke (2003) found that word length and word difficulty both increased the rate of stuttering in adults who stutter, while stuttering rate was only significantly influenced by word length in children. Danzger and Halpern (1973) found that stuttering frequency increased with word-length even when words were said in isolation.

Thus, as the length or the complexity of utterances is increased, more demands are placed on speech planning, both cognitively, linguistically, and motorically. Increases in length have been associated with increases in demands especially on motor planning of the utterance (Oviatt, 1995), while increases in complexity have been assumed to require more time for the finding, formulating, and initiating aspects of the linguistic plan for the utterance (Lickley, 2001; Clark & Wasow, 1998). In light of the findings that disfluency usually increases with increased length and complexity of utterances, it is reasonable to suppose that this is due to the increased processing demands that longer and more complex utterances place on the speech production system. Although the load on both the linguistic and the motor aspects of planning are increased, several studies have confirmed a special role for complexity that exceeds the length factor in disfluent speech (Brundage & Ratner, 1989; Logan & Conture, 1995). This research, therefore, reveals trends of increased disfluency as cognitive-linguistic demands increase, and may help explain the disfluencies attributed to bilingual learning and demands on phonological working memory.

Bilingual Learning and Increased Disfluencies

Parallel to increased disfluencies with an increased cognitive-linguistic load for monolingual English speakers, bilingual learning has also been linked to a higher occurrence of disfluency. Second language learners and bilingual children often display more disfluencies than proficient monolingual adults and children. For instance, research suggests that bilingual speakers produce more mazes than proficient monolingual adults and children (Bedore, Fiestas, Peña, & Nagy, 2006; Lofranco, Peña, & Bedore, 2006; Poulisse, 1999). Mazes consist of lexical revisions, grammatical revisions, phonological revisions, filled pauses, and repetitions of sounds, parts of words, whole words, or phrases (Byrd, Bedore, & Ramos, 2015). While second language learners tend to overuse both filled and unfilled pauses (Tavakoli, 2011) and while the pauses of second language learners were noted to be markedly longer and more complex than those found in native speakers (Tavakoli, 2011; Klapi, Lüdeling, & Pompino-Marschall, 2011), repetitions of all kinds have been found to be the most frequently occurring type of maze in Spanish-English bilingual children (Bedore et al., 2006). Byrd et al. (2015) noted that of all the maze types, the sound and syllable repetitions appeared to comprise most of the mazes produced by bilingual Spanish-English speakers. They explained that Loban's (1976) definition of mazes overlapped with Conture's (2001) definition of stuttering. In turn, a potential relationship was proposed between the disfluencies commonly seen in Spanish-English bilingual language learners (i.e. mazes) and those found in PWS (i.e. SLDs).

When the speech disfluencies of bilingual speakers are analyzed in terms of SLDs and ODs (Ambrose & Yairi, 1999) rather than mazes, the overlapping type of disfluencies present in the stuttering and bilingual populations is accentuated. Byrd et al. (2015) found that all their bilingual participants, who were considered typically fluent speakers, produced an overall frequency of SLDs that would be considered indicative of stuttering in monolingual English speakers. This finding accentuates the point that bilingual learning appears to significantly increase disfluencies and particularly SLDs.

It is unclear whether it is the lack of proficiency with a language or the inherent production and processing demands of specific languages that trigger more breakdowns in fluency. Some research suggests that normally fluent bilingual individuals produce more disfluencies in their less proficient language. For instance, various studies found mazes to occur more frequently in the less proficient language or second language of normally fluent bilingual speakers (Lennon, 1990; Poulisse, 1999). Hincks (2008) also found normally fluent bilingual speakers to use a slower rate of speech, and shorter utterances in their less proficient language. Some research also found bilingual PWS to produce more SLDs in their less proficient language (Ardila, Ramos, & Barrocas, 2011; Jankelowitz & Bortz, 1996; Lim, Lincoln, Chan, & Onslow, 2008). By contrast, other research revealed that bilingual PWS produce more SLDs in their more proficient language (cf. Jayaram, 1983). Still, other studies involving NFS (e.g. Byrd et al., 2015) and PWS (e.g. Dale, 1977; Ratner & Benitez, 1985) found subjects to produce more ODs and SLDs in specific languages even when language dominance was equal. Byrd et al. (2015) interpreted the increased disfluencies in these studies to stem from characteristics of greater linguistic and motoric complexity, which is inherent to some languages.

Whether or not the less proficient language is independently more disfluent in NFS, the less proficient language does seem to be more vulnerable to conditions that cause disfluency in monolingual NFS, such as delayed auditory feedback (DAF). For instance, under DAF, in which speakers heard themselves at a 150-millisecond to a 300-millisecond delay, bilingual speakers have been shown to speak slower and produce more SLDs in their less familiar language (MacKay, 1970; MacKay & Bowman, 1969; Van Borsel, Sunaert, & Engelen, 2005).

Researchers suggest that the increased disfluency in bilingual/non-native speakers stems from the increased processing demands or planning pressures of language formulation and speech production in this population (Byrd et al., 2015; Jiřelová, 2018).

Working Memory and Attentional Demands and Increased Disfluencies

Two important subcomponents of cognitive-linguistic demands that may affect speech fluency are attentional demands and working memory load. Studies of dual-task conditions involving speech have shown that attention and memory loads can result in increased disfluency. In a study with 14 PWS and 16 matched NFS, Bosshardt (2002) found that in a dual-task of simultaneously repeating words and either reading aloud or memorizing words silently, disfluencies significantly increased for the PWS (but not for the NFS). Increased attentional demands have also been shown to result in more disfluencies. For example, Caruso, Chodzko-Zajko, Bidinger, and Sommers (1994) observed that PWS produced more SLDs in the Stroop Color and Word test in which the color to be named and the ink color are incongruous compared to a simple color-word naming task with no incongruency. Similarly, Bosshardt (1999) found that when nine PWS and ten NFS concurrently repeated words and performed a mental calculation (adding numbers), SLDs increased in both groups, PWS and NFS.

The impact of attention and dual-task factors on speech fluency is not straightforward. Vasić and Wijnen (2005) found that in an attention-demanding dual-task in which the secondary task involved a visual-motor (non-verbal) activity, SLDs significantly decreased. Similarly, in another study of attention-demanding dual-task conditions with 19 PWS and 20 NFS, fluency was enhanced in both groups during their simultaneous speaking and working-memory demanding tasks (Eichorn, Marton, Schwartz, Melara, & Pirutinsky, 2016).

Eichorn et al. (2016) explained the unexpected results of their dual-task conditions on disfluency with the Matched Filter hypothesis (Chrysikou, Weber, & Thompson-Schill, 2014). According to this hypothesis, when attentional resources are actively controlled by cognition, it can “hurt” the performance of motor tasks (such as those involved with speech production) that are typically managed with automatic processes (Chrysikou et al., 2014, p. 342). Eichorn et al. (2016) suggested that some dual tasks with speaking may require more reliance on the automatic processes involved in speech production, and in turn be responsible for increased fluency, while other dual tasks may require increased cognitive attentional controls over otherwise automatic processes of speech production, thereby being responsible for greater disfluency. Thus, it might be possible for moments of disfluency to be triggered by generating increased attention to aspects of speech that can, and perhaps should be performed with more automaticity.

A specific aspect of attentional demands that has been found to affect fluency, is phonological working memory. Phonological working memory refers to the capacity to retain phonetic and acoustic information about speech sounds for the short-term while the entire phonological code is put together (Pelczarskia & Yaruss, 2016). Several researchers suggest that phonological working memory is used to integrate phonemes during the phonological encoding stage within the Levelt model of speech production (Alt & Plante, 2006; Bajaj, 2007; Acheson & MacDonald, 2009). Nonword repetition tasks possibly serve as the most frequently employed measure of phonological working memory capacities. In nonword repetition tasks, the participant imitates a random set of nonwords of various syllable lengths, comprised of language-appropriate phonemes assembled in novel combinations, for example, /voub/ or /teivoitʃaig/. Examiners analyze the productions for phoneme accuracy and response time.

Research has revealed that preschool children who stutter have weaker capacities for nonword repetition skills than normally fluent preschool children who are matched by age and gender as well as phonological, and language abilities (Pelczarskia & Yaruss, 2016; Spencer & Weber-Fox, 2014; Anderson, Wagovich, & Hall, 2006). Similar results have been found for school-age children (Oyoun, Dessouky, Shohdi, Fawzy, 2010; Seery, Watkins, Ambrose, & Throneburg, 2006). Still other research with adults who stutter and age/gender-matched NFS, comparably revealed that adults who stutter produced significantly more errors on the longest nonwords that had 7 syllables (Byrd, Vallelya, Anderson, Sussman, 2012).

An interesting finding of several studies was that even when the shorter nonwords were repeated, kinematic measures (i.e. speech movement) revealed a reduction in movement variability in both children and adults who stuttered, but not in NFS (Sasisekaran & Weisberg, 2014; Sasisekaran, 2013; Sasisekaran, Smith, Sadagopan, & Weber-Fox, 2010). Taken together, the findings of nonword repetition studies in PWS suggest that when a speaker is vulnerable to a breakdown in fluency (e.g., PWS), conditions of greater demands on phonological working memory will both impede their speech movements and trigger more errors.

Furthermore, the consequences of demands that are placed on phonological working memory capacities of PWS could also be a reason for findings from a more recent study involving a phoneme monitoring task. Howell and Ratner (2018) researched the accuracy and speed of phoneme monitoring abilities in 15 adults who stutter and 15 matched normally fluent adults. They presented picture stimuli and instructed participants to monitor for a predetermined target phoneme within the names of these picture stimuli (which participants silently named).

After each picture stimulus was presented, for 3000 milliseconds, the subjects received another 3000 milliseconds to press “yes” or “no” and thereby indicate whether they thought the predetermined target phoneme occurred within the name of the picture. The results showed that both stuttering and normally fluent groups demonstrated better (faster and more accurate) monitoring abilities for word-initial phonemes as compared to phonemes in medial positions of words. The study also revealed that when trying to monitor for word-medial targets PWS made significantly more errors in accurately identifying whether the phoneme was present. The researchers posed their findings as evidence of phonological encoding differences in PWS.

In sum, this research suggests that PWS may be more disfluent due to different capacities in phonological encoding, and more specifically in the way that they monitor sounds within words. Thus, these studies suggest that the distinguishing feature of stuttering - splintered speech sounds – may indicate that processes involved in assembling and monitoring phonological structures are where the system breaks down to result in stuttering.

Summary and Rationale

Multiple theories were presented to suggest potential reasons for disfluencies, such as the Demands and Capacity Model, Fault Line Hypothesis, the neurospycholinguistic theory, and the EXPLAN theory (Adams, 1990; Howell, 2002; Perkins, Kent, & Curlee, 1991; Wingate, 1988). In addition, studies related to the disfluencies of bilingual speakers, people who stutter, and normally fluent speakers have suggested that demands on speech planning and production processes may trigger disfluency (Byrd et al., 2015; Zackheim & Conture, 2003). Finally, evidence suggests that for speech delivery to flow smoothly, some speech planning needs to be handled by automatic processes rather than attentional control processes (Chrysikou et al., 2014). These concepts are compatible with the hypothesis that when excessive attention is given to the planning of speech sounds, it might be a reason for some disfluent speech.

Even if these theories offer explanations as to why disfluencies occur, more knowledge is needed to understand conditions that will induce moments of disfluency. There is abundant evidence that disfluency can be increased by greater cognitive-linguistic demands (Ratner & Sih, 1987; Smith & Clark, 1993; Smith, Goffman, Sasisekaran, & Weber-Fox, 2012; Wagovich & Hall, 2017); however, some of these conditions mainly increase ODs, while others also increase SLDs. Similarly, learning to speak a new language can affect fluency; however, the precise way in which it triggers each disfluency event is still unknown. Thus, several broad conditions of psycholinguistic demands have been linked to higher frequencies of disfluencies; yet uncertainty still clouds an understanding of what factors actually trigger disfluencies at the moments they occur.

The model of fluent speech production demonstrates how speech is a complex interaction of both regulated and relatively automatic processes. In the production of speech, the monitoring and self-regulation mostly occur at the level of conceiving the message; whereas the processes involved in transforming that message into spoken utterances are mostly automatic (Levelt, 1989). Moreover, according to Chrysikou et al.'s (2014) Matched Filter hypothesis, the attempt to take cognitive control over processes that take place automatically could be harmful to those processes. Based on differences in phonological working memory and phoneme monitoring in PWS, as compared with NFS, increased monitoring at phonemic levels of speech production could be a potential trigger of moments of disfluency. Consistent with this concept, when a speaker gives increased attention to monitoring the planning and production of phonemes, rather than monitoring the larger speech envelope while automatic processes take care of these tasks, it might act as the more specific trigger of disfluencies (especially SLDs), at their moment of occurrence. Thus, the aim of the present study was to test the hypothesis that certain conditions believed to increase demands on phonologic encoding processes will trigger disfluencies. Based on the psycholinguistic theories and models of speech production, the sound regulation condition in this study, although untested previously, is predicted to result in increased disfluency.

Research Questions:

1. Does heightened attention to how specific sounds/phonemes are produced within the context of connected speech, trigger greater levels of disfluent speech?

Based on theoretical models of speech planning and production (Chrysikou et al., 2014; Levelt, 1989), it is hypothesized that the experimental condition will place increased demands on the attentional resources affecting the timely assembly of what is usually an automatic component of retrieving and integrating speech sounds for execution. This added load on the cognitive-linguistic planning system is expected to disrupt the smooth delivery of phonetic strings during speech production, resulting in higher instances of disfluencies.

2. Which types of disfluencies (SLD vs. OD) are triggered in a condition that demands increased attention to phoneme production?

Based on previous studies of fluency disruptions, it is hypothesized that the experimental condition will place greater demands on the planning processes for phonological encoding rather than the grammatical encoding (Levelt, 1989). This proposal can be combined with studies suggesting that instances of Other Disfluencies tend to arise from uncertainties at the level of semantic/syntactic formulation (Smith and Clark, 1993), while instances of Stuttering-like disfluencies tend to arise from uncertainties at the level of phonologic-motoric processes (Smith, Goffman, Sasisekaran, & Weber-Fox, 2012). Therefore, the task of incorporating newly learned sounds into connected speech would be expected to add attentional load for the phonologic-motoric assembly rather than semantic/syntactic assembly, and therefore result in higher instances of Stuttering-Like Disfluencies (SLDs) rather than the Other Disfluencies (ODs).

METHODS

Participants

Participant Characteristics

This study included 20 normally fluent adult college students, 10 males and 10 females. Ages ranged from 18 to 32 years (*M*=20.7, *SD*=3.2). The mean age of the males was 21.2 (*SD*=4.4) years and the mean age of the females was 20.2 (*SD*=1.5) years.

To prevent extraneous variables from affecting performance, eligibility criteria were established to ensure normal levels of cognitive capacity as well as speech, hearing, language, attentional, and reading abilities. For example, all participants had achieved a minimum level of reading competency associated with college-level education. All reportedly had no speech, language, or hearing disorders, and no intellectual disabilities. Finally, none majored in the field of Communication Sciences and Disorders.

Only participants who considered themselves monolingual native speakers of American English (i.e. did not possess native/bilingual fluency in another language) were included in the study. If participants learned another language in school, they were asked about which language/s and their level of proficiency. The included participants reported exposure to languages such as Spanish, German, French, Japanese, Hebrew, Yiddish, and American Sign Language. Yet, none of the participants reported possessing more than a “limited working proficiency” in these languages.

Furthermore, participants who were included had reported no exposure to any of the languages in which the /ʡ/ phoneme (IPA number 173) occurs (i.e. Alyutor, Amis, Archi, Dahalo, Haida, Jah Hut). Similarly, participants had no exposure to the languages in which the

/ʁ/ phoneme (IPA number 121) occurs (i.e. Kele, Kom, Komi-Permyak, Lizu, Medumba, Neverver, Nias, Pará Arára, Pirahã, Pumi, Sercquiais, Titan, Ubykh, Unua, Wari, Sangtam, and the Lebang dialect of Ngwe).

Recruitment Procedures

Email announcements and flyers posted around the University of Wisconsin-Milwaukee campus were used to recruit participants (see Appendix A). Recruitment was also conducted through word of mouth invitations to acquaintances. In addition, this study was advertised through instructors of various University of Wisconsin-Milwaukee courses. Some of these courses offered students bonus points toward their course grade for research participation.

Because speech performance in this study could be affected by hearing, attentional and reading abilities, these skills were screened and minimum criteria were met for participant data to be included. All participants who were included passed a bilateral pure-tone hearing screening responding to at least two out of three presentations via air conduction at 25 dB HL at 1000 Hz, 2000 Hz, and 4000 Hz.

All participants met minimum criteria on the *Attention Index* of the *Repeatable Battery for the Assessment of Neuropsychological Status (RBANS*, Randolph, 1998) by performing better than 1.5 standard deviations below the mean (i.e. a percentile rank above 7). The *RBANS Attention Index* is derived from two subtests, *Digit Span* and *Coding.* The *Digit Span* subtest involves auditory attention processes, and the *Coding* subtest involves visual attention processes. Based on the cut-off criterion described, six potential participants were excluded because their attention performance was lower than 1.5 standard deviations below the mean on the *RBANS* Attention Index. This screening aided in the exclusion of those with deficits in basic attention and timely information processing. The RBANS Index scores of those who qualified as participants ranged from 80 to 116 (*M*=101.9, *SD*=10.8).

Reading abilities were screened based on the number of errors produced on the baseline reading. Participants were included if the error level was fewer than 2% of words (Hubbard, 1998). That is, they made less than 7 errors (substitutions, additions, omissions) on the 330 words in the baseline reading task. Based on this eligibility criterion, four potential participants were excluded due to reading error levels greater than the established 2% criterion (Hubbard, 1998). The number of reading errors produced by those who qualified as participants in the study during the baseline reading task ranged from 0 to 6 errors (*M*=2.1, *SD*=1.9).

Fluency abilities were screened for inclusion based on criteria of less than 3% Stuttering-Like Disfluency (SLD) and less than 7% Other Disfluency (OD) during the baseline reading task (Adams, 1980; Boey, Wuyts, Van den Heyning, De Bodt, & Heylen, 2007; Conture, 2001; Hara, Ozawa, Ishizaka, & Hata, 2015). The frequency of SLDs exhibited by the included participants ranged from 0% (i.e. no SLDs) to 1.5% (i.e. 5 SLDs in 330 words). The frequency of ODs by included participants ranged from 0.3% (i.e. 1 OD) to 3.3% (i.e. 11 ODs). Those who qualified as participants in the study produced a mean of 0.5% SLDs (*SD*=0.5) and 1.2 % ODs (*SD*=0.9) during the baseline reading task. These levels were comparable to levels reported for other normally fluent young adults (White, 2002).

To summarize, in order to obtain 20 eligible participants for this study, a total of 30 individuals were recruited. Ten ineligible people were disqualified for the following reasons: Six were excluded because their attention performance was lower than 1.5 standard deviations below the mean on the *RBANS* Attention Index. Four were excluded due to reading error levels greater than the established 2% criterion (Hubbard, 1998). Among the six who did not pass the attention screening, one would have been excluded on another basis (full proficiency in a second language) and another failed the hearing screening. None were excluded based on the SLD and OD criteria established.

Setting and Equipment

To minimize environmental distractions and ensure recordings free of extraneous noise, all experimental procedures, including screenings were performed in a sound-treated booth inside a closed laboratory room located in Enderis Hall at the University of Wisconsin-Milwaukee on the same floor with the Speech and Language Clinic. In addition, scripted instructions helped ensure the examiner said the same words to each participant. The same recording equipment was calibrated and used to record each participant's session for later analysis. Audio-visual (AV) recordings were made with both a lapel (Shure MX183BP) and omnidirectional microphone (Shure MX393/O), and a Panasonic DMR-T2020 digital color camera, both connected to a Mackie 1202-VLZ PRO mixer transmitting the signal to recording devices. The lapel microphone was positioned approximately 3 inches below the participant's mouth for the oral reading samples. The samples for both the baseline and experimental readings were collected and recorded on high-quality disks and analyzed offline with AV playback software (e.g., VLC media player). Each sample was labeled with a de-identified number as the participant designation.

Study Session Procedures

Before participation in the experimental part of the study, the participants filled out a consent form (see Appendix B) and a demographics form (see Appendix C). The completed consent form documented the participants' agreement to participate in the experimental task despite the possibility of feeling uncomfortable by the challenge of learning a new task. The completed information form provided the researcher with necessary demographic information about the participants, including their exposure to languages other than English. Next, the hearing screening and *RBANS* attention tasks were administered.

Following these, collection of a baseline reading sample was obtained. Performance on the baseline reading not only served as the reference measure to compare the effects of the experimental condition, but also served as the screening for eligibility based on disfluency levels and oral reading error frequency.

The participant sat across the table from the researcher, who delivered instructions from a written script (see appendix D) asking the participant to read the 330-word *Rainbow Passage* (adapted from Fairbanks (1960), see Appendix E) aloud, as he/she normally would. A slightly adapted version of the *Rainbow Passage* was used for this study, substituting a couple of neutral words instead of gender-biased ones (e.g., '*people* have explained' vs. '*men* have explained').

The passage read in baseline and experimental conditions had exactly the same appearance. Because the experimental condition prompted the participant to use new sounds where certain letters were highlighted in yellow and green, this was how the passage looked, regardless of the condition. In the baseline (1^{st}) reading, the participant was told simply to ignore the highlighting in the passage. The researcher offered to answer any questions the participant had generally about the task; however, no other instruction for the baseline task (condition A) was provided.

After the collection of the baseline oral reading sample, the participant was taught the two new sounds, which he/she learned for purposes of the experimental reading condition (condition B). The researcher followed a script (see Appendix F) of standard instructions provided to each participant. This script included the process of teaching two new sounds to the participant. Both of the sounds were consonants that do not exist in the English phoneme inventory (i.e. /ʡ/ and /ʙ/). Each sound was taught one at a time. The participant first listened only to the new sound three times and then imitated each of ten more presentations of the sound. The same computer-generated model of each sound was presented to all participants at the same level of sufficient intensity (about 65dB HL). After learning both sounds, the participant practiced the task of replacing highlighted letters with the newly learned sounds in five words and one sentence (see Appendix G).

Following their learning experience, participants engaged in the experimental reading (condition B) of reading the same passage aloud again, but this time replacing highlighted letters with the two new sounds. The new sounds consisted of the epiglottal plosive, /ʡ/, and the bilabial trill, /ʙ/.

Each participant was instructed to incorporate the new /ʡ/ sound in place of the sounds of letters highlighted in yellow (t's and n's) within the passage (124 times). The "t" letters were only highlighted (yellow) when the original target was a released /t/ allophone. The "n" letters were only highlighted (yellow) when the original target was the /n/ phoneme (this did not include words such as "boiling," which are pronounced with the /ŋ/, rather than the /n/ phoneme). The participant was also instructed to incorporate the newly taught /ʙ/ sound in place of letters highlighted in green (b's and r's) within the passage (85 times). The "b" letter was only highlighted (green) when the original target was a released /b/ allophone (especially no silent letters). The "r" letter was only highlighted (green) when the original target was a released prevocalic /r/ allophone. Specific phonetic targets were chosen as locations for substitutions rather than mere letters, so the task would more appropriately impact the phonological assembly processes. In addition, consonant targets were chosen for substitution with the novel consonant sounds (i.e. /ʡ/ and /ʙ/) because vowels would tend to be less novel, considering their wider allowable allophonic variations across English dialects compared to consonants. Two letter targets (t, n) were highlighted in yellow (to be replaced with /ʡ/) and two letter targets (b, r) were highlighted in green (to be replaced with /ʙ/) to ensure the task involved a sufficiently high number of production replacements.

Finally, participants were reminded to self-monitor their production of the new sounds as they read the passage, imitating models they had heard as closely as possible. Participants were offered an opportunity to ask any last relevant questions about task implementation before they began the 2nd reading in which the new sounds would be substituted.

After the baseline and experimental tasks were performed, participants used a five-point self-rating scale, to rank their level of attention to the task of speaking their sounds during Reading 1 (R1/baseline condition) as compared to Reading 2 (R2/experimental condition) (see Appendix H). On this basis, the examiner confirmed that 19 of the 20 participants indicated they paid a lot more attention to producing their speech sounds in R2 than R1, and 1 participant indicated slightly more attention to producing speech sounds in R2 than R1. The ratings of participant perceptions added to examiner confidence that the second reading had placed greater demands on attention to speech production, as intended.

Post-session Sample Analysis

Dependent Measures

Later after the study session, the researcher listened and viewed the recordings to analyze the numbers of SLDs (i.e. single-syllable whole-word repetitions; single-syllable part word repetitions; dysrhythmic phonations: sound prolongations, tense pauses/glottal blocks, broken words) and ODs (i.e. interjections, revisions, phrase, and multisyllabic word repetitions) per sample (330 words). Another dependent variable measured was the participant's time used for each oral reading, obtained by noting the start time and the end time of each sample reading to the nearest second. The time was converted for an estimate of oral reading rate, in words per minute (wpm), for each reading of the passage. Measures of oral reading rate were of secondary interest to compare the change in speech performance between the baseline and experimental conditions.

Analysis Procedures

A consistent procedure of disfluency analysis was conducted with each participant's sample data. This procedure consisted of listening to each sample at least three times, to mark the transcript focused on a different broad class of disfluencies each time. The first time of listening, the sample transcript was marked only for moments of unambiguous SLDs, indicated by an S placed above the word on which the SLD occurred. Types of SLDs were not specified; however, markings were made for any instance that met the definition of SLD described by Yairi and Ambrose (2005, p.20): "interruptions in the flow of speech in the form of repetitions of parts of words (e.g., sounds and syllables) and monosyllabic words, as well as by disrhythmic phonations –prolongations of sounds and arrests of speech (blocks).” In the case of ambiguous SLDs, a question mark was placed above the associated word, so that these instances could be re-examined later.

The second time of listening, the sample transcript was marked only for moments of unambiguous ODs indicated by an O placed above the word on which the OD occurred. In the case of interjections between words, the location defaulted to the word following the interjection. In the case of revisions and/phrase repetitions, the location defaulted to the word where the start of the revision or phrase repetition occurred. As in the case of SLDs, specific types of ODs were not indicated; however, markings were made for any instance that conformed to the definition of OD by Yairi and Ambrose (2005, p.38): “interjection, revision-incomplete phrase, multisyllabic word, and phrase repetitions.” In the case of questionable ODs, a question mark was placed above the associated word, again so these ambiguous disfluencies could be re-examined later.

The third time of listening to each sample, all initially ambiguous SLDs and ODs were re-examined so decisions could be made. Each location with an ambiguous moment of disfluency was replayed approximately three times to decide whether it fell into the category of SLD, OD, no disfluency, or inconclusive (still ambiguous). If the decision was ‘no disfluency,’ the question mark was erased. If the decision was inconclusive, the question mark remained but was excluded from disfluency counts. If the decision was an SLD, the question mark was replaced with an S, and if the decision was an OD, it was replaced with an O. Only instances classified as SLDs (marked with an S) or ODs (marked with an O), were included in the final analysis of disfluency counts for each reading sample.

The disfluency analysis was conducted as a function of the word locations. This yielded measures of the percentage of words associated with each of the two broad classes of disfluency (SLD and OD). The transcript was not marked for the frequencies of disfluencies irrespective of word locations; instead, markings of an S or an O were constrained by their association with the words in the passage. Thus, although there were times when multiple instances of disfluency in the same broad category (SLD or OD) occurred on the same word, these did not count as additional instances. Consequently, a given word was marked with a maximum of one SLD and one OD.

Overall speaking rate was calculated based on the time it took for each participant to complete the reading from start to finish regardless of pausing or disfluencies that occurred. To obtain the rate, the number of words within *The Rainbow Passage* (i.e. 330) was divided by the time (in seconds) for reading of the passage and then multiplied by 60 (second per minute). Thus, the overall rate measure reflected total time taken to produce the 330-word passage. This rate analysis procedure was similar to methods described by Wendell Johnson who explained that for a verbal output rate measure: "each word repeated singly or in a phrase is counted only once, and interjected sounds or words not regarded as integral parts of the meaningful context are not counted. In any instance of revision only the words in the final forms are counted. The verbal output for the reading passage is always taken as ### words even though some subjects may have omitted or added words" (1961, p.4). As a result, the oral reading rates calculated for this study were influenced by any pausing, extra or deleted words, and/or revisions that may have occurred during both the baseline and experimental reading tasks.

Reliability Measures

Intra- and inter-judge reliability measures were evaluated for both disfluency counts and oral reading times. To assess the intra-judge reliability, 25% of the reading samples were re-evaluated by the same examiner 5-6 weeks after the initial analyses were made. To assess the inter-judge reliability, 25% of the reading samples were reevaluated by a different researcher/research assistant. The 25% of participant samples were selected at random, but with the constraint to re-analyze equal numbers of males and females and equal numbers of R1 and R2 samples.

To calculate indices of reliability, the following formula was used: % agreement = $a/(a+d)100$, where a is the number of agreements, and d is the number of disagreements (Barlow, Hayes and Nelson, 1984).

Interjudge and intrajudge reliability figures greater than 80% were considered satisfactory. See the table of obtained coefficients below:

Table 1
Intra- and Inter-judge Reliability for Stuttering-Like Disfluency (SLD), Other Disfluency (Other), Total Disfluency (Total)

Reliability Type	SLD	Other	Total
Intrajudge	82%	88%	87%
Interjudge	75%	90%	90%

Reliability results, both intra- and inter-judge measures, were relatively strong for both Total disfluencies and Other disfluencies, ranging from 87% to 90%. The measures of SLD reliability were not fully as high but close to the target 80%. In the case of interjudge reliability measures, there was one participant's values for R1 that compared as 0 and 1 SLD, yielding a

0% agreement, averaging into the measure. If that one instance were removed, the SLD interjudge agreement would have risen to 84%. It must be considered that because half of the measures of SLD were from R1, numbers being compared for those passages were all below 10 (criteria set at less than 3% SLDs per words), thus, the same size differences yield lower percentages than when the numbers compared are larger. Thus, all the percentage agreements were considered sufficiently strong to place confidence in data results.

Intra- and inter-judge reliability measures were also made for a random selection of 25% of the participants' passage reading times. Agreement was 99% for both of these measures, with the range of differences between any two measures ranging from 0 to 2 seconds maximum.

Analyses

Measures of central tendency (means, medians, and standard deviations) were examined to compare the two readings for total disfluencies, frequencies of SLDs and ODs, and oral reading rates. The data did not conform to assumptions of the normal distribution, especially as numbers varied greatly across participants and between readings, medians were therefore considered to be the most representative measure of central tendency. A consideration of the range in values and the nature of disfluency data as discrete counts indicated a negative binomial distribution was the most appropriate model for statistical analyses. Other researchers have similarly decided that data involving disfluency instances are better fit to the negative binomial distribution than the normal distribution (Tumanova, Conture, Lambert & Walden, 2014). For the examination of oral reading rates, a Wilcoxon's Signed Rank test was used for comparison of the matched continuous data from R1 and R2.

RESULTS

Effect on Overall Fluency

The first question examined by this study was whether heightened attention to how specific sounds/phonemes are produced within the context of connected speech triggers greater levels of disfluent speech. Analysis of the total number of disfluencies (i.e. Stuttering-Like Disfluency (SLD) and Other Disfluency (OD) combined), produced by participants during the baseline reading (Reading 1) compared to the experimental reading (Reading 2) revealed substantial differences. Disfluency instances were greater in the second experimental reading condition (R2) than in the first baseline reading condition (R1) for every participant. Table 2 reveals that the total number of disfluencies increased from a median average of 4.5 (range 1 to 13) in Reading 1 (R1) to a median average of 52 (range: 4 to 97) in Reading 2 (R2). These differences between readings are also depicted graphically in Figure 2.

Table 2
Total Disfluency Counts Produced by Each Participant in Each Passage (330 words) and Total Disfluency Counts per 100 Words for Baseline Reading 1 (R1) and Experimental Reading 2 (R2)

Participant	Gender	*R1* *Total counts*	*R2* *Total counts*	R1 Total per 100 words	R2 Total per 100 words
1	Male	1	38	0.3	11.5
2	Male	5	56	1.5	17.0
3	Female	1	4	0.3	1.2
4	Female	1	14	0.3	4.2
5	Female	5	47	1.5	14.2
6	Male	13	65	3.9	20.0

7	Female	2	42	0.6	12.7
8	Female	4	46	1.2	13.9
9	Male	9	97	2.7	29.4
10	Male	11	81	3.3	24.5
11	Male	7	48	2.1	14.5
12	Male	12	90	3.6	27.3
13	Male	1	42	0.3	12.7
14	Female	3	48	0.9	14.5
15	Female	2	65	0.6	19.7
16	Female	8	95	2.4	28.8
17	Male	9	95	2.7	28.8
18	Male	10	95	3.0	28.8
19	Female	2	66	0.6	20.0
20	Female	4	39	1.2	11.8
All	Mean (sd)	5.5 (4.0)	58.7 (27.1)	1.7 (1.2)	17.8 (8.2)
All	Median	4.5	52	1.35	15.8

The negative binomial model was used to analyze the differences in total disfluency frequency between readings. More specifically, the model compared relative incidence rates (Hardin & Hilbe, 2007). Medians were compared due to the non-normal data distribution, especially for R1. The average (median) incidence rate of total disfluencies in R2 was approximately 10.66 times greater than in R1, which was significant with a p-value < .0001.

Thus, results showed that the experimental reading (R2) triggered a substantially greater number of disfluencies than the baseline reading (R1).

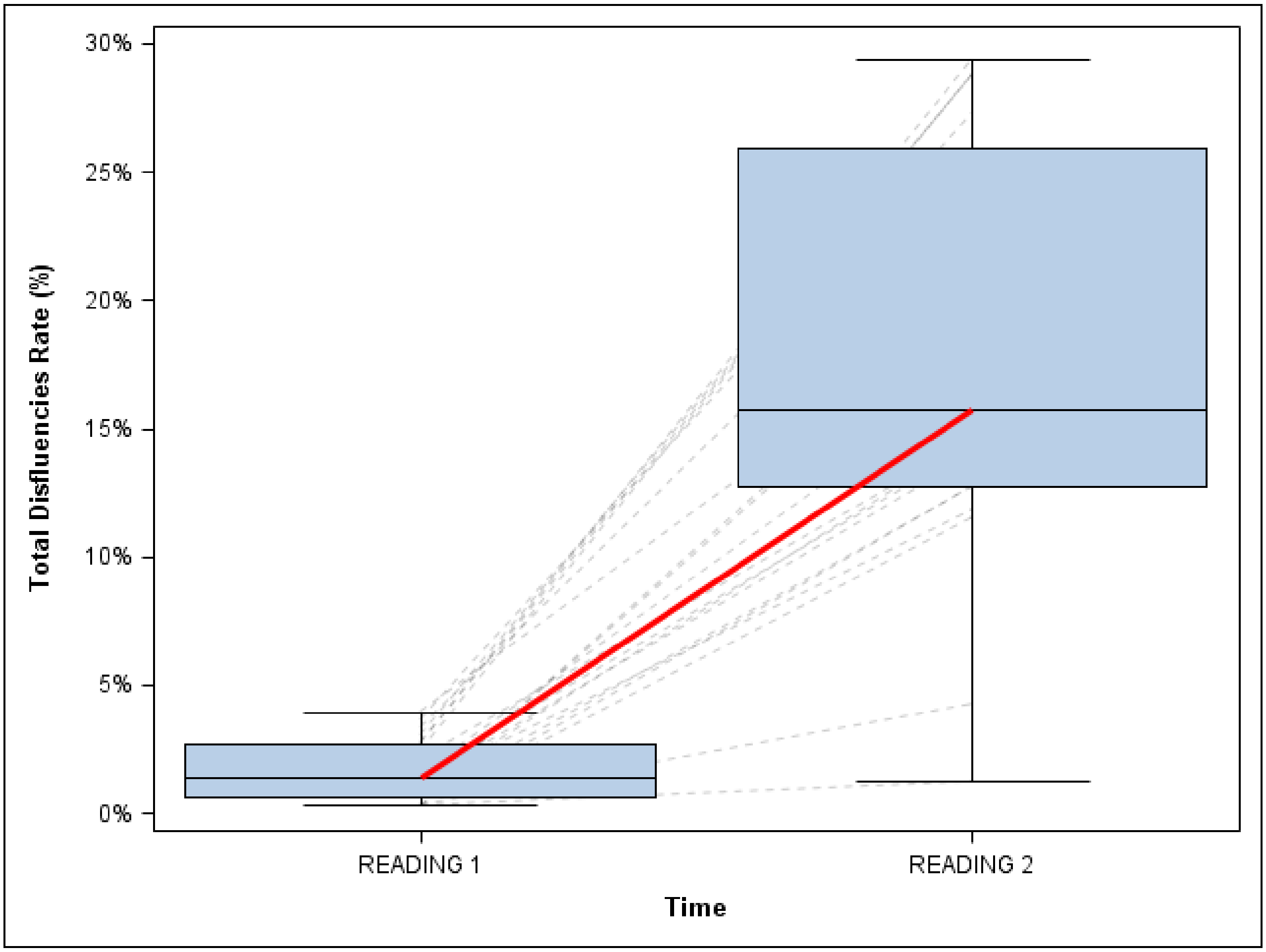

Figure 2. Median total disfluency frequency per 100 words (horizontal dark line) in Reading 1 (left side) compared to Reading 2 (right side). The gray dotted lines represent the individual participants' change in values, while the dark line connects the boxes at the medians of the distributions. The boxes span the standard deviations while the outermost lines span the range.

Effect on SLDs and ODs

The second question was whether the SLDs and ODs were affected differently by the experimental condition. The effect of the experimental condition on the SLDs and ODs were evaluated separately first and then for their relative change.

Effect on SLDs

All participants produced more SLDs in the R2 experimental reading task than in the R1 baseline task. Table 3 reveals that the SLD disfluencies increased from a median average of 1 (range 0 to 5) in R1 to a median average of 28 (range: 3 to 53) in R2. These differences in the SLDs levels in R1 and R2 are also displayed graphically in Figure 3.

Table 3
Participant Frequencies of Stuttering-Like Disfluencies (SLD) per 100 Words in Reading 1 (R1) and Reading 2 (R2)

Participant	Gender	R1 SLD Counts	R2 SLD Counts	R1 SLDs per 100 words	R2 SLDs per 100 words
1	Male	0	17	0.0	5.2
2	Male	3	26	0.9	7.9
3	Female	0	3	0.0	0.9
4	Female	0	5	0.0	1.5
5	Female	1	14	0.3	4.2
6	Male	2	28	0.6	8.5
7	Female	0	16	0.0	4.8

8	Female	1	28	0.3	8.5
9	Male	5	47	1.5	14.2
10	Male	4	43	1.2	13.0
11	Male	1	28	0.3	8.5
12	Male	5	47	1.5	14.2
13	Male	0	19	0.0	5.8
14	Female	0	40	0.0	12.1
15	Female	0	33	0.0	10.0
16	Female	3	48	0.9	14.5
17	Male	3	52	0.9	15.8
18	Male	1	35	0.3	10.6
19	Female	0	53	0.0	16.1
20	Female	2	25	0.6	7.6
All	Mean (sd)	1.6 (1.7)	30.4 (15.6)	0.5 (0.5)	9.2 (4.6)
All	Median	1	28	0.3	8.5

As depicted in Figure 3, the average (median) number of words in the passage associated with SLDs increased from 0.3% (range: 0.0% – 1.5%) in R1 to 8.5% (range: 0.9% – 16.1%) in R2. The analysis of the negative binomial distribution revealed the incidence rate of SLDs in R2 was approximately 19.58 times greater than in R1. The difference was significant with a p-value < .0001.

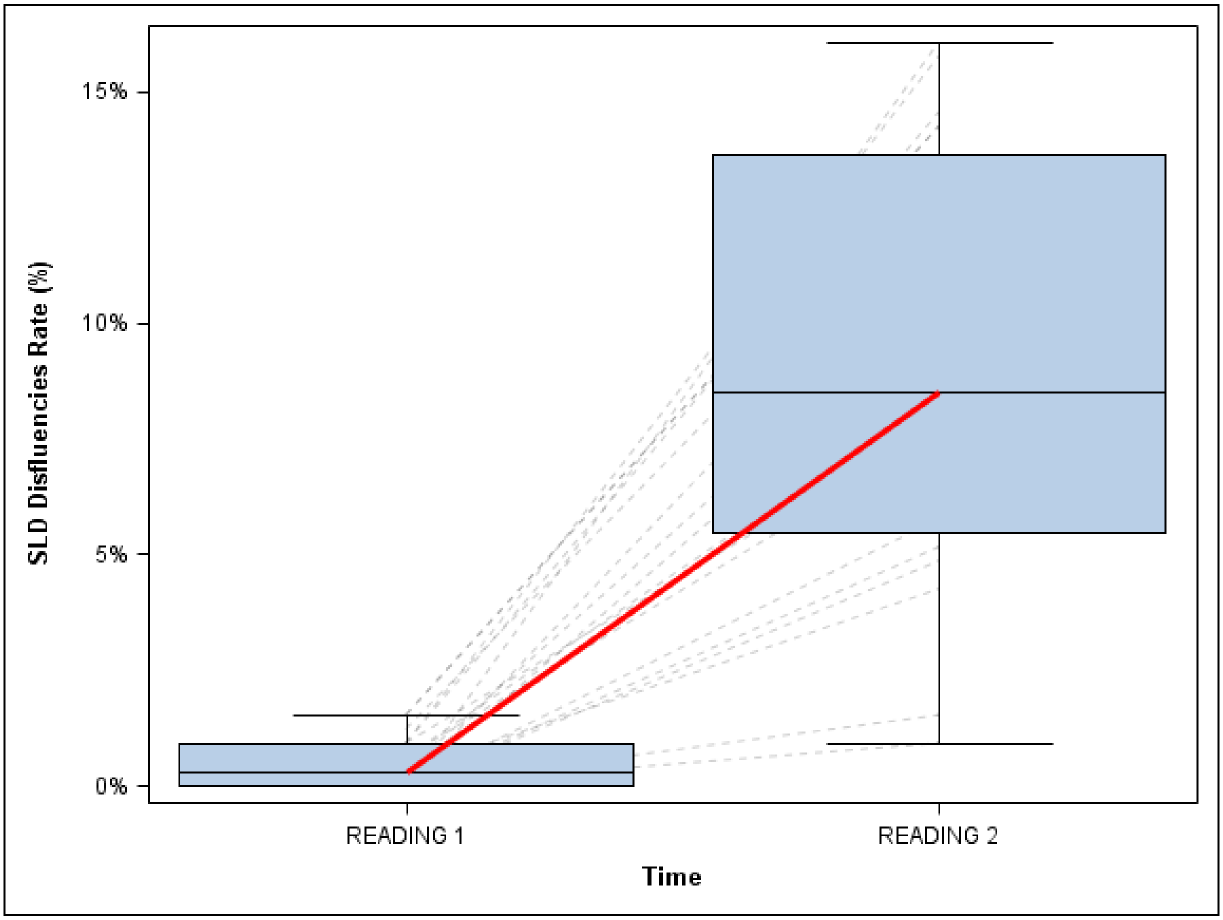

Figure 3. Median Stuttering-Like Disfluency (SLD) frequency per 100 words (horizontal dark line) in Reading 1 (left side) compared to Reading 2 (right side). The gray dotted lines represent the individual participants' change in values, while the dark line connects the boxes at the medians of the distributions. The boxes span the standard deviations while the outermost lines span the range.

Effect on ODs

All but one of the participants produced more ODs in the R2 experimental reading task than in the R1 baseline task. Table 4 reveals that the OD disfluencies increased from a median average of 3 (range 1 to 11) in R1 to a median average of 28 (range: 1 to 60) in R2. These differences in the ODs levels in R1 and R2 are graphically displayed in Figure 4.

Table 4

Participant Frequencies of Other Disfluencies (OD) per 100 words in Reading 1 (R1) and Reading 2 (R2)

Participant	Gender	R1 OD Counts	R2 OD Counts	R1 ODs per 100 words	R2 ODs per 100 words
1	Male	1	21	0.3	6.4
2	Male	2	30	0.6	9.1
3	Female	1	1	0.3	0.3
4	Female	1	9	0.3	2.7
5	Female	4	33	1.2	10.0
6	Male	11	37	3.3	11.2
7	Female	2	26	0.6	7.9
8	Female	3	18	0.9	5.5
9	Male	4	47	1.2	14.2
10	Male	7	38	2.1	11.5
11	Male	6	20	1.8	6.1
12	Male	7	43	2.1	13.0
13	Male	1	23	0.3	7.0
14	Female	3	8	0.9	2.4
15	Female	2	32	0.6	9.7
16	Female	5	47	1.5	14.2
17	Male	6	43	1.8	13.0
18	Male	9	60	2.7	18.2
19	Female	2	13	0.6	3.9

20	Female	2	14	0.6	4.2
All	Mean (sd)	4.0 (2.9)	28.2 (15.5)	1.2 (0.9)	8.5 (4.7)
All	Median	3	28	0.9	8.5

As depicted in Figure 4, the average (median) number of words in the passage associated with ODs increased from 0.9% (range: 0.3% – 3.3%) in R1 to 8.5% (range: 0.3% – 18.2%) in R2. The analysis of the negative binomial distribution revealed the incidence rate of ODs in Reading 2 was approximately 7.13 times greater than in R1. The difference was significant with a p-value < .0001.

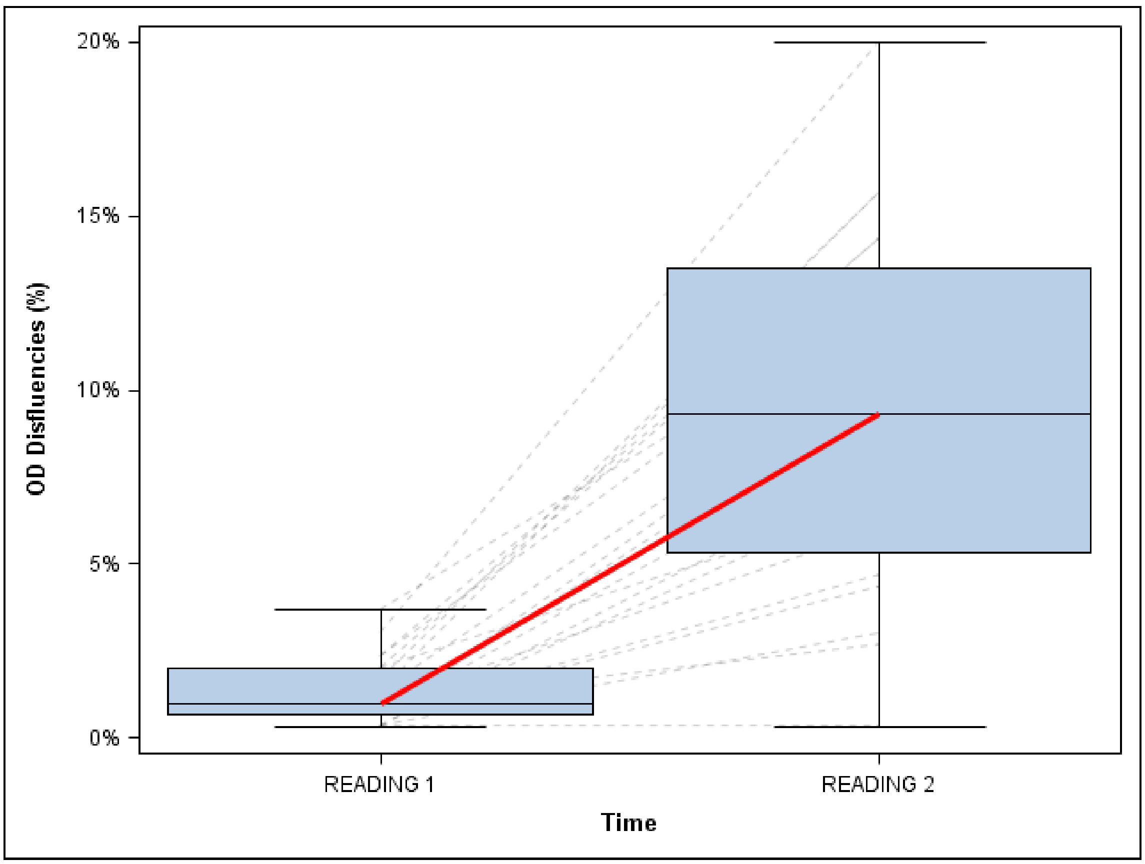

Figure 4. Median Other Disfluency (OD) disfluency frequency per 100 words (horizontal dark line) in Reading 1 (left side) compared to Reading 2 (right side). The gray dotted lines represent the individual participants' change in values, while the dark line connects the boxes at the medians of the distributions. The boxes span the standard deviations while the outermost lines span the range.

Effects of SLDs and ODs Compared

In addition to the separate analyses, the relative changes from R1 to R2 in the frequencies of SLDs and ODs were compared. Comparing the medians for SLD and OD in each condition, it can be seen from Tables 3 and 4 that the number of words associated with SLDs increased from 0.3% to 8.5%, and the number of words associated with ODs increased from 0.9% to 8.5%. These figures suggest that levels of the SLDs and ODs were similar in the R2 condition, but that the increase in the SLDs was somewhat larger than the increase in the ODs.

The negative binomial model revealed that in R1, the incidence of ODs was about 2.55 times greater than the incidence of SLDs, which was significant (p-value <.0001). However, in R2, ODs were only about 0.93 times greater than SLDs (no significant difference between the levels of ODs and SLDs).

The remarkable extent of change in the SLDs from R1 to R2 (19.58 times greater in R2), was a change that was significantly higher (p-value <.0001) than the change in the ODs (7.13 times greater in R2). In other words, while ODs increased significantly by about seven times from R1 to R2, SLDs increased by a much greater extent, nearly 20-fold. Thus, the second reading condition triggered a significantly greater change in SLDs than in ODs.

Secondary Findings

Effect on Oral Reading Rate

Measures of individual performance and central tendency (means, medians and standard deviations) for oral reading rates were additionally compared between the baseline (R1) and experimental (R2) reading tasks. Oral reading rates in terms of both overall time (in seconds) taken to read the passage and estimated words per minute (wpm) for R1 and R2 are depicted in Table 4. It is apparent that oral reading rate decreased for all participants from R1 to R2.

Table 5

Total Seconds Taken to Read Each Passage of 330 Words and Associated Words per Minute (wpm) for Baseline Reading 1 (R1) and Experimental Reading 2 (R2).

Participant	Gender	R1 Total Seconds Taken	R2 Total Seconds Taken	R1 Rate wpm	R2 Rate wpm
1	Male	118.0	436.0	167.8	45.4
2	Male	111.0	620.0	178.4	31.9
3	Female	110.0	404.0	180.0	49.0
4	Female	126.0	405.0	157.1	48.9
5	Female	118.0	549.0	167.8	36.1
6	Male	106.0	423.0	186.8	46.8
7	Female	116.0	532.0	170.7	37.2
8	Female	98.0	437.0	202.0	45.3
9	Male	128.0	623.0	154.7	31.8

10	Male	115.0	422.0	172.2	46.9
11	Male	98.0	345.0	202.0	57.4
12	Male	135.0	497.0	146.7	39.8
13	Male	122.0	781.0	162.3	25.4
14	Female	108.0	553.0	183.3	35.8
15	Female	99.0	578.0	200.0	34.3
16	Female	123.0	612.0	161.0	32.4
17	Male	105.0	380.0	188.6	52.1
18	Male	100.0	287.0	198.0	69.0
19	Female	102.0	420.0	194.1	47.1
20	Female	112.0	444.0	176.8	44.6
All	Mean (sd)	112.5 (10.8)	487.4 (117.4)	177.5 (16.7)	42.9 (10.2)
All	Median	111.5	440.5	177.6	45.0

Parallel to the changes in disfluency levels, the differences in oral reading rates between the baseline reading (R1) and the experimental reading (R2) were large. Table 5 reveals that the median estimated wpm slowed from 177.6 (range 154.7 to 202.0) in R1 to 45 (range 25.4 to 69.0) in R2. The difference in oral reading rate between R1 and R2 was significant based on a Wilcoxon Signed Rank Test (p-value < .0001). Participants took 3.3x longer to read the passage in R2 than in R1.

DISCUSSION

Interpretation of Results

The main purpose of this study was to test the hypothesis that increased attention to speech sound production during oral reading is a possible trigger for instances of disfluency. The results supported this proposition, by showing that typically speaking college students had significantly more disfluency of all types: Other Disfluency (OD) and Stuttering-Like Disfluency (SLD). Although ODs had increased significantly to be seven times greater in the experimental condition than at baseline, the SLDs had increased significantly more than the ODs, to be 20 times greater in the experimental condition than at baseline. The greater increase in the SLDs compared to the ODs in a task of integrating newly learned speech sounds in oral reading, adds support for the hypothesis that when the phonological system is burdened for attention resources to how speech sounds are produced, it impacts the speaker by especially triggering SLDs. Nonetheless, the lesser, but coinciding increase in ODs in the experimental task implies that this same condition also burdens the overall planning of semantic/syntactic structures for connected speech production. Therefore, the interference and added load on these typically automatic assembly processes trigger disruptions of fluent speech that take other, multiple forms.

As may be expected, the total time taken for oral reading in the experimental condition also increased significantly. This was likely due to a combination of two factors. Participants may have slowed down to give the necessary attention to the phonological planning and production task, but also, to the extent that disfluencies were triggered, these instances also added to the duration of the oral reading. It must be recalled that oral reading rates were influenced by instances of pausing, extra or deleted words, and/or revisions that occurred during the baseline and/or experimental reading tasks.

An explanation for the disruption in fluency is provided by theories of speech sound planning. When phonological encoding and articulatory execution processes must assume responsibility for greater attentional resources, the speech fluency system may be over-burdened such that disfluencies increase (Hartsuiker and Kolk, 2001; Howell, 2002; Levelt, 1989; Levelt, Roelofs, & Meyer, 1999). The results of this study also fit with the Matched Filter hypothesis (Chrysikou et al., 2014) which proposes that the performance of typically automatic motor tasks, such as those involved in speech-sound production for connected speech, can be disrupted when cognition takes active control over the usually automatic attentional resources.

The increase in SLDs associated with the task of incorporating newly learned sounds into speech is especially interesting in relation to theories about potential causes of stuttering. While there may be other potential causes of SLDs, the results suggest that one reason for the high prevalence of stuttering in young children could be the burden on their speech processes of integrating articulatory improvements into their phonological productions. The evidence that this type of demand on the speech production system triggers SLDs, also adds support for theories of stuttering including the Demands and Capacities Model (Adams, 1990), the Fault Line Hypothesis (Wingate, 1988), the Neuropsycholinguistic theory (Perkins, Kent, & Curlee, 1991), and the EXPLAN theory (Howell, 2002). These theories propose that disfluencies arise when there is an excessive load on cognitive-linguistic planning processes and are consistent with the idea that too much attention to the planning of speech sounds might be a reason for disruptions of fluent speech.

The results of this study additionally fit well with the findings of studies that have been related to stuttering, processes of attention, and phonological production planning. For instance, research by Kamhi and McOsker (1982) suggested that People Who Stutter (PWS) pay more attention to speech than do Normally Fluent Speakers (NFS). In addition, researchers have looked at memory recall and reaction time of PWS and NFS in a dual-task paradigm and concluded that phonological and cognitive processing is more vulnerable in adults who stutter when cognitive load is increased during attention-demanding tasks (Jones, Fox, Jacewicz, Bacon, & Liss, 2012). In addition, Riley and Riley (1948) reported that a relatively high percentage (27%) of their sampled population of children who stutter experienced deficits related to the reception and manipulation of auditory information. Moreover, Donaher and Richels (2012) found a strong positive relationship between a family history of recovered stuttering and a concomitant diagnosis of ADHD in children who stutter. Lastly, Montgomery and Fitch (1988) found a lower prevalence of stuttering (0.12%) in students with hearing impairments based on their large-scale survey including 9,930 students. If the tendency to listen too closely to the production of speech sounds as they are produced within connected speech does indeed influence the development of stuttering, then this could contribute to a possible explanation for the lower prevalence of stuttering in people with hearing impairments. Without adequate hearing, children might be less inclined or not able to listen closely to their own production of speech sounds while they talk. In general, the results of this study add to the expanding body of research related to phonological capacities, attentional processes, and stuttering.

Although an increase in phonological encoding demands is one explanation for the increased disfluencies, there might be other explanations. For example, it could be argued that task unfamiliarity may impact performance. The experimental condition was unfamiliar and may have induced a greater sense of uncertainty by the participants about how to execute the novel reading task. It must be considered, however, whether a sense of uncertainty would be expressed in various disfluencies or simply slow someone down. Previous research suggests that speaker uncertainty about the content or structure of a message has been linked to ODs rather than SLDs (Smith & Clark, 1993; Brennan & Williams, 1995; Krahmer & Swerts, 2005; Oviatt, 1994; Schachter, Rauscher, Christenfeld, & Tyson Crone, 1994). Hence, although a portion of the increased disfluencies produced during the experimental condition of this study may have been influenced by task uncertainty, this explanation is insufficient to account for the significant increase in SLDs, which were impacted at a proportionately greater extent compared to ODs. It is therefore suspected that beyond task uncertainty, uncertainty within cognitive-linguistic processes was induced by the experimental condition.

Yet despite this deduction, the question remains whether the uncertainty caused by the experimental condition occurred at the semantic-syntactic level, the phonological level, or both levels of cognitive-linguistic processing. If as hypothesized along with the research questions, ODs are related to semantic-syntactic uncertainty (Smith and Clark, 1993) and SLDs to phonologic-motoric uncertainty (Smith, Goffman, Sasisekaran, & Weber-Fox, 2012), then it can be inferred that the experimental condition affected both the semantic and phonologic levels of cognitive-linguistic processing. This conclusion is based on the observation that all types of ODs (revisions, multisyllabic word repetitions, phrase repetitions, and interjections) and all types of SLDs (dysrhythmic phonations, single-syllable word repetitions, and part-word repetitions) were increased in the experimental condition. However, one would expect the task of integrating newly learned sounds into connected speech to specifically add load to the attentional resources for retrieving and executing speech sounds and thus place more demands on the phonological processing level. Perhaps this was demonstrated in the significantly greater rate of increase in SLDs as compared to ODs. Thus, the results of this study supported the idea that uncertainty about the correct phonemic production of sounds can trigger increased SLDs. It can be proposed that this was due to the demands for increased attention and self-monitoring at the phonemic encoding and motoric production levels. For this reason, it can be argued that study results were primarily the result of uncertainty and heightened attention to encoding and motoric processes for the phonological level as opposed to uncertainty at the semantic-syntactic level.

Considering the nature of the experimental task and theories reviewed, the increase in SLDs may be easier to explain than the increase in ODs. One possible explanation for the increase in the ODs in this study is that perhaps they represented adjustments and coping behaviors to be expected in a condition that triggers SLDs. While SLDs may have more directly indicated a breakdown in the speech sound assembly system, perhaps the ODs were an indirect reaction to that breakdown. For example, Prins and Beaudet (1980) suggested that speakers may have choices about how their fluency disruptions are expressed. Perhaps the increase in the ODs represented the speakers' tendencies for adjustments as they reacted to the core instances of fluency failure. Although nearly all participants displayed an increase in both SLDs and ODs, there was one participant whose SLDs increased but whose OD's did not. Perhaps he or she did not react to the condition of increased SLDs in the manner that others did.

Another possible reason that might be proposed for more disfluencies in the experimental condition is that these were an obvious result of participants' attempts to revise their phonemic productions of the new sounds. The disfluencies would, therefore, have arisen at the highlighted locations for substitution with the new sounds. Although a formal analysis was not made of the locations of disfluencies, the examiner noticed SLDs frequently did not occur at the locations of the highlighted sounds within the passage. Therefore, the impression was that these disfluencies arose more from the planning processes underlying the task, rather than from the motor speech act of engaging in the substitutions. What was evident from these observations was that speech planning processes take place in the moments before, not only during, the productions of the sounds.

Implications for Specific Populations

As described, heightened attention to and self-monitoring of the production of sounds during connected speech appears to be the most likely explanation for the increase of disfluency from R1 to R2 in the simulated experimental condition used in this study. It is therefore essential to consider implications for other more natural and frequently occurring situations in which speakers give heightened attention to the production of their phonemes. There are especially three populations for whom this result is important. These include young children who are learning speech, second language learners, and children in articulation therapy. Previous literature has indicated tendencies for increased disfluencies in these three populations.

Early childhood is the time when stuttering onset is most likely. Yairi and Ambrose (2005) report that most stuttering, 85% of cases, begins between the ages of 18 and 42 months. Young children are in the early stages of learning to speak, and phonological errors are commonly seen before age 3. Their on-going speech improvements place high demands on attentional resources as they re-integrate new learning with their previously acquired system. Thus, as demonstrated in the results of the present study, the need for increased attention to incorporating newly learned speech sounds may help to explain young children's tendencies for disfluent speech. Although stuttering instances have been found to coincide more often with locations of greater phonological complexity (Howell, Au-Yeung, & Sackin, 2000; Sasisekaran, 2014; Wolk & LaSalle, 2015), most studies of children who stutter have not revealed stuttering to be associated with specific speech sound errors (Gregg & Yairi, 2007; Wolk, Blomgren & Smith, 2000). It must be pointed out that based on the results of the present study, the general task of system integration related to speech sound acquisition and/or phonological learning, not the specific problem of speech sound accuracy, may be implicated as a source of speech breakdown.

Second language learners across the lifespan constitute another population that is at risk for increased disfluency. Although often classified as mazes, the widespread disfluencies of bilingual speakers consist of both SLDs and ODs (Bedore et al., 2006; Byrd, Bedore, & Ramos, 2015; Lofranco, Peña, & Bedore, 2006; Poulisse, 1999; Tavakoli, 2011). Research on the prevalence of stuttering demonstrates that as compared to monolingual individuals, stuttering is more common and often even more severe in bilingual speakers (Travis, Johnson, & Shover, 1937; Stern, 1948). Second language learners revisit early stages of learning to speak. As with young children, their on-going speech learning, which involves incorporating a new phonology and a new phonological inventory into connected speech, likely increases self-monitoring of and attentional resources to speech sounds while speaking. The present study revealed that a focus on incorporating newly learned speech sounds into connected speech impeded fluency. Thus, if second language learning is associated with increased attention to and self-monitoring of new phoneme productions, these results could help explain the spike in disfluency found in second language learners (Byrd et al., 2015).

Furthermore, if attention to incorporating speech sounds into the overall connected speech production taxes the fluency system in both early learning of speech and learning of a new language, then this raises additional questions about the implication of this study regarding children who experience both these learning conditions simultaneously. The results of the present study could imply that if two languages are introduced to a child from birth, then the demands of incorporating, attending to, and distinguishing between the diverse phonemes and phonology of each language are multiplied in children who start and continue to speak both languages. This might provide insight into why Howell, Davis, and Williams (2009) noticed that there was a lower chance of recovery from stuttering for children who were introduced to a second language since birth as compared to children who were introduced to a second language only after the formative preschool years.

Finally, the results of the present study suggest an increased risk for disfluency in the population of children who focus on incorporating newly learned sounds into connected speech during or after receiving articulation therapy. This adds some level of credence to anecdotal evidence from concerned parents whose children began to stutter during or after speech-language therapy (Hall, 1999-2000; Unicomb, Hewat, Spencer, & Harrison, 2013; Wilder, 2017). Some research also suggests that speech sound disorders (i.e. articulation and phonology disorders) may be the most frequent type of concurrent communication disorder in children who stutter (Blood & Seider, 1981; Louko, 1995; Nippold, 2002; Wolk, Edwards & Conture, 1993). From a study in which speech-language pathologists (SLPs) were surveyed regarding a total of 2,628 school-age children who stutter, the incidence of articulation disorders was more than 33% and the incidence of phonology disorders was more than 12% (Blood, Ridenour, Qualls, & Hammer, 2003). These incidence levels are quite high when compared to those in schoolchildren in general, which varies between 2% and 6% (Beitchman, Nair, Clegg, & Patel, 1986; Conture, 2001; Gierut, 1998). In a “Stuttertalk” interview, Professor Scott Yaruss**,** PhD, CCC-SLP, BCS-F, F-ASHA acknowledged that researchers do not yet fully understand why some children begin to stutter after speech therapy. He further noted that although the three disorders of articulation, phonology, and fluency appear to be closely related, the question of how they are related remains unanswered. The results of the present study might represent a step in the right direction in the quest to answer this question.

Based on the heightened phonological learning demands for these three populations (i.e. children learning to speak, second language learners, and recipients of articulation therapy), it is not surprising to find increased levels of disfluency in speakers who are in these situations of speech-language learning. The present study offers a better understanding of the common demands on the fluency system across these learners. It is therefore also worth considering how to help prevent disorders of fluency for these learners.

Implications for Clinical Application

It follows logically that perhaps the most essential clinical implication of this study is for SLPs to be specifically supportive and preventive of stuttering when working with children who are learning to speak, second language learners, and recipients of articulation therapy. Speech intervention for all types of learners should aim to reduce the weight of attentional demands to the planning and production processes during transfer of new speech sound targets into connected speech. For example, the clinician can model a slow easy manner of moving the articulators as newly learned speech sounds are integrated into a sentence.

The results of this study suggest clinicians would do well to adopt a supportive, preventative style toward fluency when clients practice their new speech sound targets in connected speech. SLPs may want to start with some of the conditions that are known to be fluency-inducing. They may want to encourage learners not to push too hard with time pressure to speak quickly and to make sure the learner is truly ready for transfer of learning to connected speech before that step is attempted (Yairi & Seery, 2015).

It is well-known that certain conditions such as singing and soft whispering often have a fluency-inducing effect for PWS. In consideration of the results of this study, it can be hypothesized that some of these conditions lead to decreased attention to how the specific speech sounds are produced. Perhaps the reason why singing, chorus reading, shadowing, prolonged speech, syllable-timed speech, etc. have a fluency-inducing effect is because they divert attention away from the planning and production of speech sounds and instead direct the speaker's focus toward the larger envelope of the overall speech delivery.

In addition to preventing excessive disfluencies in the three populations described earlier, this study has important implications for treating PWS who additionally require articulation intervention. There will be an exceptional need to support their fluency with the strategies previously described. These results add to cautions against adopting a sequential approach where direct articulation therapy is delivered first followed by fluency therapy for children who have concomitant speech sound and stuttering disorders (Conture, Louko, and Edwards, 1993). Instead, it might be better for fluency to be addressed first or concurrently. Only with a supportive foundation of fluency strategies should treatment for articulation therapy be introduced with care. In addition, fluency needs to be adequately supported all the while that articulation therapy is provided to children who stutter.

Based on the results of the present study, it appears clear that increasing attention to speech sounds by incorporating newly learned sounds into speech places a heavy load on the fluency system. Care must be taken to prevent disfluencies by understanding that the demands of speech sound learning can contribute to the breakdown in fluent speech.

Study Limitations

There are two main sources of the limitations in: aspects of the methodology and knowledge related to appropriate interpretation of the results. These sources of limitations constrain the extent to which confidence may be placed in the conclusions that have been drawn.

One possible limitation could have been an unconscious influence of examiner bias affecting the disfluency analyses. A strong methodology ensures that when examiners conduct analyses, they are blind to the knowledge of which condition they may be analyzing. In this case, the examiner would have done better to analyze samples without knowing if it was from Reading 1 (R1) or Reading 2 (R2). However, this was impossible due to the nature of the experimental reading task, to ignore that in R2, new sounds were replacing old ones. The second reading was clearly distinguishable from the baseline read task. Therefore, there was no way for an examiner to be blind to the purpose of the study, during analysis of the baseline and experimental reading samples. This leaves room for the possibility that examiner expectations for increased disfluencies may have impacted the data. Despite this possibility, no better alternative for testing the present hypothesis could be determined, and thus ideas are needed in future research for how this type of situation can be alleviated.

Another methodological limitation could have been the approach used to analyze the reading samples. In the original analyses, instances of SLDs were listened for first. This first listening of each sample was followed by a second listening during which ODs were identified. According to the research by Williams and Kent (1958), there is a potential for listeners to mark more disfluencies under the category of disfluency which they listen for first. Based on this, it is worth considering whether listening for SLDs first might have led to an inflated number of identified SLDs. To control for this issue, it may have been better to counterbalance the order of analysis by listening for ODs first, and SLDs second, in half of the samples. As a cross-check on whether order could be affecting results, when the examiner conducted the intrajudge reliability analyses, she used the reverse order, listening first for ODs and then SLDs. Despite the reverse procedure, strong levels of reliability (greater than 80%) were obtained, suggesting the data possessed reasonable validity anyway.

The methodology of the study may have introduced a third constraint on interpretation of results, in so far as the nature of the experimental condition itself, must be considered. Although the learning of new sounds might sometimes be as challenging as the task in this study, from another perspective the experimental condition was not as “natural” as most learning conditions. Perhaps a situation of learning and incorporating sounds that come from a language completely outside of a participants’ own phonological system created a remarkably unique level of speech production demands. It is possible that this experimental condition placed even greater demands on the fluency system than what is associated with learning speech sounds for a new language within the same phonological system. If so, then the interpretation of results must be guarded.

An additional methodological limitation was the lack of applying any form of established criteria for accuracy of production during the training of the new speech sounds. This meant it was possible for the different speakers to perform the new sounds with various levels of precision. Different phonetic characteristics of the sounds being produced by the participants along with varying levels of attentional and cognitive-linguistic resources given to the oral reading task could have introduced an uncontrolled factor. Even if there was no objective measure for how much effort and accuracy each participant gave to the production of their newly learned sounds, all 20 participants indicated they gave “a lot more” or “slightly more” attention to their production of speech sounds in the second (vs. baseline) reading task. Actually, all but one indicated “a lot more” attention was given. This strengthened confidence in the interpretation of the experimental task as a condition that placed greater demands on participants’ attentional resources for speech sound production.

Finally, the gaps in scientific knowledge about the details of speech planning and production limit our understanding of the results of this study. As a result of this limited knowledge, caution is needed when implications are drawn from the observation of increased disfluencies in the experimental condition. There is no way to differentiate between whether the breakdown in fluency occurred because of self-monitoring demands, attentional demands, and/or speech-planning processes. Thus, any interpretation of the precise reasons for the effect of the experimental condition is constrained because not enough is known yet about the nature of all the processes involved. Clearly, this condition created demands on several aspects of production planning; however, it is not yet possible to pinpoint the specific process/es on which demands were placed. More research is needed to isolate these components of the speech production system before further interpretation of the results is possible.

Future Research

Expansion of both the methodology and the topic at large represent overarching future research directions associated with the results and implications of the present study. For the current study, criteria were established to limit various aspects of participant characteristics in an effort to control for extraneous variables. However, to expand on the previous methodology, future research might manipulate the controlled variables of participant characteristics and/or aspects of the task and variables measured in relation to speech sound production. By implementing these expansions, future research can add to the knowledge foundation for evidence-based practice by revealing a more exact description of the nature of conditions that trigger speech disfluencies.

The methodology applied in this study may also be varied in other ways. For example, future research, in addition to simply replicating these findings, could involve a larger sample size and wider age range. A larger sample size may also permit examination of gender differences in these results. The current data suggested the impression that gender differences may have existed in the amounts and proportions of increased disfluencies. A better understanding of the contribution of gender in conditions that trigger disfluency may add understanding to the nature of the gender ratio of more males than females who stutter. Another participant population to explore would be backgrounds of wider linguistic diversity. Such studies would add knowledge regarding how previous language exposure (e.g. monolingual, bilingual, multilingual) affects disfluency levels in the condition of heightened attention to speech sound production during oral reading.

Future research may also manipulate the speaking task demands to observe which lengths of stimuli (e.g. words, phrases, sentences, paragraphs) can be impacted by the task demands. In other words, to explore whether the disfluency levels may be impacted by utterance length and complexity. The examiner noticed disfluencies occurring even during the preliminary learning period when participants practiced the novel sounds in 5 isolated words and one sentence that was 10 words in length. Thus, shorter spoken utterances may be sufficient to elicit disfluencies without having to involve a longer oral reading passage (in this case, the Rainbow Passage).

Furthermore, future research is needed to better understand whether different types of disfluencies (SLDs and ODs) are directly related to different types of linguistic demands (phonologic-motoric and semantic-syntactic). It would be helpful to be able to more directly compare the effects on fluency of phonologic-motoric demands versus semantic-syntactic demands. Therefore, future research is needed to find a way of directly comparing the effects of increased phonologic-motoric load (similar to this study) with increased semantic-syntactic load. If equivalent loads could be placed on these different systems to compare the impact on disfluency types, it might be illuminating.

Another direction for future research is to study possible changes in the locations of SLD and OD affected by the experimental condition. An examination could also be made to compare the locations of the disfluencies relative to locations of highlighting within the passage. However, any research to examine the locations of disfluency should consider the characteristics of words that are already known to potentially impact their locations (consonant vs. vowel-initial words, content vs. function words, word length, position in clauses, etc.) to ensure controls of the opportunities for an impact of the multiple factors related to locations. Still, further analyses of the locations of disfluencies, especially to compare possible differences in locations of SLD and OD disfluency types in this experimental task, could yield greater understanding of how the temporal aspects of phonological production planning are associated with speech breakdowns.

Finally, the methodology could be designed to compare the results in a context of conversational speech rather than oral reading. In turn, this information could have implications about the extent to which the various levels of conversation and reading should be supported for preventative and enhanced fluency therapy.

Regarding population variables, future research is needed to better understand the relationship between the disfluencies triggered by this experiment and those seen in stuttering. One step toward this objective would be to conduct this study with participants who stutter. Research has suggested the possibility that normal disfluency and stuttering are connected (Barasch, Guitar, B., McCauley, & Absher, 2000; Bloodstein, 1995). Therefore, it would be interesting to discover whether, and to what extent, this condition of increased attention to speech sound production during connected speech impacts the SLDs and ODs in PWS. However, due to the nature of the condition, one may expect PWS would find it even more challenging than speakers who do not stutter. Researchers must take care to consider the ethics of placing PWS in a condition that may multiply disfluencies and the speaker's mental-emotional distress.

Finally, to better understand the nature of underlying processes involved in the experimental condition of this study, future research may want to conduct a similar study while simultaneously watching brain activity. This information may provide vital information that could aid the understanding of fluency and stuttering. More and more recent brain research on both developmental and neurogenic stuttering is pointing to network activations that span multiple regions, rather than individual specific regions, as holding responsibility for complex functions such as speech fluency (e.g. Theys, De Nil, Thijs, van Wieringen, & Sunaert, 2013). Consequently, it would be very interesting to examine how the experimental condition designed for this study influences the activation of the brain as speakers give heightened attention to new speech sound productions and experience increased disfluencies.

To summarize, this study demonstrated that a condition that heightened participants' attentive self-monitoring to specific speech sounds being spoken during the act of talking, triggered disfluencies; yet future research is needed to understand various potential interactions among other important variables. For example, to shed light on the potential interaction between attention and a tendency for triggered disfluencies, future research could include participants with a wide range of attentional abilities and analyze whether those with varying standard scores of attentional abilities produce different levels of disfluencies in the experimental condition. To shed light on another potential interaction, additional research can compare effects on types of disfluency by a condition that manipulates phonologic demands with a condition that manipulates of semantic-syntactic demands. To shed light on the potential interaction of planning vs. motoric phonological processes and disfluency, future research can look at locations of disfluencies to determine the extent to which they were associated with the location of highlighted sounds. In addition, the stuttering disorder itself represents a disorder beyond the nature of the increased disfluencies that occurred in this study. There is, therefore, a need to further illuminate whether the challenges of speech learning play a role in the development of stuttering.

Although the experimental condition in this study was not a direct variable that instigated the stuttering disorder in the normally fluent adult participants, it was certainly one of the first studies to demonstrate that a specific condition of cognitive-linguistic demands triggers a remarkably consistent and noticeable increase in SLDs and ODs across all participants. Therefore, it generated the discussion of many important implications and served as a springboard for valuable future research topics. Research following the suggested directions should lead to the improved understanding, prevention, and intervention of disfluent speech in the future. Future research with different populations or expanded procedures can specifically explore the connections among stuttering, attentional processes, and phonological production planning.

REFERENCES

Acheson, D. J., & MacDonald, M. C. (2009). Verbal working memory and language production: Common approaches to the serial ordering of verbal information. *Psychological Bulletin*, *135*(1), 50.

Adams, M.R. (1980). The young stutterer: Diagnosis, treatment and assessment of progress. *Seminars in Speech, Language and Hearing 1*,289-299.

Adams, M. R. (1990). The demands and capacities model I: Theoretical elaborations. *Journal of Fluency Disorders*, *15*(3), 135-141.

Alt, M., & Plante, E. (2006). Factors that influence lexical and semantic fast mapping of young children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *49*(5), 941-954.

Ambrose, N. G., & Yairi, E. (1999). Normative disfluency data for early childhood stuttering. *Journal of Speech, Language, and Hearing Research*, *42*(4), 895-909.

Anderson, J. D., Wagovich, S. A., & Hall, N. E. (2006). Nonword repetition skills in young children who do and do not stutter. *Journal of Fluency Disorders*, *31*(3), 177-199.

Andrade, C. R. F. (2004). Fluência. In C. R. F. Andrade, D. M. Béfi-Lopes, H. F. Wertzner, & F. D. M. Fernandes (Eds.), *ABFW – Teste de Linguagem Infantil: nas áreas de fonologia, vocabulário, fluência e pragmática* (2nd ed., pp. 71–94). Barueri: Pró-Fono.

Ardila, A., Ramos, E., & Barrocas, R. (2011). Patterns of stuttering in a Spanish/English bilingual: A case report. *Clinical Linguistics & Phonetics*, *25*(1), 23-36.

Arnold, J. E., Kam, C. L. H., & Tanenhaus, M. K. (2007). If you say thee uh you are describing something hard: the on-line attribution of disfluency during reference comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(5), 914.

Bajaj, A. (2007). Working memory involvement in stuttering: Exploring the evidence and research implications. *Journal of Fluency Disorders*, *32*(3), 218-238.

Barasch, C. T., Guitar, B., McCauley, R. J., & Absher, R. G. (2000). Disfluency and time perception. *Journal of Speech, Language, and Hearing Research*, *43*(6), 1429-1439.

Barlow, D., Hayes, S., & Nelson, R. (1984). *The scientist practitioner: Research and accountability in clinical and educational settings.* Oxford, England: Pergamon Press.

Beattie, G. W., & Butterworth, B. L. (1979). Contextual probability and word frequency as determinants of pauses and errors in spontaneous speech. *Language and Speech*, *22*(3), 201-211.

Bedore, L. M., Fiestas, C. E., Peña, E. D., & Nagy, V. J. (2006). Cross-language comparisons of maze use in Spanish and English in functionally monolingual and bilingual children. *Bilingualism: Language and Cognition*, *9*(3), 233-247.

Beitchman, J. H., Nair, R., Clegg, M., & Patel, P. G. (1986). Prevalence of speech and language disorders in 5-year-old kindergarten children in the Ottawa-Carleton region. *Journal of Speech and Hearing Disorders*, *51*(2), 98-110.

Biber, D., Johansson, S., Leech, G., Conrad, S. & Finegan, E. (1999). *Longman grammar of spoken and written English*. London: Longman.

Bjerkan, B. (1980). Word fragmentations and repetitions in the spontaneous speech of 2–6-yr-old children. *Journal of Fluency Disorders*, *5*(2), 137-148.

Blood, G. W., & Seider, R. (1981). The concomitant problems of young stutterers. *Journal of Speech and Hearing Disorders*, *46*(1), 31-33.

Blood, G. W., Ridenour Jr, V. J., Qualls, C. D., & Hammer, C. S. (2003). Co-occurring disorders in children who stutter. *Journal of Communication Disorders*, *36*(6), 427-448.

Bloodstein, O. (1995*). A handbook on stuttering*. (5th ed.) San Diego; CA: Singular Publ. Group, Inc.

Bluemel, C.S. (1913). *Stammering and cognate defects of speech*. New York: Stechert.

Boehmler, R. M. (1958). Listener responses to nonfluencies. *Journal of Speech & Hearing Research, I,* 132.

Boey, R. A., Wuyts, F. L., Van de Heyning, P. H., De Bodt, M. S., & Heylen, L. (2007). Characteristics of stuttering-like disfluencies in Dutch-speaking children. *Journal of Fluency Disorders*, *32*(4), 310-329.

Boomer, D. S. (1965). Hesitation and grammatical encoding. *Language and Speech*, *8*(3), 148-158.

Bortfeld, H., Leon, S. D., Bloom, J. E., Schober, M. F., & Brennan, S. E. (2001). Disfluency rates in conversation: Effects of age, relationship, topic, role, and gender. *Language and Speech*, *44*(2), 123-147.

Bosshardt, H. G. (1999). Effects of concurrent mental calculation on stuttering, inhalation and speech timing. *Journal of Fluency Disorders*, *24*(1), 43-72.

Bosshardt, H. G. (2002). Effects of concurrent cognitive processing on the fluency of word repetition: Comparison between persons who do and do not stutter. *Journal of Fluency Disorders*, *27*(2), 93-114.

Brennan, S. E., & Williams, M. (1995). The feeling of another′ s knowing: Prosody and filled pauses as cues to listeners about the metacognitive states of speakers. *Journal of Memory and Language*, *34*(3), 383-398.

Brubaker, R. S. (1972). Rate and pause characteristics of oral reading. *Journal of Psycholinguistic Research*, *1*(2), 141-147.

Brundage, S. B., & Ratner, N. B. (1989). Measurement of stuttering frequency in children's speech. *Journal of Fluency Disorders*, *14*(5), 351-358.

Butcher, A. (1981*). Aspects of the speech pause: Phonetic correlates and communicative functions*. Doctoral dissertation, University of Kiel.

Byrd, C. T., Bedore, L. M., & Ramos, D. (2015). The disfluent speech of bilingual Spanish–English children: Considerations for differential diagnosis of stuttering. *Language, speech, and hearing services in schools*, *46*(1), 30-43.

Byrd, C. T., Vallely, M., Anderson, J. D., & Sussman, H. (2012). Nonword repetition and phoneme elision in adults who do and do not stutter. *Journal of Fluency Disorders*, *37*(3), 188-201.

Caruso, A. J., Chodzko-Zajko, W. J., Bidinger, D. A., & Sommers, R. K. (1994). Adults who stutter: Responses to cognitive stress. *Journal of Speech, Language, and Hearing Research*, *37*(4), 746-754.

Chafe, W. (1987). Cognitive constraints on information flow. *Coherence and Grounding in Discourse*, *11*, 21-51.

Chon, H., Kraft, S. J., Zhang, J., Loucks, T., & Ambrose, N. G. (2013). Individual variability in delayed auditory feedback effects on speech fluency and rate in normally fluent adults. *Journal of Speech, Language, and Hearing Research*, *56*(2), 489-504.

Chrysikou, E. G., Weber, M. J., & Thompson-Schill, S. L. (2014). A matched filter hypothesis for cognitive control. *Neuropsychologia*, *62*, 341-355.

Clark, H. H., & Wasow, T. (1998). Repeating words in spontaneous speech. *Cognitive Psychology*, *37*(3), 201-242.

Conture, E. G. (2001). *Stuttering: Its nature, diagnosis, and treatment*. Needham Heights, MA: Allyn & Bacon.

Conture, E., Louko, L., & Edwards, M. L. (1993). Simultaneously treating childhood stuttering and disordered phonology: Experimental therapy, preliminary findings. *American Journal of Speech Language Pathology*, *2*, 72–81.

Dale, P. (1977). Factors related to dysfluent speech in bilingual Cuban-American adolescents. *Journal of Fluency Disorders*, *2*(4), 311-313.

Danzger, M., & Halpern, H. (1973). Relation of stuttering to word abstraction, part of speech, word length, and word frequency. *Perceptual and Motor Skills*, *37*(3), 959-962.

Donaher, J., & Richels, C. (2012). Traits of attention deficit/hyperactivity disorder in school-age children who stutter. *Journal of Fluency Disorders*, *37*(4), 242-252.

Dworzynski, K., Howell, P., & Natke, U. (2003). Predicting stuttering from linguistic factors for German speakers in two age groups. *Journal of Fluency Disorders*, *28*(2), 95-113.

Eichorn, N., Marton, K., Schwartz, R. G., Melara, R. D., & Pirutinsky, S. (2016). Does working memory enhance or interfere with speech fluency in adults who do and do not stutter? Evidence from a dual-task paradigm. *Journal of Speech, Language, and Hearing Research*, *59*(3), 415-429.

Eklund, R. (2004). *Disfluency in Swedish human–human and human–machine travel booking dialogues*. Doctoral dissertation, Linköping University, Linköping, Sweden.

Emerick, L. L. (1963). A Clinical Observation on the 'Final' Stuttering. *Journal of Speech and Hearing Disorders*, *28*(2), 194-195.

Fairbanks, G. (1960). *Voice and Articulation Drill Book*. New York: Harper and Row.

Ferreira, F. (1991). Effects of length and syntactic complexity on initiation times for prepared utterances. *Journal of Memory and Language*, *30*(2), 210-233.

Fox Tree, J. E. (1995) The effects of false starts and repetitions on the processing of subsequent words in spontaneous speech. *Journal of Memory and Language*, *34*(6), 709–738.

Froeschels, E. (1961). New viewpoints on stuttering. *Folia Phoniatrica et Logopaedica*, *13*(3), 187-201.

Fromkin, V. A. (1973). *Speech Errors as Linguistic Evidence*. The Hague: Mouton.

Fudge, E. C. (1969). Syllables. *Journal of linguistics*, *5*(2), 253-286.

Gaines, N. D., Runyan, C. M., & Meyers, S. C. (1991). A comparison of young stutterers' fluent versus stuttered utterances on measures of length and complexity. *Journal of Speech, Language, and Hearing Research*, *34*(1), 37-42.

Gierut, J. A. (1998). Treatment efficacy: Functional phonological disorders in children. *Journal of Speech, Language, and Hearing Research*, *41*(1), S85-S100.

Goldman-Eisler, F. (1968). *Psycholinguistics: Experiments in spontaneous speech*. London: Academic Press.

Gordon, P. A., & Luper, H. L. (1989). Speech disfluencies in nonstutterers: Syntactic complexity and production task effects. *Journal of Fluency Disorders*, *14*(6), 429-445.

Gregg, B. A., & Yairi, E. (2007). Phonological skills and disfluency levels in preschool children who stutter. *Journal of Communication Disorders*, *40*(2), 97-115.

Guitar, B. (2006). *Stuttering: An integrated approach to its nature and management.* Baltimore: Lippincott Williams & Wilkins.

Guitar, B. (2014). *Stuttering: An integrated approach to its nature and treatment*. Philadelphia, PA: Lippincott, Williams & Wilkins.

Hahn, E. F. (1942). A study of the relationship between stuttering occurrence and phonetic factors in oral reading. *Journal of Speech Disorders*, *7*, 143-151.

Hall, N. (1999-2000). Treating co-existing stuttering, language and phonology disorders. *The Stuttering Foundation.* Retrieved 07/19/2019 from https://www.stutteringhelp.org/treating-coexisting-stuttering-language-and-phonology-disorders

Hara, Y., Ozawa, E., Ishizaka, I., & Hata, W. (2015). A study of disfluencies in people who do not stutter estimated using the Assessment of Stuttering. *The Kitasato Medical Journal*, *45*(2), 138-145.

Hardin, J. W., & Hilbe, J. M. (2007). *Generalized linear models and extensions* (2nd ed.). College Station, TX: Stata Press.

Hartsuiker, R. J., & Kolk, H. H. (2001). Error monitoring in speech production: A computational test of the perceptual loop theory. *Cognitive Psychology*, *42*(2), 113-157.

Hartsuiker, R. J. & Notebaert, L. (2010) Lexical access problems lead to disfluencies in speech. *Experimental Psychology,* 57, 169–177.

Heller, D., Arnold, J. E., Klein, N., & Tanenhaus, M. K. (2015). Inferring difficulty: Flexibility in the real-time processing of disfluency. *Language and Speech*, *58*(2), 190-203.

Hincks, R. (2008). *Presenting in English or Swedish: Differences in speaking rate*. Paper presented at the FONETIK 2008, 21-24. The XXIst Swedish Phonetics Conference, University of Gothenburg.

Howell, P. (2002). The EXPLAN theory of fluency control applied to the treatment of stuttering by altered feedback and operant procedures. In: E. Fava (Ed.), *Pathology and Therapy of Speech Disorders*, Amsterdam: John Benjamins.

Howell, P. (2007, July). Development of fluency control and the speech-language interface: The EXPLAN model of fluency control. In *Development and Learning, 2007. ICDL 2007. IEEE 6th International Conference on* (pp. 336-341). IEEE.

Howell, P., Au-Yeung, J., & Sackin, S. (2000). Internal structure of content words leading to lifespan differences in phonological difficulty in stuttering. *Journal of Fluency Disorders*, *25*(1), 1-20.

Howell, P., Davis, S., & Williams, R. (2009). The effects of bilingualism on stuttering during late childhood. *Archives of Disease in Childhood*, *94*(1), 42-46.

Howell, T. A., & Ratner, N. B. (2018). Use of a phoneme monitoring task to examine lexical access in adults who do and do not stutter. *Journal of Fluency Disorders*.

Hubbard, C. (1998). *Speech Errors in Oral Reading of Adults Who Stutter and Do Not Stutter.* Paper presented at the 73rd Annual Convention of the American Speech-Language-Hearing Association, San Antonio, TX.

Hubbard, C. P., & Prins, D. (1994). Word familiarity, syllabic stress pattern, and stuttering. *Journal of Speech, Language, and Hearing Research*, *37*(3), 564-571.

Hubbard, C. P., & Yairi, E. (1988). Clustering of disfluencies in the speech of stuttering and nonstuttering preschool children. *Journal of Speech, Language, and Hearing Research*, *31*(2), 228-233.

Jankelowitz, D. L., & Bortz, M. A. (1996). The interaction of bilingualism and stuttering in an adult. *Journal of Communication Disorders*, *29*(3), 223-234.

Jayaram, M. (1983). Phonetic influences on stuttering in monolingual and bilingual stutterers. *Journal of Communication Disorders*, *16*(4), 287-297.

Jiřelová, K. (2018). *Language transfer and fluency* (Thesis dissertation). Retrieved from https://dspace.cuni.cz/bitstream/handle/20.500.11956/95325/120290169.pdf?sequence=1

Johnson, W. (1961). Measurements of oral reading and speaking rate and disfluency of adult male and female stutterers and nonstutterers. *Journal of Speech and Hearing Disorders, Monograph Supplement*, (7), 1–20.

Johnson, W., & Associates (1959). *The onset of stuttering.* Minneapolis: University of Minnesota Press.

Johnson, W., & Brown, S. F. (1935). Stuttering in relation to various speech sounds. *Quarterly Journal of Speech*, *21*(4), 481-496.

Jones, R.M., Fox, R.A., Jacewicz, E., Bacon, S., & Liss, J. (2012). The Effects of Concurrent Cognitive Load on Phonological Processing in Adults Who Stutter. *Journal of Speech, Language & Hearing Research, 55*(6), 1862-1875.

Juste, F., & Andrade, C. R. (2011). Speech disfluency types of fluent and stuttering individuals: Age effects. *Folia Phoniatrica et Logopaedica, 63*(2), 57-64.

Kamhi, A. G., & McOsker, T. G. (1982). Attention and stuttering: Do stutterers think too much about speech? *Journal of Fluency Disorders, 7*(3), 309-321.

Kelly, E. M., & Conture, E. G. (1992). Speaking rates, response time latencies, and interrupting behaviors of young stutterers, nonstutterers, and their mothers. *Journal of Speech, Language, and Hearing Research, 35*(6), 1256-1267.

Kessler, B., & Treiman, R. (1997). Syllable structure and the distribution of phonemes in English syllables. *Journal of Memory and language, 37*(3), 295-311.

Klapi, E. V. M. M., Lüdeling, A., & Pompino-Marschall, B. (2011). *Disfluency Patterns: A Contrastive Analysis of L1 and L2 Speakers of German* (Doctoral dissertation, Thesis. Humboldt-Universität zu Berlin).

Krahmer, E., & Swerts, M. (2005). How children and adults produce and perceive uncertainty in audiovisual speech. *Language and Speech*, *48*(1), 29-53.

Lennon, P. (1990). Investigating fluency in EFL: A quantitative approach. *Language Learning, 40*(3), 387-417.

Levelt, W. J. (1983). Monitoring and self-repair in speech. *Cognition*, *14*, 41-104.

Levelt, W. J. M. (1989). Speaking. *From intention to articulation.* Cambridge, MA-London: ACL-MIT Press.

Levelt, W. J., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22*(1), 1-38.

Lickley, R. (2001). Dialogue moves and disfluency rates. *In ITRW on Disfluency in Spontaneous Speech*, Edinburgh, Scotland, UK, August 29-31, 2001, pp. 93–96.

Lickley, R. (2017). In Bertini C., Celata C., Lenoci G., Meluzzi C. and Ricci I. (Eds.), *Disfluency in typical and stuttered speech.* Officinaventuno. doi:10.17469/O2103AISV000019

Lim, V. P., Lincoln, M., Chan, Y. H., & Onslow, M. (2008). Stuttering in English–Mandarin bilingual speakers: The influence of language dominance on stuttering severity. *Journal of Speech, Language, and Hearing Research*, *51*(6), 1522-1537.

Loban, W. (1976). *Language development: Kindergarten through grade twelve*. Urbana, IL: National Council of Teachers of English.

Lofranco, L. A. L., Peña, E. D., & Bedore, L. M. (2006). English language narratives of Filipino children. *Language, Speech, and Hearing Services in Schools*, *37*(1), 28-38.

Logan, K. J., & Conture, E. G. (1995). Length, grammatical complexity, and rate differences in stuttered and fluent conversational utterances of children who stutter. *Journal of Fluency Disorders*, *20*(1), 35-61.

Logan, K. J., & Conture, E. G. (1997). Selected temporal, grammatical, and phonological characteristics of conversational utterances produced by children who stutter. *Journal of Speech, Language, and Hearing Research*, *40*(1), 107-120.

Louko, L. J. (1995). Phonological characteristics of young children who stutter. *Topics in Language Disorders, 15,* 48-59.

Louko, L. J., Edwards, M. L., & Conture, E. G. (1999). Treating children who exhibit co-occurring stuttering and disordered phonology. In R. F. Curlee (Ed.), *Stuttering and related disorders of fluency* (2nd ed., pp. 124–138). New York: Thieme Medical Publishers.

Mackay, D. G. (1970). How does language familiarity influence stuttering under delayed auditory feedback? *Perceptual and Motor Skills*, *30*(2), 655-669.

MacKay, D. G., & Bowman, R. W. (1969). On producing the meaning in sentences. *The American Journal of Psychology*, *82*(1), 23-39.

McLaughlin, S. F., & Cullinan, W. L. (1989). Disfluencies, utterance length, and linguistic complexity in nonstuttering children. *Journal of Fluency Disorders*, *14*(1), 17-36.

Melnick, K. S., & Conture, E. G. (2000). Relationship of length and grammatical complexity to the systematic and nonsystematic speech errors and stuttering of children who stutter. *Journal of Fluency Disorders*, *25*(1), 21-45.

Mercer, N. M. (1976). Frequency and availability in the encoding of spontaneous speech. *Language and Speech, 19,* 129-143.

Meyers, S. C. (1986). Qualitative and quantitative differences and patterns of variability in disfluencies emitted by preschool stutterers and nonstutterers during dyadic conversations. *Journal of Fluency Disorders, 11*(4), 293-306.

Meyers, S. C. (1989). Nonfluencies of preschool stutterers and conversational partners: Observing reciprocal relationships. *Journal of Speech and Hearing Disorders*, *54*(1), 106-12.

Monsell, S. (1991). The nature and locus of word frequency effects in reading. In D. Besner and G.W. Humphreys (Eds.), *Basic Processes in Reading: Visual Word Recognition* (pp. 148-197). Hillsdale NJ: Erlbaum.

Montgomery, B. M., & Fitch, J. L. (1988). The prevalence of stuttering in the hearing-impaired school age population. *Journal of Speech and Hearing Disorders*, *53*(2), 131-135.

Nippold, M. A. (2002). Stuttering and phonology: Is there an interaction? *American Journal of Speech-Language Pathology, 11*, 99–110.

O'Connell, D. C., & Kowal, S. (1983). Pausology. In S. Y. Sedelow & W. A. Sedelow (Eds.), *Computers in language research* (Vol. 2). Berlin: De Gruyter.

Oldfield, R.C., & Wingfield, A. (1965). Response latencies in naming objects. *Quarterly Journal of Experimental Psychology 17*(4), 273–281.

Onslow, M., Gardner, K., Bryant, K. M., Stuckings, C. L., & Knight, T. (1992). Stuttered and normal speech events in early childhood: The validity of a behavioral data language. *Journal of Speech, Language, and Hearing Research, 35*(1), 79-87.

Oviatt, S. (1994, April). Interface techniques for minimizing disfluent input to spoken language systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 205-210). ACM.

Oviatt, S. (1995). Predicting spoken disfluencies during human-computer interaction. *Computer Speech and Language, 9*(1), 19-36.

Owens, S. J., Thacker, J. M., & Graham, S. A. (2018). Disfluencies signal reference to novel objects for adults but not children. *Journal of Child Language*, *45*(3), 581-609.

Oyoun, H. A., El Dessouky, H., Shohdi, S., & Fawzy, A. (2010). Assessment of working memory in normal children and children who stutter. *Journal of American Science, 6*(11), 562-6.

Pearl, S. Z., & Bernthal, J. E. (1980). The effect of grammatical complexity upon disfluency behavior of nonstuttering preschool children. *Journal of Fluency Disorders*, *5*(1), 55-68.

Pelczarski, K. M., & Yaruss, J. S. (2016). Phonological memory in young children who stutter. *Journal of Communication Disorders*, *62,* 54-66.

Pellowski, M. W., & Conture, E. G. (2002). Characteristics of speech disfluency and stuttering behaviors in 3-and 4-year-old children. *Journal of Speech, Language, and Hearing Research*, *45*(1), 20-34.

Perkins, W. H. (1990). What is stuttering? *Journal of Speech and Hearing Disorders*, *55*(3), 370-382.

Perkins, W. H., Kent, R. D., & Curlee, R. F. (1991). A theory of neuropsycholinguistic function in stuttering. *Journal of Speech, Language, and Hearing Research*, *34*(4), 734-752.

Poulisse, N. (1999). *Slips of the tongue: Speech errors in first and second language production* (Vol. 20). John Benjamins Publishing.

Prins, D., & Beaudet, R. (1980). Defense preference and stutterers' speech disfluencies: Implications for the nature of the disorder. *Journal of Speech, Language, and Hearing Research*, *23*(4), 757-768.

Randolph, C. (1998). *Repeatable battery for the assessment of neuropsychological status*. San Antonio, TX: The Psychological Corporation.

Ratner, N. B., & Benitez, M. (1985). Linguistic analysis of a bilingual stutterer. *Journal of Fluency Disorders*, *10*(3), 211-219.

Ratner, N. B., & Sih, C. C. (1987). Effects of gradual increases in sentence length and complexity on children's dysfluency. *Journal of Speech and Hearing Disorders*, *52*(3), 278-287.

Rispoli, M., & Hadley, P. (2001). The leading-edge: The significance of sentence disruptions in the development of grammar. *Journal of Speech, Language, and Hearing Research*, *44*(5), 1131-1143.

Riley, G., & Riley, J. (1984). A component model for treating stuttering in children. In M. Peins (Ed.), *Contemporary approaches in stuttering therapy* (pp. 39–71). Boston: Little-Brown.

Sasisekaran, J. (2013). Nonword repetition and nonword reading abilities in adults who do and do not stutter. *Journal of Fluency Disorders, 38*(3), 275-289.

Sasisekaran, J. (2014). Exploring the link between stuttering and phonology: a review and implications for treatment. *Seminars in Speech and Language, 35*(2), 95-113.

Sasisekaran, J., & Weisberg, S. (2014). Practice and retention of nonwords in adults who stutter. *Journal of Fluency Disorders*, *41*, 55-71.

Sasisekaran, J., Smith, A., Sadagopan, N., & Weber-Fox, C. (2010). Nonword repetition in children and adults: Effects on movement coordination. *Developmental Science, 13*(3), 521-532.

Sawyer, J., Chon, H., & Ambrose, N. G. (2008). Influences of rate, length, and complexity on speech disfluency in a single-speech sample in preschool children who stutter. *Journal of Fluency Disorders*, *33*(3), 220-240.

Schachter, S., Christenfeld, N., Ravina, B., & Bilous, F. (1991). Speech disfluency and the structure of knowledge. *Journal of Personality and Social Psychology, 60*(3), 362.

Schachter, S., Rauscher, F., Christenfeld, N., & Tyson Crone, K. T. (1994). The vocabularies of academia. *Psychological Science, 5*(1), 37-41.

Seery, C. H., Watkins, R. V., Ambrose, N., & Throneburg, R. (2006). *Non-word repetition of school-age children who stutter*. Paper presented at the Annual Convention of the American Speech-Language-Hearing Association. Miami, FL.

Selkirk, E. (1982). The syllable. *The structure of phonological representations, 2*, 337-383.

Shriberg, E. E. (1994). *Preliminaries to a theory of speech disfluencies*. Unpublished Ph.D. dissertation, University of California, Berkeley.

Siegman, A. W. (1979). Cognition and hesitation in speech. In A. W. Siegman & S. Feldstein (Eds.), *Of speech and time: Temporal speech patterns in interpersonal contexts* (pp. 151–178). Hillsdale, NJ: Erlbaum.

Smith, A., Goffman, L., Sasisekaran, J., & Weber-Fox, C. (2012). Language and motor abilities of preschool children who stutter: Evidence from behavioral and kinematic indices of nonword repetition performance. *Journal of Fluency Disorders*, *37*(4), 344-358.

Smith, V. L., & Clark, H. H. (1993). On the course of answering questions. *Journal of Memory and Language*, *32*(1), 25-38.

Spencer, C., & Weber-Fox, C. (2014). Preschool speech articulation and nonword repetition abilities may help predict eventual recovery or persistence of stuttering. *Journal of Fluency Disorders*, *41*, 32-46.

Starkweather W. (1987). *Fluency and stuttering*. Englewood Cliffs, NJ: Prentice Hall.

Starkweather, C. W., & Gottwald, S. R. (1990). The demands and capacities model II: Clinical applications. *Journal of Fluency Disorders*, *15*(3), 143-157.

Stern, E. (1948). A preliminary study of bilingualism and stuttering in four Johannesburg schools. *South African Journal of Communication Disorders*, *1*(1), 15-24.

Swerts, M. (1998). Filled pauses as markers of discourse structure. *Journal of Pragmatics*, *30*(4), 485-496.

Swerts, M., & Ostendorf, M. (1997). Prosodic and lexical indications of discourse structure in human-machine interactions. *Speech Communication*, *22*(1), 25-41.

Tavakoli, P. (2011). Pausing patterns: Differences between L2 learners and native speakers. *ELT Journal*, *65*(1), 71-79.

Taylor, I. K. (1966). What words are stuttered? *Psychological Bulletin*, *65*(4), 233.

Theys, C., De Nil, L., Thijs, V., van Wieringen, A., & Sunaert, S. (2013). A crucial role for the cortico-striato-cortical loop in the pathogenesis of stroke-related neurogenic stuttering. *Human Brain Mapping*, *34*(9), 2103-2112.

Travis, L. E., Johnson, W., & Shover, J. (1937). The relation of bilingualism to stuttering: A survey of the East Chicago, Indiana, schools. *Journal of Speech Disorders*, *2*(3), 185-189.

Tumanova, V., Conture, E., Lambert, E. & Walden, T. (2014). Speech disfluencies of preschool-age children who do and do not stutter. *Journal of Communication Disorders*, *49*, 25-41.

Unicomb, R., Hewat, S., Spencer, E., & Harrison, E. (2013). Clinicians' management of young children with co-occurring stuttering and speech sound disorder. *International Journal of Speech-Language Pathology*, *15*(4), 441-452.

Van Borsel, J., Sunaert, R., & Engelen, S. (2005). Speech disruption under delayed auditory feedback in multilingual speakers. *Journal of Fluency Disorders*, *30*(3), 201-217.

Van Riper, C., & Hull C. J. (1955). The quantitative measurement of the effect of certain situations on stuttering. In W. Johnson & R. R. Leutenegger (Eds.), *Stuttering in children and adults* (pp. 199–206) Minneapolis: University of Minnesota Press.

Vasić, N., & Wijnen, F. (2005). Stuttering as a monitoring deficit. In R. J. Hartsuiker, R. Bastiaanse, A. Postma, & F. Wijnen (Eds.), *Phonological encoding and monitoring in normal and pathological speech* (pp. 226–247). Hove, England: Psychology Press.

Wagovich, S. A., & Hall, N. E. (2017). Stuttering frequency in relation to lexical diversity, syntactic complexity, and utterance length. *Communication Disorders Quarterly, 39*(2), 335-345.

Weiss, A. L., & Zebrowski, P. M. (1992). Disfluencies in the conversations of young children who stutter: Some answers about questions. *Journal of Speech, Language, and Hearing Research*, *35*(6), 1230-1238.

Wheeldon, L., & Lahiri, A. (1997). Prosodic units in speech production. *Journal of Memory and Language*, *37*(3), 356-381.

White, E. A. (2002). Normal disfluency in young adults across three speech tasks (Unpublished master's thesis). University of Wisconsin-Milwaukee.

Wilder, L. (2017, April 30). Can therapy cause stuttering? *Canadian Stuttering Association.* Retrieved 7/21/2019 from https://www.stutter.ca/articles/research/457-does-therapy-cause-stuttering.html

Williams, D. E., & Kent, L. R. (1958). Listener evaluations of speech interruptions. *Journal of Speech, Language, and Hearing Research*, *1*(2), 124-131.

Williams, D. E., Silverman, F. H., & Kools, J. A. (1968). Disfluency behavior of elementary school stutterers and non-stutterers: The adaptation effect. *Journal of Speech, Language, and Hearing Research*, *11*(3), 622-630.

Wingate, M. (1988). *The structure of stuttering*. New York: Springer-Verlag.

Wolk, L., Blomgren, M., & Smith, A. B. (2000). The frequency of simultaneous disfluency and phonological errors in children: A preliminary investigation. *Journal of Fluency Disorders*, *25*(4), 269-281.

Wolk, L., Edwards, M. L., & Conture, E. G. (1993). Coexistence of stuttering and disordered phonology in young children. *Journal of Speech, Language, and Hearing Research*, *36*(5), 906-917.

Wolk, L., & LaSalle, L. R. (2015). Phonological complexity in school-aged children who stutter and exhibit a language disorder. *Journal of Fluency Disorders*, *43,* 40-53.

Yairi, E. (1972). Disfluency rates and patterns of stutterers and nonstutterers. *Journal of Communication Disorders*, *5*(3), 225-231.

Yairi, E. (1981). Disfluencies of normally speaking two-year-old children. *Journal of Speech, Language, and Hearing Research*, *24*(4), 490-495.

Yairi, E., & Ambrose, N. (1992). A longitudinal study of stuttering in children: A preliminary report. *Journal of Speech, Language, and Hearing Research*, *35*(4), 755-760.

Yairi, E., & Ambrose, N. (2005). *Early childhood stuttering*. Austin, TX: Pro-Ed.

Yairi, E., & Lewis, B. (1984). Disfluencies at the onset of stuttering. *Journal of Speech, Language, and Hearing Research*, *27*(1), 154-159.

Yairi, E., & Seery, C. H. (2015). *Stuttering: Foundations and clinical applications*. Boston: Pearson.

Yaruss, J. S. (1997). Clinical implications of situational variability in preschool children who stutter. *Journal of Fluency Disorders*, *22*(3), 187-203.

Yaruss, J. S. (1999). Utterance length, syntactic complexity, and childhood stuttering. *Journal of Speech, Language, and Hearing Research*, *42*(2), 329-344.

Yaruss, J. S., Newman, R. M., & Flora, T. (1999). Language and disfluency in nonstuttering children's conversational speech. *Journal of Fluency Disorders*, *24*(3), 185-207.

Zackheim, C. T., & Conture, E. G. (2003). Childhood stuttering and speech disfluencies in relation to children's mean length of utterance: A preliminary study. *Journal of Fluency Disorders*, *28*(2), 115-142.

Zebrowski, P. M. (1991). Duration of the speech disfluencies of beginning stutterers. *Journal of Speech, Language, and Hearing Research*, *34*(3), 483-491.

Zebrowski, P. M., & Conture, E. G. (1989). Judgments of disfluency by mothers of stuttering and normally fluent children. *Journal of Speech, Language, and Hearing Research*, *32*(3), 625-634.

APPENDICES

Appendix A: Recruitment Material

Greetings,

Are you a student between the ages of 18-25 years?

Are you a student in a field that is not communication sciences & disorders?

Then we hope you will be interested in this opportunity to participate in a research study that involves talking and reading aloud.

The purpose of this research is to examine how the speaker’s attention to the production of sounds during speech influences speech output. Participants must have no history of speech, language, hearing, intellectual, or attentional problems and must be monolingual native speakers of American English. In addition, participants must not be familiar with any of the following languages:□ Alyutor □ Amis □ Archi □ Dahalo □ Haida □ Jah Hut □ Kele □ Kom □ Komi-Permyak □ Lizu □ Medumba □ Neverver □ Nias □ Pará Arára □ Pirahã □ Pumi □ Sercquiais □ Titan □ Ubykh □ Unua □ Wari □ Sangtam □ the Lebang dialect of Ngwe

In this study, the participants will read aloud and then incorporate some newly learned sounds into their oral reading, as well as first receive screenings of hearing, attention, and speech fluency in oral reading. The procedures take approximately 30-45 minutes and will be conducted in the UWM Speech and Language Clinic located on the 8th floor of Enderis Hall, room 882.

To set up an appointment, please contact the student principal investigator, Chana Halpern, by phone at (414) 477-9516 or email at chalpern@uwm.edu. If you have questions about this study or would like more information please contact the Chana Halpern or contact the principal investigator, Dr. Seery, by phone at (414) 229-4291 or email at cseery@uwm.edu.

If you know someone who may be interested to participate, please pass this message along!

Thank you,

Chana B. Halpern
UW-Milwaukee Student Principal Investigator
chalpern@uwm.edu | (414)-477-9516
Department of Communication Sciences and Disorders

Study Title: *The Effect of Attention to Self-Regulation of Speech Sound Productions on Speech Fluency in Oral Reading*, IRB # 19.A.209, Approved 02/25/2019 through 02/24/2022

The Fluency Lab in the Communication Sciences and Disorders Department is looking for people to participate in a study in which we will examine how attention to the production of sounds during speech influences speech output.

- **You will:**
- Participate in a hearing screening, and a screening of attentional abilities.
- Read a 330-word passage aloud 2 times.
  - The first time, you will read the passage as you normally would.
  - The second time, you will be asked to replace certain sounds with two new sounds that you will be taught.
- The experiment will take approximately 30-45 minutes.
- The research will take place in the UWM Speech and Language Clinic located on the 8th floor of Enderis Hall, Room 864.
- To participate in the study, you must:
  - be between the ages of 18-25 years.
  - have no history of speech, language, hearing, intellectual, or attentional problems.
  - be attending college.
  - be a monolingual native speaker of American English.
  - pass the hearing screening.
  - pass the screening of fluency, oral reading, and attentional abilities.
  - not have exposure to the following languages: ✧Alyutor, ✧Amis, ✧Archi, ✧Dahalo, ✧Haida, ✧Jah Hut, ✧Kele, ✧Kom, ✧Komi-Permyak, ✧Lizu, ✧Medumba, ✧Neverver, ✧Nias, ✧Pará Arára, ✧Pirahã, ✧Pumi, ✧Sercquiais, ✧Titan, ✧Ubykh, ✧Unua, ✧Wari, ✧Sangtam, ✧the Lebang dialect of Ngwe.
  - not be a student in the field of Communication Sciences and Disorders

If interested, please e-mail chalpern@uwm.edu to set up an appointment.

If you have any questions or want to learn more about the study, please contact Chana Halpern at (414) 477-9516 or at chalpern@uwm.edu.

Appendix B: Consent Form

Study title	The Effect of Attention to Self-Regulation of Speech Sound Productions on Speech Fluency in Oral Reading
Researchers	Chana Halpern, B.S. and faculty advisor, Carol H. Seery, Ph.D., CCC-SLP Department of Communication Sciences and Disorders at the University of Wisconsin-Milwaukee.

We're inviting you to participate in a research study. Participation is completely voluntary. If you agree to participate now, you can always change your mind later. There are no negative consequences, whatever you decide. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What is the purpose of this study?
We want to learn how attention to the production of sounds during speech influences speech output.

What will I do?
For this study you will be asked to:

- Complete an informational demographics and language exposure form. (5 minutes)
- Participate in a hearing screening. (5 minutes)
- Participate in a screening of attentional abilities. (5 minutes)
- Participate in a task in which a 330-word passage is read aloud 2 times.
  - The first time, you will read the passage as you normally would. (5 minutes)
  - The second time, you will be asked to replace certain sounds with two new sounds that you will be taught. (5 minutes)
- Complete a brief rating scale in which you self-assess your level of attention to sounds while reading the passages. (5 minutes)

The procedures will take approximately 30 minutes to complete.

Risks

Possible risks	**How we're minimizing these risks**
The feelings of uncertainty and discomfort that are common when someone attempts to learn a new task	Tell us about any discomfort you feel. We want to reassure you it is natural and common to feel some level of discomfort about learning and doing a new task that is unfamiliar. We will remind you about the option to withdraw at any time without negative consequences if the task is too uncomfortable for you.
During the new reading tasks, participants may temporarily experience that reading is harder than usual. Participants may find it challenging, may make speech mistakes &/or have speech disfluencies.	Tell us about any discomfort you feel about how hard the tasks are. We want to reassure you it is natural and common to experience the tasks as hard. We encourage you to understand that the mistakes, disfluencies and challenge you may experience during these tasks is a temporary discomfort. We will remind you about the option to withdraw at any time without negative consequences if the task is too uncomfortable for you.

Breach of confidentiality (your data being seen by someone who shouldn't have access to it)	• We'll keep your identifying information separate from your research data, but we'll be able to link it to you by using a study ID. We will destroy this link after we finish analyzing the data. • Any sort of report made public will not include any information that will make it possible to identify you. • Research records will be kept in a locked file in a locked room, and any E-records in password protected paths; only the researchers/research assistants will have access to the records. • The video and audio recordings will be destroyed after they have been analyzed, unless you consent to the use of these recordings for educational purposes (see Consent Form II).

There may be risks we don't know about yet. Throughout the study, we'll tell you if we learn anything that might affect your decision to participate.

Other Study Information

Possible benefits	• The satisfaction of contributing to scientific knowledge • The educational experience gained by participation in research • The possibility that this research will improve future services for those who need to learn new speech tasks
Estimated number of participants	20
How long will it take?	Approximately 30 minutes
Costs	None
Compensation	None
Future research	The de-identified (all identifying information removed) data may be analyzed in greater depth in the future. You will not know specific details about these future analyses, if they should occur.
Recordings / Photographs	We will be making audiovisual recordings of you for later review and analysis by the examiners and student laboratory assistants. The recording is necessary to this research. If you do not want to be recorded, you should not be in this study.
Removal from the study	In order to prevent unwanted variables from affecting our data, it is important that participants have similar levels of cognitive capacity as well as speech, hearing, language, and reading abilities. Therefore, you will only be included in this study if you: - have no history of speech, language, hearing, intellectual, or attentional problems - pass a hearing screening - pass a screening of attentional abilities - are between the ages of 18-35 years

	- are attending college - are a monolingual native speaker of American English - pass screenings of oral reading fluency - have not studied communication sciences & disorders
Funding source	N/A

Confidentiality and Data Security

We'll collect the following identifying information for the research: your name, gender identification, and age. This information is necessary to ensuring that we select a representative sample of participants for our study and to help determine if you meet the selection criteria.

Where will data be stored?	Kept in a locked file in a locked room and on a password secured university network drive accessible only to the researcher, mentor and/or research assistants associated with this project.
How long will it be kept?	3 years or until publications associated with this project have been finalized

Who can see my data?	**Why?**	**Type of data**
The researchers	To conduct the study and analyze the data	Coded (names removed and labeled with a study ID)
The IRB (Institutional Review Board) at UWM The Office for Human Research Protections (OHRP) or other federal agencies	To ensure we're following laws and ethical guidelines	Coded (names removed and labeled with a study ID)
Anyone (public)	If we share our findings in publications or presentations	• De-identified (no names, birthdate, address, etc.) • If we quote you, we'll use a pseudonym (fake name) • Aggregate (grouped) data

Contact information:

For questions about the research	1. Dr. Carol H. Seery, Ph.D., CCC-SLP 2. Chana Halpern, B.S.	1. cseery@uwm.edu or 414-229-4291 2. chalpern@uwm.edu or at (414) 477-9516
	IRB (Institutional Review Board; provides ethics oversight)	414-229-3173 / irbinfo@uwm.edu

For questions about your rights as a research participant **For complaints or problems**	1. Dr. Carol H. Seery, Ph.D., CCC-SLP 2. Chana Halpern, B.S.	1. cseery@uwm.edu or 414-229-4291 2. chalpern@uwm.edu or at (414) 477-9516

Signatures

If you have had all your questions answered and would like to participate in this study, sign on the lines below. Remember, your participation is completely voluntary, and you're free to withdraw from the study at any time. The decision to withdraw will not affect how you are treated or result in any penalty or loss of benefits to which you are usually entitled (e.g., clinical or educational services at UWM). If a participant withdraws from the study, partial data may be analyzed and held in secure storage until completion of the research. Upon your request at any time however, data could be destroyed immediately (i.e., audiovisual recordings erased, computer files deleted, paper documents shredded).

____

Name of Participant (print)

_______________________________________ ______________

Signature of Participant Date

____

Name of Researcher obtaining consent (print)

_______________________________________ ______________

Signature of Researcher obtaining consent Date

The Effect of Attention to Self-Regulation of Speech Sound Productions on Speech Fluency in Oral Reading

Consent Form II: PERMISSION FOR EDUCATIONAL USE OF AUDIOVISUAL RECORDINGS:

I agree to the educational use of the audiovisual recordings obtained in this study. I understand that these recordings will be viewed only by students of speech-language pathology learning to identify features of speech. I understand that personal identities (names) will not be disclosed under any circumstances; however, it remains a possibility that someone could be recognized if there was an acquaintance.

This agreement to the use of the audiovisual recordings for educational purposes is completely optional and voluntary. You may decline this permission at any time. The decision to decline will not affect how you are treated or result in any penalty or loss of benefits to which you are usually entitled (e.g., clinical or educational services at UWM).

Statement of Consent: I have read the above information and have received answers to any questions I asked. I consent to the educational use of the audio/video recordings collected for this study.

Your Signature ____ Date _____________

Your Name (printed) ____

Signature of person obtaining consent ____

Date _____________________

Printed name of person obtaining consent ____

Contact information:
Dr. Carol Hubbard Seery
Dept. of Communication Sciences and Disorders
University of Wisconsin-Milwaukee
2400 E. Hartford Ave., P.O. Box 413, Enderis Hall 853
Milwaukee, WI 53201
(414) 229-4291

If you have any complaints about your treatment as a participant in this study, please call or write:

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

The Institutional Review Board may ask your name, but all complaints are kept in confidence.

Code: ______________________________ Date____________________

Gender identification: ☐ Male ☐ Female ☐ Other

Age: _____

Have you ever had any speech or language disorders? ☐ Yes ☐ No

Have you ever had any hearing disorders? ☐ Yes ☐ No

Have you ever had any intellectual or attentional disabilities? ☐ Yes ☐ No

Are you a monolingual native English speaker? ☐ Yes ☐ No

Have you had **exposure** to any of the following languages?

Alyutor ☐ Yes ☐ No

Amis ☐ Yes ☐ No

Archi ☐ Yes ☐ No

Dahalo ☐ Yes ☐ No

Haida ☐ Yes ☐ No

Jah Hut ☐ Yes ☐ No

Kele ☐ Yes ☐ No

Kom ☐ Yes ☐ No

Komi-Permyak ☐ Yes ☐ No

Lizu ☐ Yes ☐ No

Medumba ☐ Yes ☐ No

Neverver ☐ Yes ☐ No

Nias ☐ Yes ☐ No

Pará Arára ☐ Yes ☐ No

Pirahã ☐ Yes ☐ No

Pumi ☐ Yes ☐ No

Sercquiais ☐ Yes ☐ No

Titan ☐ Yes ☐ No

Ubykh ☐ Yes ☐ No

Unua ☐ Yes ☐ No

Wari ☐ Yes ☐ No

Sangtam ☐ Yes ☐ No

Lebang dialect of Ngwe ☐ Yes ☐ No

Have you had **exposure** to any other languages besides English that were not listed above?
☐ Yes ☐ No

If "Yes," please indicate the other language(s) to which you have been exposed below:

____

If "Yes," please indicate your level of proficiency in the language(s) to which you have been exposed:

☐ Elementary Proficiency ☐ Limited Working Proficiency ☐ Professional Working Proficiency ☐ Full Professional Proficiency

Script for Condition A (Baseline):

Please read this written passage out loud as you normally would read any other written material. You may notice that some of the letters are highlighted. This highlighting does not have significance for this reading task. You can ignore the highlighting and simply read the passage aloud.

Key: Green= /ʙ/ yellow = /ʡ/

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow. Throughout the centuries people have explained the rainbow in various ways. Some have accepted it as a miracle without physical explanation. To the Hebrews it was a token that there would be no more universal floods. The Greeks used to imagine that it was a sign from the gods to foretell war or heavy rain. The Norsemen considered the rainbow as a bridge over which the gods passed from earth to their home in the sky. Others have tried to explain the phenomenon physically. Aristotle thought that the rainbow was caused by reflection of the sun's rays by the rain. Since then physicists have found that it is not reflection, but refraction by the raindrops which causes the rainbow. Many complicated ideas about the rainbow have been formed. The difference in the rainbow depends considerably upon the size of the water drops, and the width of the colored band increases as the size of the drops increases. The actual primary rainbow observed is said to be the effect of superposition of a number of bows. If the red of the second bow falls upon the green of the first, the result is to give a bow with an abnormally wide yellow band, since red and green lights when mixed form yellow. This is a very common type of bow, one showing mainly red and yellow, with little or no green or blue.

[**The Rainbow Passage:** Adapted from Fairbanks (1960): *Voice and Articulation Drill Book*]

Script for Condition B (Attention to Sounds):

I am going to teach you two sounds that do not occur in the English language. First, I will let you listen to each sound three times. The man saying the sounds says the new sound followed by the vowel /a/ and then in between two /a/ vowels. Although the /a/ sound is being said in the model, when it is time for you to imitate the sound, your job will be to only imitate the new consonant and not the vowel.

Now I will present the sound. All you need to do is listen, especially to the consonant, without repeating yet.

*** at this point the researcher will let the participant listen to the audio recorded production of the /ʁ/ phoneme 3 times.

I will present the recording another 10 times. Every time I present the recording I want you to try to repeat the new sound to the best of your ability immediately after you hear it. I will check if you are producing the target with relative accuracy.

*** at this point the researcher will present the recording another ten times. After each presentation, the participant should try to produce the new sound. If the participant says the consonant together with the vowel sound, they will be reminded to say the consonant in isolation, without the vowel.

Now let us do the same for one more new sound. First, listen 10 times.

*** at this point the researcher will let the participant listen to the audio recorded production of the /ʔ/ phoneme 10 times.

Just like we did for the other sound, I will present the recording another 10 times. Every time I present the recording I want you to try to repeat the new sound to the best of your ability.

*** at this point the researcher will present the recording another ten times. After each presentation, the participant should try to produce the new sound. If the participant says the consonant together with the vowel sound, they will be reminded to say the consonant in isolation, without the vowel.

Now I want you to read the Rainbow Passage aloud again. This time every time you see the "t" or "n" highlighted in yellow replace it with the /ʔ/ sound (play the recording to indicate which sound). In addition, every time there is a "b" or "r" sound that is highlighted in green replace it with the /ʁ/ sound (play the recording to indicate which sound). Again, remember only replace it with the new sound and not the extra vowels.

Your task is to self-monitor and replace target sounds with the new sounds to the best of your ability.

Do you have any questions?

Two New Sounds:

/ʙ/ /ʡ/

Practice:

Boat

Rabbit

Brand

Tom

Tornado

Today, I biked and rowed a boat in the park.

ID Code: _________________ **Date: __________________**

Self-Rating Scale of Attention to Speaking the Sounds

Comparison of Readings 1 and 2

During **the first reading** task (R1), you were asked to read the passage normally, and ignore the highlighting, how hard did you pay attention to making your speech sounds? During **the second reading** task (R2), you were asked to replace highlighted sounds with two new sounds you were taught, how hard did you pay attention to making your speech sounds?

Please compare the two readings (R1 and R2) for how much attention you paid to making your speech sounds by rating it below:

(put a check or x on the circle corresponding to your rating)

Making my speech sounds was done with. . .

a lot more attention in: R1 > R2	slightly more attention in: R1 > R2	about the same attention in: R1 = R2	slightly more attention in: R2 > R1	a lot more attention in: R2 > R1