THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF COMMUNICATION SCIENCES AND DISORDERS

AN EXPLORATION OF PHONETIC COMPLEXITY IN ADULTS WHO STUTTER

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SPRING 2020

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree in Communication Sciences and Disorders
with honors in Communication Sciences and Disorders

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ABSTRACT

Stuttering is a communication disorder in which sounds, syllables, or words are repeated, stopped, or prolonged, interrupting the natural flow of speech (Logan, 2015). These disruptions in speech may be accompanied by secondary behaviors, including rapid eye blinking or lip tremors. Stuttering can make it difficult for an individual to communicate, which often affects quality of life. The cause of this disorder has no current consensus; however, several theories have been suggested. The EXPLAN theory, proposed by Howell (2004), suggests that the planning (PLAN) and execution (EX) of speech are independent processes that reflect motor and linguistic levels. In order to confirm this theory, additional research is required to evaluate the influence of phonetic complexity on the planning and execution of speech surrounding a moment of stuttering.

The purpose of the present study is to investigate the influence of phonetic complexity in stuttering moments of adults who stutter (AWS). The phonetic product (PP) estimator, developed by Bauer (1988) was utilized in order to observe the relationship between phonetic complexity and stuttering behavior. Conversational speech samples of a group of 10 AWS served as the database. Across the first 200-words of each speech sample, the individual moments of stuttering were identified, as well as the word immediately preceding and following the moment of stuttering. A phonetic product was calculated for each word. The results indicated a significant difference between the PP of the pre-stuttered and stuttered words. This study provides support for the EXPLAN theory as evidenced by the influence of word phonetic complexity on moments of stuttering.

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ACKNOWLEDGEMENTS

I would like to thank my thesis supervisor, Dr. Michael Robb, for his unwavering support and encouragement throughout this research project. His immense knowledge in the field of communication disorders has provided me with valuable insight and inspiration for research in the future. It has been an honor to work with him.

I would also like to extend my thanks to my honors advisor, Dr. Carol Miller, for her advice and support throughout my academic endeavors. I appreciate her input in helping me complete my undergraduate thesis.

My sincere thanks goes to Mrs. Cindy Lafond, the Speech-Language Pathologist that I shadowed at Putnam Elementary School. Her passion for helping children with communication disorders has inspired me to pursue the path of becoming a speech therapist in a school setting.

Thank you to the Schreyer Honors College for the privilege to represent The Pennsylvania State University as an honors scholar. I am proud to be a part of such a prestigious organization.

Lastly, I would like to thank my family and friends for their continued support throughout my time as an undergraduate student. Without them, all that I have accomplished so far in my academic career would not have been possible.

Chapter 1

Introduction

Communication Disorder

A communication disorder is defined as an impairment in the ability to receive, send, process, and comprehend concepts or verbal, nonverbal, and graphic symbol systems (ASHA, 1993). There are a range of communication disorders that affect speech sound production, language organization, hearing, and central auditory processing. Individuals across the lifespan may exhibit one or any combination of these disorders. The severity of a communication disorder can range from mild to severe. Communication disorders can be organized according to two categories: acquired and developmental. Acquired communication disorders are not present at birth and include impairments in speech due to brain trauma, strokes, or neurodegenerative diseases. Developmental communication disorders are present or occur shortly after birth and include speech disorders such as stuttering.

Stuttering

Fluency is defined as the effortless flow of speech, which includes the rate/speed of talking, the inclusion of pauses between words and at the conclusion of utterances, as well as the natural rhythmic characteristics of speech (Logan, 2015). When there is an alteration in any of these features, disfluency occurs. We all produce disfluent speech and include speech patterns such as hesitations and interjections (um, er, well, you know). These typical disfluencies are not considered to be a form of stuttering. However, when there is an over-abundance of these disfluencies paired with sound repetitions (such as *l-l-l-like*) or sound prolongations (such as *ssssssssssoup*), a fluency disorder occurs. A fluency disorder can be defined as interruptions in the flow of speaking characterized by atypical rate, rhythm, and repetitions in sounds, syllables, words, and phrases (ASHA, 1993). The most common type of fluency disorder is stuttering. Stuttering is a speech disorder characterized by a breakdown in the forward flow of speech. In addition to repetition of sounds, syllables or words and prolongation of sounds, an interruption in speech known as blocks is a common feature of stuttering (NIDCD, 2017). These disfluencies may also be accompanied by associated behaviors such as physical facial movements (e.g., eye blinks, mouth/jaw tension) or word avoidance (ASHA, 1999).

Stuttering is possibly the most observable speech disorder in the range of communication disorders, which occurs in 1% of the population. One of the earliest reports of stuttering can be traced back centuries to Demosthenes (384-322 B.C.), who is recognized as one of the greatest Ancient Greek orators. At the beginning of his oratorical career, he had an obvious speech impairment, which created difficulty when addressing the public. Attempting to overcome his speech disfluency, he adopted exercises such as reciting speeches with pebbles in his mouth (Cicurel & Shvarts, 2003). Although he eventually reached success in a position that required the ability to exceptionally speak, he most likely never overcame his stutter, avoiding opportunities to speak spontaneously and having all his speeches well-rehearsed in advance. However, his case remains relevant today when researching possible theories as to how and why stuttering occurs.

Theories of Stuttering

There are a number of theories proposed regarding the cause of stuttering. One of the classic theories of stuttering was proposed by Wendell Johnson in the early 1940s. His theory can be referred to as the diagnosogenic or semantogenic theory, which looks at the possibility of stuttering being a learned behavior emerging from the normal disfluencies of childhood (Silverman, 1988). Childhood speech can be characterized by normal repetitions and other various speech hesitations. There appears to be a significant difference in speech development of a child depending on whether or not a diagnosis is made in attempt to characterize normal repetitions and other hesitations. This theory assumes that a young child could be made to stutter by having someone (such as a parent) diagnose normal disfluency behavior as abnormal and indicating to this child, verbally or nonverbally, directly or indirectly, to speak with less hesitation. The theory has since been refuted based on more current research indicating that stuttering is not a learned behavior (Yairi & Seery, 2015).

A physiological theory of stuttering was developed by Max, Caruso, and Gracco (2003). These researchers led a study exploring neuromotor differences between people who stutter and people who do not stutter. Examining speech movements, orofacial nonspeech movements, and finger movements, it was discovered that timing measures are sensitive and provide evidence for motor deficits in people who stutter. Furthermore, Smith and Kleinow (2000) analyzed articulatory kinematics to determine if AWS have poorer speech movement patterns and if changing speech rate affects their stability in the same way it affects normally fluent controls. Overall, their results show the kinematic characteristics of the fluent speech of AWS overlap fluent speakers, but are also susceptible to speech motor breakdowns when performance demands increase.

There are also several linguistic theories of stuttering. Early research conducted by Brown (1945) established four basic types of words that are likely to be disfluently spoken by AWS , which are content (rather than function) words, long words, words positioned early in a sentence, and words that begin with a consonant. Linguistically, all four of these factors increased semantic difficulty, leading to the idea of these certain characteristics influencing the likelihood of a stuttering moment (Brown, 1945). In addition to this linguistic finding, it has been found that multisyllabic words are more likely to be stuttered upon compared to monosyllabic words, however the specific types of sounds and sound combinations has received limited research attention (Prins, Hubbard, & Krause, 1991).

Howell (2004) proposed the EXPLAN Theory of stuttering. The general idea of this theory suggests that the planning (PLAN) and execution (EX) of speech are independent processes that reflect motor and linguistic levels. A stuttering moment may occur when the plan of the word about to be produced is not ready at the exact time that the execution of the previous word has been concluded. Failures within the PLAN and EX processes lead to speech disfluencies when plans are supplied to the motor system too late, speaking to the exact timing necessary for optimum functioning/planning of the motor speech system (Wolk & LaSalle, 2013). Two types of disruption in fluency occur in this theory: stalling and advancement. Stalling involves a tactic where the person who stutters either repeats an entire word or phrase immediately before the word that is more phonetically difficult to produce. That is, the word that is stuttered upon is less phonetically complex than the neighboring word. The advancing form of stuttering occurs on words that are more phonetically complex and are characterized by initial sound repetitions or prolongations/blocks. Phonetic levels in the planning system have been examined within this theory, suggesting a deficit with phonetic difficulty in speech output.

The EXPLAN theory proposed by Howell (2004) has not been critically evaluated. In order to confirm this theory, additional research is required to examine the influence of phonetic complexity on a moment of stuttering. Phonetic complexity is the intrinsic difficulty of the speech sounds of a language, hierarchical constituents of word-level speech planning and production (Wolk and LaSalle, 2013). This includes distinctive features, as well as segmental, syllabic, and prosodic structures. Johnson and Brown (1935) were the first propose that the more difficult a phonological unit (e.g. word) is, the more likely a word will be produced disfluently.

To further look into phonetic complexity, Wolk, Blomgren, and Smith (2000) led a study with preschool-aged boys as participants using a conversational speech task. Their findings showed more disfluencies on initial consonant clusters with phonological errors as opposed to clusters without phonological errors. This suggests phonological complexity may intensify disfluencies in this population, being that consonant clusters are more complex than singletons (Wolk et al., 2000). Additionally, Howell, Au-Yeung, and Slackin (2000) investigated whether stuttering frequency was affected by factors that specify the phonological difficulty of sounds and if there were influences across multiple age groups. Phonological factors that were examined include whether the word contained a late emerging consonant and whether the word contained a consonant string. It was discovered that the effects of phonetic difficulty are more apparent in older speakers who stutter compared to younger speakers. Overall, these studies strongly suggest that phonetic complexity influences motor execution and speech planning, which then provides evidence for the EXPLAN model.

The EXPLAN model also accounts for the pattern of stuttering on content and function words demonstrated by children and adults. Content words are words that carry meaning, such as nouns, verbs, and adjectives. Function words carry grammatical meaning, such as articles and prepositions. A well-known observation is that children tend to stutter more often on function words, while adults stutter on content words (Howell, Au-Yeung, & Slackin, 1999). Presumably, content words are most problematic for both children and adults. However, children tend to stutter on the word preceding the content word, whereas an adult will stutter directly on the content word. If the mental plan for speech formulation is built from left to right, the likely reason the child stutters on the function word is due to anticipation of the upcoming content word. Adults abandon this strategy, leading to the stuttering moment to occur on the content word. Missing from this theory is a closer examination of the phonetic complexity of the words surrounding a moment of stuttering. A possible drawback with the EXPLAN theory is the examination of the relationship between the phonetic complexity of a stuttered word in comparison to the word preceding the stuttered word. Further, there have been no attempts to examine the phonetic complexity of words immediately following the stuttered word.

Phonetic Complexity

Over three decades ago, a measure of phonetic complexity was developed by Bauer (1988). He created a measure known as the phonetic product (PP) estimator to examine the development of phonetic complexity in the speech of young children. The PP measure is a sensitive indicator as it reflects phonetic characteristics of consonants and vowels related to the place/position spatial differences and children's normative acquisition of American English relative to phonetic class proportions (Bauer, 1988). The PP can be measured for either individual words or entire speech utterances using this general equation:

$$\boldsymbol{PP}=[(\sum Cb+1)(\sum Ca+1)(\sum Cp+1)(\sum Cv+1)(\sum Cg+1)(\sum Vf+1)(\sum Vc+1)(\sum Vb+1)]$$

This equation considers consonant (C) articulation according to five places of articulation: bilabial (Cb), apical (Ca), palatal (Cp), velar (Cv), and glottal (Cg) (Stowers, Robb, & Zebrowski, 2009). Three tongue advancement categories evaluate vowel articulation: front (Vf), central (Vc), and back (Vb). Weighting values can be assigned to each consonant and vowel categories based on the occurrence of each sound in American English conversations. The PP equation with the actual frequency weightings is as follows:

$$\boldsymbol{PP}=[(\sum Cb)(.1658)+1](\sum Ca)(.3149)+1](\sum Cp)(.01129)+1](\sum Cv)(.04945)+1](\sum Cg)(.04945)+1]$$
$$(\sum Vf)(.18)+1](\sum Vc)(.1431)+1](\sum Vb(.0709)+1)]$$

An example of how the PP is calculated is provided for the word "spoon," phonetically transcribed as /spun/. In this example, there are two apical consonants (Ca), specifically /s/ and /n/. There is one bilabial consonant (Cb), which is /p, and one back vowel (Vb), /u/. The resulting PP value for this word is 2.03.

Research conducted by Bauer and Robb (1992) provided validation for the PP estimator. To test the hypothesis that the PP is an early developmental indicator of increasing phonetic diversity, two groups of typically developing infants from Omaha, NE and Syracuse, NY were studied. The PP results of these two groups show a trend of increasing phonetic complexity, affirming the ethological model of phonetic development. This means that the PP equation is developmentally appropriate and a valid measure of phonetic complexity. A measure such as the PP seems to be ideal metric to examine the phonetic complexity of words produced by people who stutter. The measure would also be useful to address the EXPLAN theory proposed by Howell (2004).

The Present Study

Previous research has suggested phonetic complexity is a crucial variable in stuttering moments in AWS. According to the EXPLAN theory, people who stutter exhibit a stalling behavior (i.e, moment of stuttering) prior to words that are more phonetically complex, such as content words. As a means of validating the EXPLAN theory, the present study examined the relationship between phonetic complexity and stuttering behavior by using the PP estimator developed by Bauer (1988). The research question posed in this study was whether the phonetic complexity of words differed between stuttered words and words immediately adjacent to the stuttered word. The hypothesis to be tested was:

1. The phonetic complexity of a stuttered word will be significantly higher than the neighboring word.

Chapter 2

Method

Participants

Participants were 10 native, monolingual English AWS. Eight males and two females were drawn from the open access data base called FluencyBank for participation in the study. The website for FluencyBank is: https://fluency.talkbank.org. All were speakers of American English, and had normal hearing, speech, and language skills aside from stuttering. The participants ranged in age from 24 to 64 years (M = 46.2 years). All participants were rated on stuttering severity using a 10-point self-rating stuttering severity scale, where 0 corresponds to no stutter and 9 corresponds to a very severe stutter. (O'Brien, Packman, & Onslow, 2004). The participants were interviewed individually, received the same interview questions, and transcripts for each interview were typed orthographically online. The general characteristics of the participants for this study are displayed in Table 1.

Speech Sampling

The data used in the present study were based on a 200-word spontaneous interview speech sample obtained from FluencyBank. The sample was first transcribed orthographically within the transcript of the interview. A total of 20 stuttering moments (repetitions and blocks) were accounted for and then phonetically transcribed for each individual, along with the word occurring immediately before and after the moment, using the symbols of the International Phonetic Alphabet (IPA). The IPA transcripts for each word were then sorted according to place of articulation (consonants) and tongue advancement (vowel) categories.

Table 1. Group of 10 AWS participants, their sex, age, stuttering severity (0-9 rating scale), and whether the participants received speech therapy for their disfluency. Standard deviations are shown in parentheses.

Participant	**Sex**	**Age**	**Severity**	**Previous Therapy**
AWS1	M	68	6	Yes
AWS2	F	50	4	Yes
AWS3	M	64	2	Yes
AWS4	M	55	5	Yes
AWS5	M	60	4	Yes
AWS6	F	24	6	Yes
AWS7	M	34	7	Yes
AWS8	M	25	9	Yes
AWS9	M	47	2	Yes
AWS10	M	35	5	Yes
Group		46.2 (15.96)	5 (2.16)	

Phonetic Complexity

An average phonetic complexity value for production of stuttered words, as well as the word immediately preceding and following the stuttered word, was calculated for every participant for the present study. The phonetic product (PP) was calculated using the PP estimator developed by Bauer (1988). Once the analyses were completed for the individual participants, an overall mean PP was calculated for the AWS group as a whole.

Statistical Analyses

To examine whether the group PP values differed according to word location, an analysis of variance (ANOVA) test was performed. The within-group factor was PP and the between-group factor was word location. In the event of a significant difference identified with the ANOVA test, a series of post-hoc t-tests were performed. A series of Pearson product-moment correlates were also performed to evaluate the relationship between stuttering severity and phonetic complexity.

Chapter 3

Results

PP Analysis

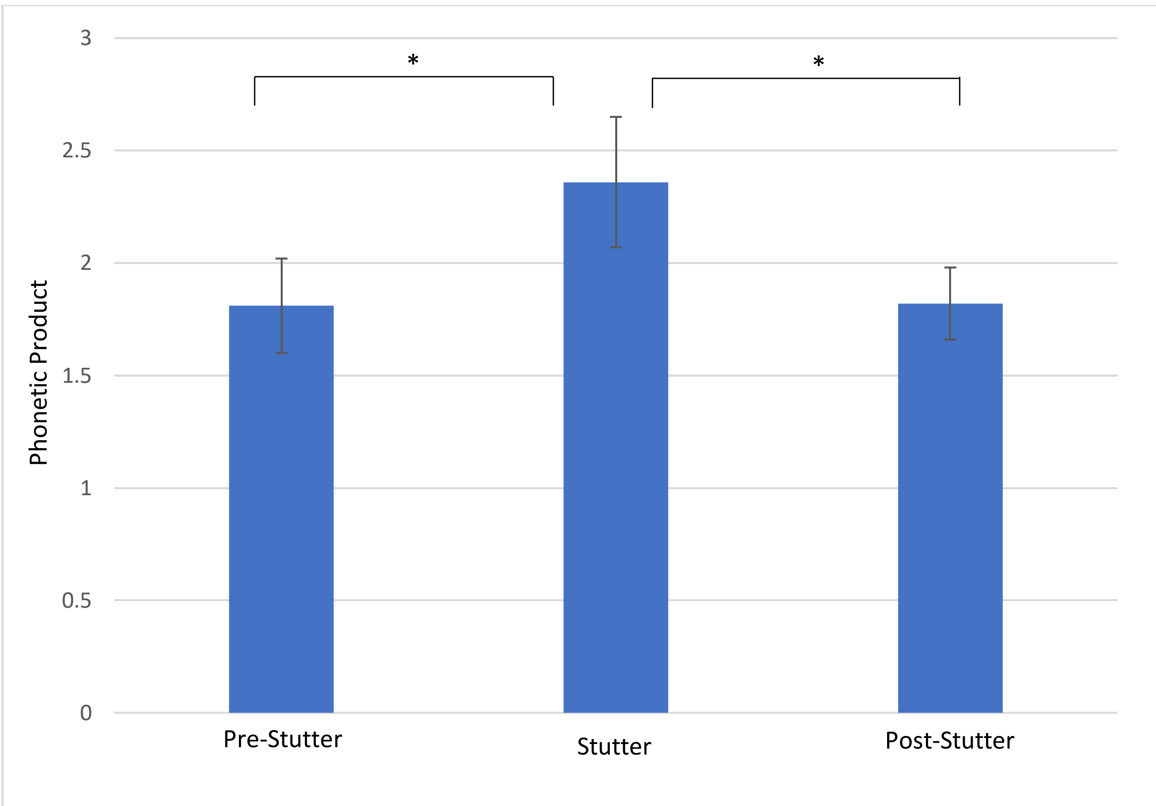
Results of the calculation of PP for AWS are listed in Table 2 and displayed in Figure 1. Across the AWS participants, PP values for pre-stuttered words ranged from 1.63 to 2.26, with a mean of 1.81 ($SD = 0.21$). For stuttered words, PP ranged from 2.01 to 2.84, with a mean of 2.36 ($SD = 0.29$). PP values for the post-stuttered word ranged from 1.56 to 2.09, with a mean of 1.83 ($SD = 0.16$).

In order to evaluate whether the average PP differed between the pre-stuttered, stuttered, and post-stuttered words, a one-way ANOVA was performed. The results of the ANOVA were significant ($F = 16.7$, $p < 0.0001$). Follow-up Tukey tests were performed. A significant difference was found between the average pre-stuttered and stuttered words ($p < 0.01$), indicating a high phonetic product for the stuttered word. There was also a significant difference between the average PP values of the stuttered and post-stuttered words ($p < 0.01$), indicating a high phonetic product for the stuttered word. There was no significant difference between the PP values of the pre-stuttered and post-stuttered words.

Table 2. Individual mean phonetic products of each AWS participant for the production pre-stuttered, stuttered, and post-stuttered words. Standard deviations are shown in parentheses.

Participant	Pre-Stutter	Stutter	Post-Stutter
AWS1	1.67 (0.31)	2.84 (0.93)	1.79 (0.69)
AWS2	1.70 (0.59)	2.79 (1.02)	1.93 (0.57)
AWS3	1.67 (0.44)	2.36 (0.82)	1.78 (0.68)
AWS4	2.26 (0.53)	2.24 (1.02)	2.03 (0.68)
AWS5	1.84 (0.49)	2.20 (0.92)	1.69 (0.40)
AWS6	1.73 (0.31)	2.57 (1.14)	1.56 (0.29)
AWS7	2.09 (0.89)	2.01 (0.88)	1.86 (0.72)
AWS8	1.63 (0.29)	2.28 (0.87)	1.73 (0.54)
AWS9	1.69 (0.57)	2.29 (0.97)	2.09 (0.94)
AWS10	1.78 (0.41)	2.02 (0.76)	1.79 (0.57)
Group	1.81 (0.21)	2.36 (0.29)	1.83 (0.16)

Figure 1. Phonetic product values for the 10 AWS participants. These values reflect the overall average phonetic complexity of the pre-stuttered, stuttered, and post-stuttered words. The * denotes a significant difference on phonetic product composites.



Correlational Analysis

Three correlations were performed to evaluate the relationship between stuttering severity and phonetic complexity. The correlation between the stuttering severity score and average PP values was non-significant for pre-stuttered words ($r = 0.13$, $p > 0.05$). For stuttered words, the stuttering severity scores and average PP scores were also not significantly correlated ($r = 0.065$, $p > 0.05$). Finally, the stuttering severity scores and average PP values for post-stuttered words were not significantly correlated ($r = -0.42$, $p > 0.05$).

Word Categories

A further analysis of the words pre-stuttered, stuttered, and post-stuttered was performed by categorizing them as either content or function words (Table 3). The types of words produced for pre-stuttered words were almost evenly split between content words (47%) and function words (53%). Content words accounted for 154 disfluencies and function words accounted for 46 disfluencies for the stuttered word. Approximately 77% of all stuttered words occurred in content words, with 23% occurring in function words. The pattern for word-type found for post-stuttered words closely resembled that found for pre-stuttered words. Content words comprised of 43.5%, of the post-stuttered word sample, and function words accounted for 56.5%. Stuttered words were found to be made up of content words, whereas pre-stuttered and post-stuttered words were found to be mainly function words.

Table 3. Group distribution of pre-stuttered, stuttered, and post-stuttered words based on word type.

	Pre-Stutter	**Stutter**	**Post-Stutter**
Content Words	94 (47%)	154 (77%)	87 (43.5%)
Function Words	106 (53%)	46 (23%)	113 (56.5%)
Total	200	200	200

Summary of Major Findings

In summary, major findings of the present study are as followed:

1. There was a significant difference in the phonetic complexity of pre-stuttered and stuttered words.
2. There was a significant difference in the phonetic complexity of stuttered and post-stuttered words.
3. There was no significant difference in the phonetic complexity between pre-stuttered and post-stuttered words.
4. Stuttered words largely consisted of content words rather than function words.

Chapter 4

Discussion

Purpose

The purpose of this study was to examine whether the phonetic complexity of a stuttered word is significantly higher than the neighboring word. A measure of phonetic complexity (PP) taken from Bauer (1988) was used to test the EXPLAN theory (Howell, 2004). The speech samples of 10 AWS were measured for moments of stuttering, as well as the PP of words stuttered and the words immediately preceding and following a stutter. The hypothesis posed was that the phonetic complexity of the stuttered word will be significantly higher than the words surrounding the stuttering moment. Based on the results of the study, it was found that the phonetic complexity of stuttered words was significantly higher compared to the pre- and post-stuttered words. Accordingly, the hypothesis was accepted.

EXPLAN Theory

The current results provide support for the EXPLAN theory (Howell, 2004). The theory states that there are planning (PLAN) and execution (EX) moments of stuttering. Stuttering occurs most often on content words, the reason being that content words occur more often in language, are longer in duration, and assumedly more phonetically complex (Brown, 1945). On the basis of this theory, the phonetic complexity of the stuttered word, as well as the words preceding and immediately following this word were examined. An interesting finding was the distribution of content and function words in the speech sample. Stuttered words were primarily made up of content words, whereas the preceding and post-stuttered words were equally divided between the two semantic categories. It is not clear what the relationship is between the moment of stuttering with content and function words, being that they were evenly split. It is possible that stuttering moments are not dependent on whether the word is a content or function word, rather how phonetically complex the word is. There may be a stronger influence of how phonetically complex the word is rather than its semantic category.

Limitations

There are some limitations to the present study that need to be considered when evaluating the results. For example, the number of participants in the study was small. This research only looked at 10 AWS participants so it is possible there was too much variability across the group. A larger sample size would be needed in order to ensure greater statistical power, and thereby more conclusive results and accurate representation of AWS. In future studies, more participants should be examined in order for the results to be generalized to the population of AWS.

Another limitation is the speech sample size from the participants itself, which may have prevented group trends from being identified. A spontaneous 200-word interview was evaluated and 20 moments of stuttering were accounted for in this study. Future research within the area of phonetic complexity should evaluate a larger speech sample from each participant. A larger amount of stuttering moments should be accounted for within the speech sample. In addition to this, a larger sample would also broaden the word types and phonetic complexity of words found within the speech sample.

Lastly, this study should also be conducted with children who stutter to examine if there is a difference in the relationship between phonetic complexity and stuttering moments. According to the EXPLAN theory, a difference between content and function words with stuttering moments could be examined, as well, being that children tend to stutter more on function words. Additional research should evaluate speech samples of children and account for stuttering moments within this population to compare to the results found in this study.

Clinical Implications

The current results provide a basis of information related to both the assessment and management of AWS. Using phonetically complex words for assessment purposes could allow the Speech-Language Pathologist (SLP) to see how vulnerable the person's fluent speech is to words of high complexity. This contributes to the management of AWS, allowing the SLP to work with the speaker on easing into phonetically complex words over time.

Furthermore, this study may contribute to clinical relevance when working with AWS. Based on the results of the study, there is a high likelihood that a stuttering moment will occur on a content word, especially one with high phonetic complexity. SLPs working with AWS may adapt therapeutic approaches to promote fluency of speech, depending on the speaker. Avoiding words with high phonetic complexity may be easier for the speaker by promoting more fluent speech. By substituting a word with less phonetic complexity, the difficult word for the individual is evaded, which could lead to more smooth speech. Conversely, working on words with high phonetic complexity could benefit the speaker. With more practice with phonetically complex words, the stuttering moment could be worked through, given more experience with these difficult words.

Future Directions

It would be worthwhile to explore the relationship between the individual sounds that comprise the stuttering moment and the word preceding the stuttering moment. A more detailed examination of the phonetic makeup of the stuttered word and the word immediately before the stuttering moment would assist to considering the linguistic components associated with stuttering. Taking a deeper look into exactly what sounds comprise the pre-stuttered and stuttered word could explain a pattern of stuttering among AWS. For instance, if the phonetic makeup of the stuttered word is more complex, perhaps the individual sounds within the word influence the moment of stuttering rather than the semantic category of the word. Future research within this area should analyze the individual sounds and their categories to see if there is a pattern among what sounds are more difficult for the person who stutters.

Another way to further explore this idea would be to examine the manner of the sounds produced in the vocal tract. The PP estimator developed by Bauer (1988) accounts for changes in place of articulation, such as bilabial, alveolar, and palatal sounds. However, some individual sounds have the same phonetic complexity but different manners of articulation. For example, words like /so/ and /toʊ/ both have one consonant in the alveolar place of articulation (/s/ and /t/) and one sound in the back vowel place of articulation (/oʊ/). These words have the same phonetic complexity of 1.41. Yet, /s/ and /t/ are two different manners of articulation, /s/ being a fricative and /t/ being a voiceless stop. This could possibly influence the stuttering moments of AWS, showing phonetic complexity within each type of sound itself. Developing a way to estimate the phonetic complexity of each manner of articulation is an idea for future direction of this study.

Looking at the types of disfluency as it relates to stuttering moments is a possible direction for future research. Examining the different types of stutters, such as prolongations, repetitions, and blocks could have been accounted for as well. Future research should identify if there is a pattern between the type of stutter and the stuttering moment. Accounting for the types of stuttering-like disfluencies may demonstrate a relationship between the phonetic complexity of the word and the type of disfluency of the stuttering moment. Research in this area could help identify and account for different types of stuttering as it pertains to the complexity of each word.

In conclusion, stuttering is a type of fluency disorder where there is a breakdown in the forward flow of speech, including the repetition of sounds, syllables or words and prolongation of sounds. There are a number of theories proposed regarding the cause of stuttering, yet the cause of this disorder remains unknown. Further research is necessary in order to determine possible causes of this disorder. The current study explored phonetic complexity as a possible influence on stuttering using the PP estimator developed by Bauer (1988). This information sheds further light on the mysterious condition of stuttering.

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APPENDIX

Orthographic speech sample for each AWS participant. The phonetic product corresponding to each word is shown in parentheses.

AWS1:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
to (1.41)	impact (2.50)	me (1.38)
of (1.33)	some (1.75)	of (1.33)
with (1.81)	acceptance (4.26)	instead (3.07)
to (1.41)	speak (1.90)	with (1.81)
is (1.55)	speaking (2.29)	with (1.81)
am (1.38)	getting (1.96)	my (1.38)
or (1.41)	message (2.11)	across (2.09)
from (2.00)	kindergarten (4.71)	on (1.41)
the (1.50)	fifties (2.95)	the (1.50)
a (1.14)	speech (1.83)	therapist (4.10)
last (2.29)	therapy (2.95)	i (1.18)
other (1.69)	questions (2.74)	i (1.18)
clear (1.86)	connection (2.82)	with (1.81)
was (1.75)	fairly (2.58)	well (1.81)
the (1.55)	vibrations (4.03)	of (1.33)
with (1.81)	fluency (3.30)	and (1.92)
real (2.20)	correlation (3.44)	there (1.92)
the (1.55)	emotion (2.26)	so (1.41)
about (2.07)	physiological (4.49)	and (1.92)
can (1.63)	speak (1.90)	to (1.41)

AWS2:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
a (1.18)	variety (2.52)	of (1.33)
of (1.33)	impacts (2.25)	on (1.41)
more (1.25)	introverted (2.94)	one (1.75)
a (1.18)	counselor (2.95)	and (1.92)
a (1.18)	therapist (4.10)	so (1.50)
my (1.25)	observational (4.91)	skills (2.33)
i (1.18)	remember (2.71)	from (2.00)
on (1.41)	breath (2.07)	which (1.39)
pretty (2.58)	annoying (1.92)	because (2.17)
the (1.55)	elementary (3.99)	school (1.83)
paper (1.80)	clowns (2.41)	and (1.92)
private (2.95)	therapist (4.10)	the (1.50)
remember (2.71)	clear (1.86)	as (1.55)
other (1.69)	high (1.24)	school (1.83)
the (1.50)	grad (2.02)	students (3.65)
and (1.92)	voluntary (4.34)	stuttering (3.10)
of (1.33)	college (1.76)	but (1.75)
about (2.07)	fluency (3.30)	its (1.92)
i (1.18)	stutter (2.50)	and (1.92)
sounds (2.67)	cliché (1.68)	but (1.75)

AWS3:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
the (1.50)	type (1.81)	of (1.33)
forty (2.50)	completely (4.22)	consumed (2.91)
i (1.18)	always (2.58)	thought (1.74)
was (1.75)	closer (2.09)	to (1.41)
the (1.55)	easy (1.79)	way (1.38)
who (1.12)	stutters (2.91)	i (1.18)
that (1.92)	cures (1.59)	it (1.55)
they (1.55)	we (1.38)	still (2.29)
say (1.55)	you (1.08)	see (1.55)
was (1.75)	mimicking (2.25)	me (1.38)
school (1.83)	things (2.02)	were (1.33)
that (1.92)	was (1.75)	good (1.48)
a (1.18)	very (2.08)	good (1.48)
of (1.33)	positive (3.34)	communication (4.00)
a (1.18)	one (1.75)	word (1.75)
it (1.55)	wasn’t (3.06)	his (1.63)
about (2.06)	everything (3.07)	my (1.38)
bachelor (2.41)	lifetime (3.52)	bachelor (2.41)
couldn’t (2.58)	meet (1.81)	up (2.41)
i (1.18)	physically (3.07)	can’t (2.02)

AWS4:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
know (1.41)	i (1.18)	could (1.48)
also (2.06)	somewhat (2.79)	negative (3.10)
was (1.75)	sixteen (2.41)	seventeen (4.06)
for (1.64)	people (2.21)	know (1.41)
there (1.92)	i (1.18)	think (1.70)
still (2.29)	probably (3.13)	does (1.86)
myself (2.91)	the (1.50)	time (1.81)
physically (3.07)	something (2.69)	happens (2.71)
and (1.92)	fluent (2.86)	speech (1.83)
that (1.92)	simultaneously (4.87)	is (1.55)
and (1.92)	who (1.12)	love (1.75)
start (2.66)	to (1.41)	sound (2.29)
therapy (2.95)	though (1.41)	one (1.75)
habits (2.71)	came (1.44)	back (1.44)
wouldn’t (2.86)	continue (2.98)	with (1.81)
feel (1.81)	quite (1.90	so (1.55)
formal (2.66)	speech (1.83)	therapy (2.95)
gotten (2.16)	feedback (2.71)	very (2.08)
effective (2.86)	communicator (3.95)	even (2.08)
being (1.66)	a (1.14)	good (1.48)

AWS5:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
formed (2.32)	for (1.64)	the (1.50)
purpose (2.25)	of (1.33)	those (1.75)
work (1.40)	its (1.92)	all (1.41)
practice (3.10)	my (1.38)	speech (1.83)
cause (1.58)	its (1.92)	part (2.03)
its (1.92)	anything (3.14)	that (1.92)
thick (1.62)	frenulum (3.53)	and (1.92)
is (1.55)	stepping (2.71)	outside (2.06)
therapy (2.95)	which (1.44)	was (1.75)
i (1.18)	forgot (2.28)	her (1.20)
with (1.81)	anything (3.14)	and (1.92)
well (1.81)	i’ve (1.38)	already (2.83)
it (1.55)	if (1.38)	i (1.18)
things (2.02)	where (1.81)	the (1.55)
unique (1.76)	perspective (3.98)	on (1.41)
and (1.92)	monday (2.56)	i’m (1.38)
future (1.46)	therapist (4.10)	to (1.41)
in (1.55)	my (1.38)	life (1.81)
in (1.55)	those (1.75)	who (1.12)
talk (1.48)	to (1.41)	those (1.75)

AWS6:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
has (1.63)	impacted (3.51)	my (1.38)
oral (2.00)	presentation (5.34)	and (1.92)
will (1.81)	even (2.08)	ask (1.63)
how (1.24)	what (1.75)	to (1.41)
all (1.41)	through (1.75)	it (1.55)
one (1.75)	interview (2.78)	and (1.92)
pretty (2.58)	confident (4.03)	so (1.41)
its (1.92)	okay (1.33)	so (1.41)
was (1.75)	younger (1.43)	so (1.41)
the (1.55)	therapy (2.95)	on (1.41)
it (1.55)	really (2.22)	much (1.35)
people (2.21)	who (1.12)	stutter (2.50)
see (1.55)	how (1.24)	they (1.38)
the (1.50)	fluency (3.30)	has (1.63)
its (1.92)	easier (2.07)	for (1.64)
like (1.63)	understand (4.39)	us (1.50)
stop (2.03)	before (2.21)	i (1.18)
have (1.44)	chosen (2.08)	like (1.63)
it (1.55)	difficult (3.47)	to (1.41)
in (1.55)	biology (2.43)	so (1.41)

AWS7:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
included (3.45)	people (2.21)	that (1.92)
so (1.41)	i (1.18)	just (1.88)
a (1.18)	med (1.66)	tech (1.63)
know (1.41)	to (1.41)	become (1.77)
an (1.55)	ENT (2.54)	the (1.55)
hindsight (3.22)	it (1.55)	might (1.81)
to (1.41)	respiratory (5.00)	care (1.63)
was (1.75)	public (2.48)	stuff (2.17)
like (1.63)	it (1.55)	is (1.55)
fluent (2.86)	person (2.56)	that (1.92)
person (2.56)	that (1.92)	has (1.63)
the (1.55)	iceberg (2.17)	stuttering (3.10)
personally (3.82)	i (1.18)	have (1.44)
um (1.25)	people (2.21)	you (1.08)
school (1.83)	for (1.64)	anthropology (4.32)
more (1.64)	helpful (2.88)	you (1.08)
costs (2.19)	a (1.14)	lot (1.75)
communication (4.00)	is (1.55)	when (1.81)
thought (1.92)	that’s (2.29)	in (1.55)
so (1.41)	i (1.18)	like (1.63)

AWS8:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
so (1.41)	currently (3.17)	i’m (1.38)
and (1.92)	finishing (2.51)	up (1.33)
of (1.33)	school (1.83)	so (1.41)
to (1.41)	express (3.24)	you (1.08)
as (1.55)	much (1.35)	as (1.55)
its (1.92)	overall (2.00)	good (1.48)
i’m (1.38)	involved (3.27)	with (1.81)
huge (1.15)	asset (2.22)	so (1.41)
help (1.90)	other (1.69)	people (2.21)
think (1.70)	the (1.50)	biggest (2.19)
know (1.41)	those (1.75)	were (1.33)
know (1.41)	because (2.17)	the (1.55)
as (1.55)	far (1.64)	as (1.55)
as (1.55)	therapy (2.95)	is (1.55)
really (2.21)	get (1.63)	anything (3.14)
know (1.41)	quite (1.90)	everything (3.04)
about (2.07)	stuttering (3.10)	but (1.75)
took (1.48)	the (1.55)	time (1.81)
and (1.92)	by (1.38)	the (1.50)
these (1.92)	therapists (4.67)	have (1.44)

AWS9:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
know (1.41)	talking (1.83)	with (1.81)
often (2.40)	when (1.81)	i’m (1.38)
in (1.55)	other (1.69)	kinds (2.41)
the (1.50)	stuttering (3.10)	and (1.92)
introducing (3.68)	myself (2.95)	it (1.55)
i (1.18)	generally (2.88)	have (1.44)
why (1.38)	the (1.50)	mechanism (3.92)
think (1.70)	more (1.64)	and (1.92)
we’re (1.57)	understanding (5.30)	what (1.75)
This (1.92)	evidence (3.52)	that (1.92)
that (1.92)	suggests (3.73)	an (1.55)
the (1.50)	speech (1.83)	disfluency (4.95)
or (1.41)	were (1.33)	treating (2.78)
a (1.14)	as (1.55)	a (1.14)
more (1.64)	honest (2.46)	and (1.92)
things (2.02)	kinda (2.31)	as (1.55)
a (1.14)	kind (2.02)	of (1.33)
i (1.18)	came (1.44)	to (1.41)
was (1.75)	most (1.90)	likely (2.33)
with (1.81)	the (1.55)	federal (2.74)

AWS10:

Pre-Stuttered Word	Stuttered Word	Post-Stuttered Word
something (2.69)	had (1.63)	to (1.41)
this (1.92)	wasn't (3.06)	didn't (3.07)
going (1.62)	anywhere (2.93)	so (1.41)
to (1.41)	come (1.40)	to (1.41)
terms (2.17)	with (1.81)	it (1.55)
a (1.14)	way (1.38)	to (1.41)
and (1.92)	some (1.75)	days (1.92)
the (1.50)	effect (2.17)	on (1.41)
mean (1.81)	i (1.18)	did (1.92)
think (1.70)	just (1.88)	conveying (2.65)
conveying (2.65)	your (1.16)	point (2.03)
a (1.14)	competent (3.96)	way (1.38)
even (2.08)	form (1.88)	a (1.14)
gone (1.48)	after (2.07)	that (1.92)
and (1.92)	one (1.75)	day (1.55)
our (1.57)	lives (2.24)	has (1.63)
the (1.50)	ability (3.34)	to (1.41)
and (1.92)	body (1.94)	can (1.63)
like (1.63)	i (1.18)	literally (3.24)
and (1.92)	cherish (1.83)	like (1.63)

ACADEMIC VITA

MIKAYLA A. KELLEY

EDUCATION

The Pennsylvania State University — Graduation May 2020
Schreyer Honors College

- Thesis Title: An Exploration of Phonetic Complexity in Adults Who Stutter
- Thesis Supervisor: Dr. Michael Robb

B.S. Communication Sciences and Disorders
Minor in Linguistics

RELEVANT RESEARCH EXPERIENCE

Undergraduate Research Assistant — Sept. 2018 – Dec. 2018
Department of Communication Sciences and Disorders, University Park, PA

- Assistant to Dr. Caron with Alternative and Augmentative Communication devices
- Organized letter-sound correspondence materials for approximately 10 AAC users
- Prepared appropriate individual learning resources for each AAC user to develop language skills

TEACHING EXPERIENCE

Teaching Assistant — August 2018 – Dec. 2018
Department of Communication Sciences and Disorders, University Park, PA

- Undergraduate assistant to Dr. Miller for CSD 300: Language Development
- Prepared detailed notes for students to ensure understanding of material
- Delivered one-to-one assistance to students during office hours outside of class

PROFESSIONAL WORK EXPERIENCE

Childcare Assistant — July 2018 – March 2019
Cherub's Haven, Northbridge MA

- Worked with 20-25 young children to promote good behavior as well as physical, emotional, and social growth
- Ensured safety in the classroom by following classroom safety procedures

Classroom Float/Nittany Lions Read Mentor — January 2019 – May 2020
Hort Woods, State College PA

- Provided supervision and care for 16 infants and toddlers
- Established and maintained a safe environment for development and growth
- Assisted with conducting age appropriate learning activities

CAMPUS AND COMMUNITY INVOLVEMENT

Penn State Dance Team (Lionettes) — 2016 – 2018

- Performed at various athletic events, such as football and basketball games
- Participated in philanthropic events, such as THON

Penn State IFC/Panhellenic Dance Marathon (THON) Volunteer — 2016 – 2019

- Ensured safety for participants and spectators at the event
- Interacted with and served meals to THON dancers and families

National Student Speech-Language-Hearing Association (NSSHLA) 2019 – 2020

- Attended professional meetings and lectures
- Planned activities with persons of all ages with a communication disorder
- Volunteered 5-10 hours of community service

MERIT-BASED AWARDS

Weber Family Open Doors Honors Scholarship	2020
Poole Family Honors Scholarship	2019
Penn State Academic Grant	2019
Skade Hintz Trustee Scholarship	2019
Behnke Open Doors Scholarship	2019
B. & L. Gall Open Doors Scholarship	2019
Newman Family Honors Scholarship	2019
Karen L. Weber Scholarship	2019
Hintz Scholarship for Encouragement	2018
Sieg Trustee Scholarship for Encouragement	2018
Hart Open Doors Scholarship	2018
International Scholarship for Study Abroad	2018
E. Stanley and Elizabeth Nowers Scholarship	2016