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Utterance Complexity and Stuttering on Function Words in Preschool-Age Children Who Stutter

Corrin Richels[1], **Anthony Buhr**[2], **Edward Conture**[3], and **Katerina Ntourou**[4]

Corrin Richels: crichels@odu.edu; Edward Conture: edward.g.conture@vanderbilt.edu

[1] Child Study Center, Old Dominion University, Norfolk, VA 23507, 757-439-5344

[2,4] Department of Hearing and Speech Sciences, Vanderbilt Bill Wilkerson Center, 10221 Medical Center East - South Tower, 1215 21st Ave. South, Nashville, TN 37232-8242

[3] Dept. Hearing and Speech Sciences, Vanderbilt University, 1215 21st Avenue South, Rm 8310, Nashville, TN 37232, Phone: 615-936-5100, FAX: 615-936-6914

1. Introduction

Several researchers have empirically assessed as well as theoretically addressed the question of why young children tend to stutter on function words (e.g., Buhr & Zebrowski, 2009; Howell, Au-Yeung, & Sackin, 1999; Natke, Sandreiser, van Ark, Pietrowsky & Kalveram, 2004). Answering this question requires the consideration of the many language factors involved in the planning and production of function words, for example, phonology, grammar, and lexical access, all of which may contribute to stuttering in young children (Hall, Wagovich, & Bernstein Ratner, 2007; see Bloodstein & Bernstein Ratner, 2008, for further discussion of variables thought to contribute to stuttering). However, the degree to which these factors influence stuttering may differ between children and adults due to inherent differences found in people acquiring skills (children) versus those who have mastered those skills (adults). Thus, the tendency to stutter more frequently on function words in childhood versus the tendency to stutter more frequently on content words in adulthood may provide a window through which one can view the influence of linguistic factors on stuttering for children (CWS) and adults (AWS) who stutter.

1.1 Function Versus Content Words: Defined and Described

Function words may be defined as having a grammatical or functional significance within an utterance without a full lexical meaning. For this reason, function words are relatively limited in number, and therefore constitute a closed class of words to which new ones are virtually never added. In contrast, content words can be defined as an open class of words that carry full lexical meanings. For example, the word "dog" can be described by its semantic features such as fur, four legs, etc. In contrast to function words, content words are added continually to a lexicon, for example, to reflect technological change (e.g., computer, iPod). The appropriate use of each word type within an utterance requires adherence to both grammatical and semantic constraints for the overarching purpose of communication, particularly during spontaneous speech.

Correspondence to: Corrin Richels, crichels@odu.edu.

1.2 Word-Based Versus Utterance-Based Accounts

At least two accounts may be used to explain why children stutter on function words: those that primarily attribute stuttering on function words to *word-level* factors and those that primarily attribute stuttering on function words to *utterance-level* factors. Word-level factors may be defined as properties of specific words that are related to stuttering, and utterance-level factors may be defined as properties of an entire utterance that are related to stuttering. From a word-level perspective, stuttering on function words could be due to factors associated with accessing or planning a function word (e.g., Ullman, 2004), or even a content word adjacent to it (Au-Yeung, Howell & Pilgrim, 1998; Howell, Au-Yeung & Sackin, 1999). From an utterance-level perspective, stuttering on function words could involve formulating communicative intentions (Levelt, 1989) or planning syntactic structures (Bernstein, 1981), both of which could be associated with stuttering at the beginning of an utterance. Thus, while it is possible that other factors (e.g., phrase-level) may also contribute to stuttering on function words, current theories suggest that word- and utterance-level factors are most salient.

1.2.1 Stuttering on function words: Word-level influences—One type of word-level process that may contribute to stuttering on function words is word retrieval. Some evidence suggests that different neural subsystems underlie the storage and/or access of function and content words (Hartshorne & Ullman, 2006; Hinojosa et al., 2001; Mohr, Pulvermuller, & Zaidel, 1994; Ullman, Corkin, Coppola, & Hickock, 1997; van der Lely & Ullman, 2001; Walenski, Mostofsky, Gidley-Larson, & Ullman, 2008; Walenski, Mostofsky, & Ullman, 2007). Particularly, procedural memory is thought to govern rule-like processes involved in syntax and morphology, and may underlie the storage and access of function words (Ullman, 2001, 2004). Failure to access function words has been noted to occur in individuals with specific language impairment (SLI), and it has been attributed to a procedural memory deficit (Ullman & Pierpont, 2005). It is plausible that factors associated with procedural memory could contribute to young children stuttering on function words. However, empirical research has shown that stuttering can also occur on non-words (Packman, Onslow, Coombes, & Goodwin, 2001), indicating that word retrieval is neither a necessary nor sufficient condition for stuttering to occur. Nonetheless, differences in how function and content words are stored and accessed may help explain why function words are more susceptible to being stuttered in young children relative to adults.

Potential word-level influences on stuttering that would seem most relevant to connected speech, however, would involve the *phonological word*, a basic unit of phonological encoding thought to consist of a content word head and any function words that precede or directly follow the content word (Fereirra, 1993; Levelt, 1989; Selkirk, 1984; Wheeldon & Lahiri, 1997). Employing the phonological word construct, Howell and colleagues (Au-Yeung et al., 1998; Howell et al., 1999) have speculated that function words are stuttered due to a subsequent content word being insufficiently planned at the time of execution. This account of stuttering on function words has been formalized in Howell and colleagues' EXPLAN model (described as the combination of the EXecution and PLANning of speech; Howell, 2002; 2004; Howell & Au-Yeung, 2002). In support of this model, Savage and Howell (2008) reported that CWS were less likely to stutter on both function words and content words after content word primes. They interpreted this finding as evidence that the planning of a content word can influence whether the preceding function word will be stuttered. More generally, results were taken to provide further evidence that phonological words are the minimal unit of phonological encoding. Results from reaction time studies have been used to support the idea that the phonological word is the minimal unit of phonological encoding.

Particularly, several empirical studies have shown that speech initiation can be related to properties of the first phonological word of the utterance, such as the gender of the nouns being produced (Schriefers & Teruel, 1999) or the prosody of the utterance being planned (e.g., Meyer, 1996; Schriefers & Teruel, 1999; Wheeldon & Lahiri, 1997). Such findings have been explained in terms of incremental speech production (Bock & Levelt, 1994; Kempen & Hoenkamp, 1987), in which speech initiation can begin as soon as the first phonological word is planned. Other evidence, however, has shown that speech initiation time can depend on properties of words that occur *after* the first phonological word (e.g., Alario, Costa, & Caramazza, 2002; Costa & Caramazza, 1999; Ferreira & Swets, 2002; Stallings, MacDonald, & O'Seaghdha, 1998). These latter findings suggest that the phonological word does not have to be the minimal unit of phonological encoding. However, it is relevant to note that these studies used adults as their participants.

Researchers have also shown that speech initiation time can be related to larger units within an utterance, such as the syntactic complexity of the initial noun phrase (Allum & Wheeldon, 2007; Ferreira, 1991) or the number of phonological words in the utterance (Ferreira, 1991; Wheeldon & Lahiri, 1997). The critical difference in these studies is that participants have time to prepare an utterance before responding, suggesting that phonological material can be stored in a buffer, and the unit of output may comprise a phonological or an intonational phrase (Ferreira, 1993; Levelt, 1989). Again, as with findings noted above, the scope of phonological encoding may extend beyond a single phonological word, depending on task requirements (Ferreira & Swets, 2002).

Thus, when speakers can prepare an utterance prior to the initiation of speech, the scope of phonological encoding could comprise an entire utterance. This would tend to be the case in spontaneous or connected speech which may be a more demanding speaking condition in which longer and more complex utterances may need to be planned (Ferreira, 1991). Evidence suggests that children who stutter produce speech more holistically (e.g., Byrd, Conture, & Ohde, 2007), and therefore may be more likely than adults who stutter to fragment entire utterances during spontaneous speech (e.g., Bloodstein & Grossman, 1981). Thus, while phonological words provide a valuable framework for evaluating stuttering on both function and content words in adults who stutter, there remain questions regarding the specific nature of phonological words in the speech of preschool-age children who stutter.

1.2.2 Stuttering on function words: Utterance-level influences—In addition to possible word-level influences on stuttering, considerable evidence points to factors that influence stuttering relative to the planning and production of the entire utterance. For example, one common finding is that stuttering is more likely in long, complex sentences (Buhr & Zebrowski, 2009; Gaines, Runyan, & Meyers, 1991; Logan, 2001; Logan & Conture, 1995, [1997]; Logan & LaSalle, 1999; Sawyer, Chon, & Ambrose, 2008; Weiss & Zebrowski, 1992; Yaruss, 1999; Zackheim & Conture, 2003). Utterance-level factors (e.g., formulating an intention or sentence structure planning) may therefore *indirectly* contribute to stuttering on function words, perhaps due to their position within an utterance. In other words, the tendency to produce utterances more holistically may, to some extent, constrain the occurrence of instances of stuttering to the beginning of an utterance.

1.3 Purpose

Given the above discussion, the present study was undertaken to investigate the utterance-level contributions to stuttering on function words in preschool-age children who stutter (CWS). It was expected that if stuttering on function words is related to utterance-level factors, then the tendency to stutter on function words would change with changes in utterance-level characteristics (e.g., the number of morphemes or grammatical complexity). On the other hand, if no change was detected, this would be taken as evidence that word-level factors closer to the level of phonological words are more involved in the tendency to stutter on function words.

Thus, the purpose of the two present investigations was to investigate the *utterance-level* conditions in which function and content words are likely to be stuttered in preschool-age children close to the onset of stuttering. Two different methodologies were used to explore whether utterance complexity, in terms of simple versus complex syntax as well as the number of morphemes within an utterance, was related to the tendency for young children to stutter more frequently on function than content words. For Study 1, grammatical complexity of an utterance was measured dichotomously in terms of simple or complex syntax. Study 2 extended measures to include utterance position and a relative measure of utterance complexity (i.e., MLU quartile). It was hypothesized that utterance-level factors may be salient factors in the tendency for CWS to stutter on function words. For example, challenges with sentence planning may be most apparent on more complex utterances. Likewise, challenges to fluent initiation of an utterance should be most apparent on whatever word type typically occurs at the beginning of an utterance. Taken together (i.e., utterance position and complexity), if function words are more apt to be stuttered because of their utterance-initial position, and complex utterances are more likely to be stuttered because of their planning requirements, the tendency to stutter on function words in children should increase with increases in grammatical complexity and/or the number of morphemes in the utterance.

2. Method: Study 1

2.1 Participants

2.1.1 Selection criteria—Participants included 30 (21 males, 9 females) preschool-age children who stutter (CWS) with mean age of 49.4 months (*SD* = 9.7 months). All participants were paid volunteers referred to the Vanderbilt Bill Wilkerson Center by their parents, speech-language pathologists, daycare, preschool, or school personnel. None of the 30 children had previously received or were receiving formal intervention for stuttering or any other communication disorder. In addition, participants had no known or reported hearing, neurological, developmental, academic, intellectual, or emotional problems. This study's protocol was approved by the Institutional Review Board of Vanderbilt University, Nashville, Tennessee. For each of the 30 participants, parents signed an informed consent, and their children assented to participation in the study.

2.1.2 Standardized speech-language tests and hearing screening—To participate in this study, all participants scored at the 16th percentile or higher on the (a) *Peabody Picture Vocabulary Test* (PPVT–R or PPVT-IIIA/B; Dunn & Dunn, 1981, 1997), (b) *Test of Early Language Development* (TELD-2 or TELD-3; Hresko, Reid & Hamill, 1991, 1999) and (c) the "Sounds in Words" subtest of the *Goldman-Fristoe Test of Articulation* (GFTA or GFTA-2; Goldman & Fristoe, 1986, 2000). These standardized tests were used to assess receptive vocabulary, receptive and expressive language skills, and articulation abilities, respectively. Furthermore, each participant passed a bilateral pure tone hearing and tympanometric screening (ASHA, 1990).

2.1.3 Race & Socioeconomic Status (SES)—The child's race was ascertained based on parental interview. Of the 30 participants 24 were Caucasian and 6 were African-American. Each child's socioeconomic status (SES) was calculated for the parents of all participants. SES was determined using the Four Factor Index of Social Position (Hollingshead, 1975), which involves the assessment of maternal and paternal occupation and educational level. Possible scores on the Four Factor Index of Social Position range from 8 to 66, with a higher score suggesting higher SES. The mean SES for the 30 CWS participants was 47.48 (*SD* = 9.68) suggesting SES in the middle range.

2.1.4 Classifying participants as children who stutter (CWS)—A child was considered to stutter if he or she (a) exhibited three or more stuttering-like disfluencies (SLD; i.e., sound/syllable repetitions, whole-word repetitions, audible and inaudible sound prolongations) per 100 words of conversational speech (based on the first 300 words of the conversational sample; Conture, 2001) and (b) received a total score of 11 or above (a severity equivalent of at least "mild" for preschool-age children) on the *Stuttering Severity Instrument-3* (SSI-3; Riley, 1994). For both studies, disfluency counts were obtained at the time the sample was recorded. Participants' mean SSI-3 score was 20 which corresponds to a severity rating of "moderate" (*SD* = 4.23).

2.2 Data Collection

2.2.1 Parent-child conversation—Loosely structured conversational speech samples were audio/video recorded in a room designed to assess children and their families located in the Vanderbilt Bill Wilkerson Center at Vanderbilt University in Nashville, TN. Conversation lasted approximately 15–30 minutes and included no less than 100 total utterances. During the conversation, the child and the parent were seated at a table or on the floor, with a standard set of toys (i.e., Fisher Price barn) situated directly in front of the child. Conversations were allowed to be child-directed with the parent mainly providing a supportive and friendly communication environment for the child. If the parent prompted the child to produce or imitate particular sentences or words, research team members typically redirected the conversation (e.g., "Wow, Johnny's really good at his ABCs. We'd like to see how he plays with the toys"). Parents were not aware of the specific purposes of this research project until after its completion when they were de-briefed by the experimenters.

2.2.2 Speech transcription—The audio-video recording of each child's parent-child conversation was orthographically transcribed in its entirety. Every utterance of each parent-child sample was transcribed following the conventions required by the Systematic Analysis of Language Transcripts computer program (SALT 7.0; Miller & Chapman, 2002). Mean length of utterance (MLU) was calculated using the SALT program for the total utterance corpus. Utterance boundaries were determined by separating utterances beginning with a coordinating conjunction (e.g., "and", "because") if there was no co-referent with the preceding clause (Scott, 1988). For instance, the utterances "the boy went to school and the dog ate his shoes" and "the boy went to school and ate lunch in the cafeteria" contain unrelated and related clauses, respectively. Dividing utterances based on these criteria was employed to reduce the risk of artificially increasing MLU and the percentage of utterances with grammatically complex syntax.

2.3 Pre-Analysis Data Processing: Exclusion of Unusable Data

Based on the parent-child conversations, those 30 participants selected for the present study produced a total of 4,643 child utterances comprising 18,440 words. However, not all utterances were considered appropriate for analysis. First, any utterance that contained one or more unintelligible words was not included in the final data corpus because word intelligibility was crucial for identification of word type. This resulted in the exclusion of 76 utterances (1.6%) from the corpus. Second, single-word utterances were not included for analysis since such utterances provide no syntactic context for identification of simple versus grammatically complex utterances. This resulted in the exclusion of 611 utterances (13.2%) from the corpus. Third, for assessment of stuttering on function versus content words, only utterances that contained at least one SLD (e.g., sound/syllable repetition) were used. Therefore, utterances containing at least one non-SLD (e.g., revision: "You put- I'll put it there") with no SLDs were not included. Exclusion of utterances with non-SLDs only resulted in the exclusion of 5.0% (*n*=231) of the utterance corpus. As a result of the above-described pre-data-analysis assessment of the 4,643 potential utterances of the 30 participants, 19.8% or 918 utterances (comprising 1318 words) were excluded from further analysis. This resulted in a *final data corpus* of 3,725 utterances (comprising 17,122 words) that were analyzed.

2.4 Utterance Coding

2.4.1 Word type—Each word of each completely intelligible multi-word utterance was categorized as either a *function* word (pronouns, articles, prepositions, conjunctions, copula verbs, auxiliary verbs) or a *content* word (nouns, main verbs, adverbs, adjectives) following the methods outlined in Au-Yeung et al. (1998). Words were also identified as being stuttered or fluent. Stuttered words were categorized as either function or content words as described above.

2.4.2 Grammatically complex syntax—An utterance was considered *grammatically complex* if it met *one* of the following four criteria (Schuele, 2002; based on the grammar of Quirk, Greenbaum, Leech, & Svartik, 1985): 1) contained two or more clauses with the clauses combined with a coordinate or subordinate clause (e.g., "I better ride the bike 'cause the horse won't go"), 2) contained two or more clauses with one clause embedded or dependent on the other clause (i.e., main clause and dependent clause, e.g., "I think that one supposed to be driving", 3) contained a noun phrase modified by a clause (i.e., relative clause; e.g., "This is the guy that owns this place"), or 4) contained two or more distinct verb phrases (an auxiliary and main verb constitute one verb phrase; e.g., "I think he's the sheriff").

2.4.3 Utterance fluency—Utterances were considered fluent only if there was a complete absence of any speech disfluency within the utterance (i.e., neither stuttering-like nor non-stuttering-like disfluencies, similar to Logan & Conture, 1995, 1997). Utterances were classified as stuttered if they contained one or more SLDs, which were identified and classified as sound syllable repetitions (e.g., buh-buh-but), whole-word repetitions (e.g., "and-and-and"), and audible and inaudible sound prolongations (e.g., "aaaand" or " S__tar Wars"). The number of stuttered words rather than the number of iterations associated with the stuttered word were counted (e.g. and-and-and = 1 SLD). Non-stuttering-like speech disfluencies (non-SLD) included revisions (e.g., "I will, I won't go") phrase repetitions (e.g., "I think-I think I will"), and interjections (e.g., "uh", "um").

2.5 Data Analysis

After all words were measured according to word class, complex syntax, and utterance fluency, frequencies of both function words and stuttered function words were calculated for each utterance type (i.e., grammatically complex vs. simple; stuttered vs. fluent). These frequencies were used to calculate the proportion of all words that were function words, the proportion of all stuttered words that were function words, the proportion of all function words that were stuttered, and the proportion of all content words that were stuttered. Because of the properties of the final data corpus, nonparametric statistical measures were chosen for data analyses. Therefore, in contingency table analyses Pearson χ^2 statistics, binomial tests, and Wilcoxon signed-rank tests were reported. The use of these statistics is consistent with recommendations made by the American Psychological Association (Wilkinson, 1999).

2.6 Measurement reliability

Six conversational samples chosen at random were transcribed and coded again by a second investigator. Transcripts were then matched to ensure that each consisted of the same set of utterances. Total words, total function words, total stuttered words, and grammatical complexity within each utterance were used to conduct reliability for word class (i.e., function vs. content), word type (i.e., stuttered versus fluent), and syntax (i.e., grammatically complex versus simple). For word class, agreement was 90% with a kappa coefficient of .80. For stuttering, agreement was 94% with a kappa coefficient of .84. For utterance syntax, agreement was 97% with a kappa coefficient of .88.

3. Study 1: Results

3.1 Stuttering on Function versus Content Words

First, to examine whether the tendency to stutter on function words differed from the tendency to stutter on content words, the proportion of all function words that were stuttered and the proportion of all content words that were stuttered were compared. Results of a 2 × 2 contingency table analysis showed that the proportion of all function words that were stuttered (12.0%) was significantly greater than the proportion of all content words that were stuttered (6.2%), Pearson χ^2 (1, $N = 30$) = 168.1, $p < .001$, *phi* = .102. A Wilcoxon signed-rank test was used to evaluate whether this tendency to stutter on function words was consistent across the 30 participants. Results indicated a significant difference between stuttering on function versus content words, $z = 3.53$, $p < .001$. Specifically, 25 (83%) preschool-age CWS stuttered more frequently on function words, and 5 (17%) stuttered more frequently on content words.

3.2 Function Words Versus Stuttering on Function Words

Second, to determine whether function words were more likely to be stuttered than their overall frequency in the sample, the proportion of all words that were function words was compared to the proportion of all stuttered words that were function words. A *z* –approximation test based on the binomial distribution indicated that the proportion of all stuttered words that were function words (66.5%) was significantly greater ($p < .001$) than the proportion of all words that were function words (50.5%). In essence, function words were more likely to be stuttered than would be expected based on their overall frequency in an utterance.

3.3 Function Words by Utterance Complexity and Utterance Fluency

Third, to examine whether function words were more likely to occur for one utterance type compared to the other, the proportion of all words that were function words was compared between simple and grammatically complex as well as between fluent and stuttered utterances. Results of two separate 2 × 2 contingency table analyses showed that the proportion of all words that were function words was (1) significantly greater on grammatically complex (53.5%) than simple (49.4%) utterances, Pearson chi;^{2}(1, $N = 30$) = 21.686, $p < .001$, *phi* = .037 (Table 1), and (2) was significantly greater on stuttered (52.9%) than fluent (49.2%) utterances, Pearson chi;^{2} (1, N=30) = 20.237, $p < .001$, *phi* = .035. These results show that grammatically complex utterances and those that contained an SLD consisted of significantly more function than content words.

3.4 Stuttering on Function Words by Utterance Complexity

Finally, to examine whether function words were more likely to be stuttered during grammatically complex utterances, the proportion of all stuttered words that were function words was compared between simple and grammatically complex utterances. Results of a 2 × 2 contingency table analysis showed that the proportion of all stuttered words that were function words did not significantly differ between grammatically complex (68.7%) and simple (65.8%) utterances, Pearson chi;^{2} (1, $N = 30$) = 1.075, $p = .300$, *phi* = .027 (Table 1). This result shows that stuttering was not more likely to occur on function words in grammatically complex utterances, contrary to expectations.

3.5 Summary of Results for Study 1

Results of Study 1 revealed three main findings. First, function words were more apt to be stuttered than content words. Second, the overall proportion of function words was significantly greater for grammatically complex than simple utterances, and for stuttered than fluent utterances. Third, the proportion of all stuttered words that were function words did not significantly differ between grammatically complex and simple utterances. Overall, findings of Study 1 are taken to suggest that even though function words were more likely to be stuttered, this effect was not related to the dichotomous measure of grammatical complexity.

4. Study 1: Discussion

Present findings showed that the proportion of all words that were function words was greater in the grammatically complex than simple utterances. Additionally, findings showed that the proportion of all words that were function words was greater in stuttered utterances than in fluent utterances. This suggests that stuttering may have at least been indirectly related to utterance complexity, consistent with previous research (e.g., Brundage & Bernstein Ratner, 1989; Buhr & Zebrowski, 2009; Gordon & Luper, 1989; McLaughlin & Cullinan, 1989; Gaines, Runyan, & Myers, 1991; Kadi-Hanifi & Howell, 1992; Zackheim & Conture, 2003). However, this possibility is qualified by the fact that the proportion of all stuttered words that were function words did not differ between grammatically complex and simple utterances. There may be a few reasons for this discrepancy.

Study 1’s dichotomous measure may have been inadequate to assess the influence of utterance complexity on stuttering for some children. For children at later stages of grammatical development, complex utterances, as defined for the purposes of Study 1, may not have posed a significant challenge to speech-language planning and production. Additionally, children at earlier stages of grammatical development may have produced relatively fewer grammatically complex utterances to contribute to the overall data set. It is also possible that the operational definitions of simple and grammatically complex syntax may not have taken into account the overall requirements of sentence planning. For example, the utterance, “She wants to walk the dog” would be categorized as grammatically complex because it contains the simple infinitive verb structure of “to walk”. However, the utterance, “She walks the pig, and dog, and sheep to the barn” is markedly longer but does not contain grammatically complex syntax. Thus, a measure of utterance complexity related to each participant’s mean number of morphemes produced per sentence may have been a more appropriate measure to use in the present study.

One other explanation for the findings of Study 1 is that the relation between utterance complexity and word type depends on utterance position. For example, it has often been reported that children tend to stutter at the beginning of an utterance on function words such as conjunctions and pronouns (Au-Yeung et al., 1998; Bloodstein & Gantwerk, 1967; Bloodstein & Grossman, 1981; Silverman, 1974; Williams, Silverman, & Kools, 1969). Likewise, Buhr and Zebrowski (2009) recently reported that young children’s SLDs tend to occur on function words at the beginning of utterances as well as in utterances that are relatively long and syntactically complex. Thus, it may be that a possible influence of utterance complexity on stuttering on function words may be most relevant at the beginning of an utterance.

Thus, it was decided to conduct a second empirical study – with a different, but comparable group of preschool-age CWS –to address the issues discussed above. To accomplish this, data from a second group of male CWS (n = 30) was collected to study the relation between word type and utterance complexity by 1) using a continuous measure of utterance complexity, and 2) taking into account word position with the utterance.

5. Study 2: Method

5.1 Participants

Participants for Study 2 included 30 male preschool-age boys with a mean age of 50.53 months (*SD* = 9.32). Participants were selected based on similar considerations as Study 1 (e.g., scoring at or above the 16th percentile on all of the speech and language standardized tests and receiving a total overall score of 11 or above on the SSI-3; Riley, 1994). The mean SSI-3 score for the participants was 20.06 (*SD* = 6.14). The protocol for Study 2 was approved by the Institutional Review Board of Vanderbilt University, Nashville, Tennessee, and for each of the 30 participants, parents signed an informed consent and their children assented to participate.

5.1.1 Race & socioeconomic status (SES)—Of the 30 participants, 25 were Caucasian, 3 were African-American, and 2 were biracial. The mean SES for the participants, as determined by the Four Factor Index of Social Position (Hollingshead, 1975), was 47.52 (*SD* = 11.65)

5.1.2 Comparison of Study 1 and Study 2 participants—A multivariate analysis of variance (MANOVA) revealed no significant between-group differences on any of the following: TELD spoken language, $F(1,58) = 1.318$, $p < .256$; GFTA, $F(1,58) = 0.007$, $p < .935$; time since onset (TSO), $F(1,54) = 1.313$, $p < .257$; SSI - 3, $F(1,43) = 0.000$, $p < .983$; and SES, $F(1,53) = 0.000$, $p < .99$. However there was a significant between-group difference on the PPVT $F(1,56) = 4.3$, $p < .043$, with Study 2 ($M = 110.9$, $S.D. = 12.12$) having higher scores than Study 1 ($M = 105.0$, $S.D. = 11.00$). All study participants ($N = 60$) had scores within normal limits when compared to same-aged peers.

5.2 Procedure

The 30 preschool-age participants participated in a parent-child conversational interaction of at least 15-minutes in duration. Utterances were transcribed and associated speech disfluencies were coded using the conventions described for Study 1. Prior to the conversational speech sample, all participants completed the aforementioned standardized speech-language testing.

5.3 Pre-Analysis Data Processing: Exclusion of Unusable Data

The 30 participants selected for Study 2 produced a total of 4545 utterances comprising 16,787 words. Like Study 1, utterances that contained one or more unintelligible words were removed. For Study 2, abandoned and interrupted utterances were also removed from the data corpus. Removing unintelligible, abandoned, and interrupted utterances resulted in the exclusion of a total of 377 (8.3%) utterances. Similar to parameters used for Developmental Sentence Scoring (Lee, 1974), utterances that did not contain a subject and a predicate were excluded for Study 2. This resulted in the further exclusion of 1,682 (37%) utterances. The final data corpus was thus comprised of 2,486 utterances and 13,553 words. The exclusion of utterances that lacked both a subject and a predicate was a major methodological difference compared to Study 1. Consequently, a higher percentage of utterances were excluded from the original data corpus for Study 2 compared to Study 1.

5.4 Utterance Coding

5.4.1 Word type—As with Study 1, for Study 2, every word of each intelligible utterance was categorized as either a function word (pronouns, articles, prepositions, conjunctions, copula verbs, auxiliary verbs) or a content word (nouns, main verbs, adverbs, adjectives), using procedures described by Au-Yeung et al. (1998).

5.4.2 Utterance quartile—For Study 2, a relative measure of utterance complexity was used to better capture the range of utterance planning and production skills of children in the present study. Within each utterance the number of morphemes was counted in accordance with Brown's (1973) morpheme selection rules, which were then normalized within a child's spontaneous speech sample (after Zackheim & Conture, 2003). Normalized values for all utterances were then aggregated across all participants and divided into quartile (i.e., 25th, 50th, etc.) rankings. This allowed word type and utterance position to be compared across quartiles (e.g., the 0 to 24th [lower] versus the 76th to 100th [upper]). The number of constituents within an utterance has been previously used as a measure of the amount of information within an utterance, referred to as grammatical weight (e.g., Clark & Wasow, 1998). Although the number of morphemes within an utterance is typically expressed in terms of *length* (e.g., MLU), this term may not reflect the underlying complexity of the utterance, and so for the purposes of Study 2 was expressed simply as the number of morphemes.

5.4.3 Utterance position—Every word within an utterance, including those that were stuttered, was categorized as occurring in either the utterance-initial or utterance non-initial position. The utterance-initial position was defined as the first word of an utterance, while utterance-non-initial positions were defined as all other positions. Starter words that could not be categorized as either a function or content word, such as simple negations (e.g., no, nah, nope) or affirmatives (e.g., yes, yeah, yep), were not counted as utterance-initial words.

5.4.4 Utterance fluency—As with Study 1, Study 2 defined utterance fluency according to whether or not an utterance contained an SLD.

5.5 Data Analysis

After all words were measured according to word class, utterance position, and utterance fluency, frequencies of both function words and stuttered function words were calculated for each utterance position across all four MLU quartiles. As in Study 1, these frequencies were used to calculate the proportion of all words that were function words, the proportion of all stuttered words that were function words, the proportion of all of function words that were stuttered, and the proportion of all content words that were stuttered. Nonparametric statistical measures were used for the data analyses. Contingency table analyses were again used and Pearson chi;^{2} statistics, binomial tests, and Wilcoxon signed-rank tests were reported.

5.6 Measurement Reliability

Six conversational samples chosen at random were transcribed and coded again by a second investigator. Transcripts were then matched to ensure that each consisted of the same set of utterances. Total words, total function words, and total stuttered words within each utterance were used to conduct reliability for word class (i.e.., function vs. content) and word type (i.e., stuttered versus fluent). For word class, agreement was 95% with a kappa coefficient of 0.90. For stuttering, agreement was 97% with a kappa coefficient of .76.

6. Study 2: Results

6.1 Stuttering on Function versus Content Words

First, in a partial replication of Study 1, the proportion of all function words that were stuttered was compared to the proportion of all content words that were stuttered. Results of a 2 × 2 contingency table analysis showed that the proportion of all function words that were stuttered (9.6%) was significantly greater than the proportion of all content words that was stuttered (5.5%), Pearson chi;^{2} (1, N = 30) = 79.237, p < .001, *phi* = .076. A Wilcoxon signed-rank test was used to evaluate whether this tendency to stutter on function words was consistent across the 30 participants in Study 2. Results indicated that significantly more participants stuttered on function words than content words, $z = 4.71$, $p < .001$. Specifically, 28 (93%) participants stuttered more frequently on function words and 2 (7%) participants stuttered more frequently on content words, findings consistent with Study 1 as well as previous empirical research.

6.2 Function Words Versus Stuttering on Function Words by Utterance Position

6.2.1 Between utterance positions—Second, the proportion of all words that were function words and the proportion of all stuttered words that were function words were each compared between utterance-initial and non-initial positions. Results showed that the proportion of all words that were function words was significantly greater at the utterance-initial (79.3%) than the utterance non-initial (46.1%) position, Pearson $\chi^2(1, N = 30) = 896.1$, $p < .001$, *phi* = .257, and that the proportion of all stuttered words that were function words was significantly greater at the initial (84.8%) than the non-initial (44.4%) position, Pearson χ^2 $(1, N = 30) = 186.3$, $p < .001$, *phi* = .424 (Table 2). Thus, both function words and stuttered function words tended to occur at the utterance-initial position.

6.2.2 Within utterance position—Next, within each of these two utterance positions, the proportion of all words that were function words was compared to proportion of stuttered words that were function words. Results of two separate *z* –approximation tests based on the binomial distribution indicated that within utterance-initial position, the proportion of all stuttered words that were function words (84.8%) was significantly greater than of the proportion of all words that were function words (79.3%), $p = .001$ (Table 2). However, within utterance-non-initial position, the proportion of all stuttered words that were function words (44.4%) did not differ from the proportion of all words that were function words (46.1%), $p = .244$ (Table 2). Thus, function words were more likely to be stuttered than their frequency of occurrence at the utterance-initial position only.

6.3 Function Words and Stuttered Function Words by MLU Quartile

Third, to examine whether function words were more likely to occur with increasing sentence length, the percentage of function words was compared across MLU quartiles at each utterance position.

6.3.1 Utterance-initial position—Results of 2 × 4 contingency table analyses showed that the proportion of all words that were function words significantly differed across MLU quartile at the utterance-initial position, Pearson χ^2 $(3, N = 30) = 93.297$, $p < .001$, *phi* = .194. Post hoc comparisons with Bonferroni-adjusted *p*-values (six total comparisons) revealed that the proportion of all words that were function words at the 2^{nd}, 3^{rd}, and 4^{th} quartiles were significantly greater than at the 1^{st} quartile (Figure 1). Results of a 2 × 4 contingency table also showed that the proportion of stuttered words that were function words was significantly different across MLU quartile at the utterance-initial position, Pearson χ^2 $(1, N = 30) = 18.914$, $p < .001$, phi = .187. Post hoc tests with Bonferroni-adjusted *p*-values (six total comparisons) revealed that the proportion of all stuttered words that were function words at the 2^{nd}, 3^{rd}, and 4^{th} quartiles were significantly greater than at the 1^{st} quartile (Figure 1). In summary for utterance-initial position, the relative frequencies of both function words and stuttered function words significantly increased from the 1^{st} to the 2^{nd} MLU quartiles.

6.3.2 Utterance-non-initial position—Results of 2 × 4 contingency table analyses showed that the proportion of all words that were of function words significantly differed across MLU quartile at the utterance-non-initial position, Pearson χ^2 $(3, N = 30) = 55.230$, $p < .001$, *phi* = .071. Post hoc tests with Bonferroni-adjusted *p*-values (six total comparisons) revealed that the proportion of all words that were function words at the 4^{th} quartile was significantly greater than at the 1^{st}, 2^{nd}, and 3^{rd} quartiles, and that the percentage of function words at the 3^{rd} quartile was significantly greater than the percent at the 1^{st} quartile (Figure 2). Results of a 2 × 4 contingency table showed that the proportion of all stuttered words that were function words was significantly different across MLU quartile at the utterance non-initial position, Pearson χ^2 (1, N = 30) = 17.537, p = .001, *phi* = .188. Post hoc testing with Bonferroni-adjusted p-values (six total comparisons) showed that the proportion of stuttered words that were function words at the 2nd, 3rd, and 4th quartiles were significantly greater than at the 1st quartile (see Figure 2). In summary for utterance-non-initial position, significant increases in the relative frequency of function words spanned the 1st to the 4th quartile, and the significant increase in the relative frequency of stuttered function occurred from the 1st to the 2nd quartile.

6.4 Observed Versus Expected Numbers of Stuttered Function Words

Although results of the preceding section showed that the proportion of stuttered words that were function words was related to the number of morphemes within an utterance, the total opportunities to stutter on function words at each MLU quartile was not controlled for. To account for this, *observed* and *expected* numbers of stuttered function words at the utterance-initial and utterance-non-initial positions were compared across MLU quartiles. Expected numbers were calculated by dividing the total number of stuttered function words at each MLU quartile by the proportional occurrence of function words at that same quartile.

Results indicated that the observed number of stuttered function words significantly increased relative to the expected number across MLU quartiles at the utterance-initial position, χ^2 (3, N = 30) = 20.509, p < .001 (Figure 3), as well as at the utterance-non-initial position, χ^2 (3, N = 30) = 23.133, p < .001 (Figure 4). Post hoc testing with Bonferroni-adjusted p-values (six total comparisons) showed that at the utterance-initial position, the observed number of stuttered function words at the 1st quartile was significantly greater than at the 3rd and 4th quartiles, while at the utterance-non-initial position, the observed number of stuttered function words at the 1st quartile was significantly greater than at the 2nd, 3rd, and 4th quartiles. Thus, stuttering frequency on function words increased across MLU quartiles, even when controlling for the opportunities to stutter on function words. This effect is particularly striking at the utterance-initial position, where the opportunities to stutter in each utterance was constrained to the first word. This finding indicates that utterance-level planning likely had some influence on whether the first word of that utterance would be stuttered.

6.5 Summary of Results for Study 2

Three main findings resulted from Study 2. First, function words were more apt to be stuttered than content words, a tendency detected only at the utterance-initial position. Second, the proportion of all words that were function words and the proportion of stuttered words that were function words increased with greater numbers of morphemes within an utterance at both the utterance-initial and non-initial positions. Third, the observed number of stuttered function words increased relative to the expected number of stuttered function words across MLU quartile at both utterance positions.

7. Study 2: Discussion

Findings from Study 2 showed that preschool-age children were more apt to stutter on function words than content words, consistent with Study 1 as well as previous studies (e.g., Au-Yeung, et al., 1998; Bloodstein & Gantwerk, 1967; Bloodstein & Grossman, 1981; Buhr & Zebrowski, 2009). This finding can be explained by the tendency for preschool-age children to begin utterances with function words and to stutter significantly more at that position. In other words, the tendency to stutter on function words may be, at least in part, an indirect result of an overlap of stuttering and function words co-occurring at the utterance-initial position. This finding is consistent with previous research showing that young children tend to stutter on function words at the beginning of an utterance (e.g., Au-Yeung et al., 1998; Bernstein, 1981; Bloodstein & Gantwerk, 1967; Bloodstein & Grossman, 1981; Buhr & Zebrowski, 2009).

Findings from Study 2 showed that the proportion of stuttered words that were function words increased with greater numbers of morphemes within an utterance at both utterance positions, and that the observed number of stuttered function words increased relative to the expected number across MLU quartiles. On the surface, this finding is inconsistent with the finding of Study 1 that the proportion of stuttered words that were function words did not differ between simple and grammatically complex utterances. One reason for this discrepancy may have been that using a relative measure of utterance complexity rather than a categorical measure increased the ability take into account differences in language skills among participants in the study.

Thus, an interaction between utterance position and utterance complexity may contribute to the tendency for young CWS to stutter on function words. As reported above, results of Study 2 found that 79.3% of the complete sentences produced had function words in the utterance initial position. Additionally, utterances with greater numbers of morphemes were also more likely to be stuttered. Taken together, these findings may be associated with increased planning requirements, resulting in a greater frequency of stuttering on utterance-initial words, the position where our data shows that function words are most likely to occur. This indicates that utterance position is a critical mediator between utterance complexity and stuttering on function words. Thus, findings of Study 2 are taken to suggest that, in early childhood, stuttering on function words is related to planning processes taking place at the initiation of an utterance.

8. General Discussion

8.1 Overview of Main Findings

Overall, results of Study 1 and Study 2 showed that 1) function words were more likely to be stuttered than content words, particularly at the utterance-initial position; 2) utterances are more likely to be stuttered with increases in the number of morphemes; and 3) utterance position appears to be a critical mediator between utterance complexity and stuttering on function words. Additional implications of these findings are discussed below.

8.2 Utterance Position

Findings from Study 2 showed that the proportion of stuttered words that were function words was greater than the overall proportion of function words at the utterance-initial position, consistent with Buhr and Zebrowski (2009). One possible explanation for this finding is that utterances that begin with function words may be associated with greater demand on sentence planning than those that begin with content words. For example, Weiss and Zebrowski (1992) found that, contrary to expectations, stuttering was significantly more likely to occur on assertive than responsive utterances. Weiss and Zebrowski suggested that assertive utterances may be associated with a greater degree of propositional content (i.e., new information to be conveyed), and therefore greater planning load. Perhaps preschool-age children’s assertive utterances – relatively novel utterances requiring on-the-fly generation of structure and content - may be more likely to begin with function words such as pronouns and conjunctions.

Interestingly, findings from Study 2 showed that the tendency for preschool-age children to stutter on function words did not differ from content words at the utterance-non-initial position. In essence, the likelihood of stuttering on each word type did not differ from their overall frequency of occurrence at this position. In contrast to this finding, Buhr and Zebrowski (2009) found that children were more likely to stutter on content words than function words at the utterance-non-initial position. One possible reason for this difference in findings is that Buhr and Zebrowski used a longitudinal design, as opposed to the cross-sectional design of the current study. It is possible that some children in their study may have produced patterns of disfluency more consistent with those found in adults by the end of data acquisition. It does appear, however, that utterance position is an important mediator of word class for children who stutter.

8.3 Utterance Complexity

Findings from Study 2 showed that the proportion of stuttered words that were function words increased across MLU quartiles at both initial and non-initial utterance positions (see Figures 1 and 2). Study 1, however, did not find such a difference using a dichotomous measure of grammatically complex and simple utterances, even though the overall percentage of function words was greater on grammatically complex utterances. One possible explanation for this discrepancy in findings is that grammatical complexity may have been confounded by other aspects of sentence planning that may have been better captured by the number of morphemes, such as phonological planning load. Utterance length has been referred to as a macrovariable that encompasses multiple levels of linguistic planning (e.g., syntactic, phonological; Logan & Conture, 1995). The number of morphemes within an utterance may have therefore been a more sensitive indicator of overall sentence planning requirements.

Although Study 1 did not show evidence of a direct grammatical contribution to stuttering on function words, it is possible that grammatical development may have been indirectly related to stuttering on function words. A number of empirical studies have shown that children are more likely to produce speech disfluencies in utterances that contain recently learned grammatical forms (e.g., Colburn & Mysak, 1982a, 1982b; Rispoli & Hadley, 2001). To the extent that speech disfluencies occur on function words at the beginning of an utterance, function words may be more likely to be stuttered for children who are acquiring grammatical forms. As language skill becomes more proficient with further development, however, grammatical planning may become less demanding, resulting in a lower likelihood of stuttering on utterance-initial words. Other aspects of planning may become more relevant to stuttering, perhaps shifting the locus of at least some instances of stuttering further into the utterance (i.e., utterance-non-initial positions), potentially resulting in content words being stuttered relatively more. One might therefore speculate that any developmental change resulting in a tendency to stutter on content words may be more likely to involve word-level factors. In other words, utterance-level factors may have their greatest influence on stuttering in young children, but with advances in grammatical skills over development, word-level factors may come to play a greater role in the locus of stuttering in older children, teens, and adults.

Perhaps the most interesting finding from the present study is that the number of morphemes within an utterance is related to whether stuttering will occur on the first word of an utterance (Figure 3). This finding is consistent with previous speculations that the loci of stuttering is related to aspects of sentence planning (e.g., Anderson & Conture, 2004;Bernstein, 1981;Buhr & Zebrowski, 2009;Howell & Au-Yeung, 1995;Jayaram, 1984). With increases in the number of morphemes, the requirements for various types of utterance-level planning would likely increase as well, leading to a greater likelihood of stuttering at the beginning of the utterance. However, although the overall number of morphemes within an utterance also influenced children's tendency to stutter on non-initial functions words, it is less certain whether utterance-level variables contributed to stuttering at this position.

8.4 Limitations

One limitation of the present study is that stuttering on phonological words was not specifically assessed because the *raison d'être* of Studies 1 and 2 was to investigate utterance-level factors in stuttering. Thus, while word-level influences on the loci of stuttering in preschool-age CWS cannot be discounted, present findings suggest that word-level factors cannot solely account for the tendency for children to stutter on function words. It is hoped, therefore, that future studies will be better able to systematically control for various word- and utterance-level contributors to stuttering. It is relevant to note that the utterance-level findings discussed above are limited to multi-word utterances. Future research may want to address word-level effects observed on single-word utterances. Additionally, Study 2's findings are limited to utterances that met the criteria of being complete sentences. This criterion may be unnecessarily limiting as children tend to produce many utterances that are not "complete" sentences. Another potential limitation was that participants in Study 1 and Study 2 differed on PPVT scores. However, because all participants were within normal limits, this difference was not assumed to have influenced the main findings.

8.5 Conclusion

Findings of the present investigation suggest that the tendency for preschool-age children to stutter on function words can be meaningfully considered within the context of the entire utterance. Specifically, function words and stuttering tend to occur at the utterance-initial position, with this position most likely associated with planning/production processes necessary for timely, fluent utterance initiation. Whether viewing stuttering on function words from a word-level or utterance-level perspective, neither factor exists outside the context of the child's attempts to communicate with a listener. Perhaps, therefore, it is worth considering the loci of stuttering within the larger context of bi-directional communication between speaker and listener. By so doing, we may gain a clearer understanding of sentence planning processes within the varying dynamics of social-communicative interaction, and thus achieve a more encompassing perspective of their influence on the loci of stuttering in children, teens and adults.

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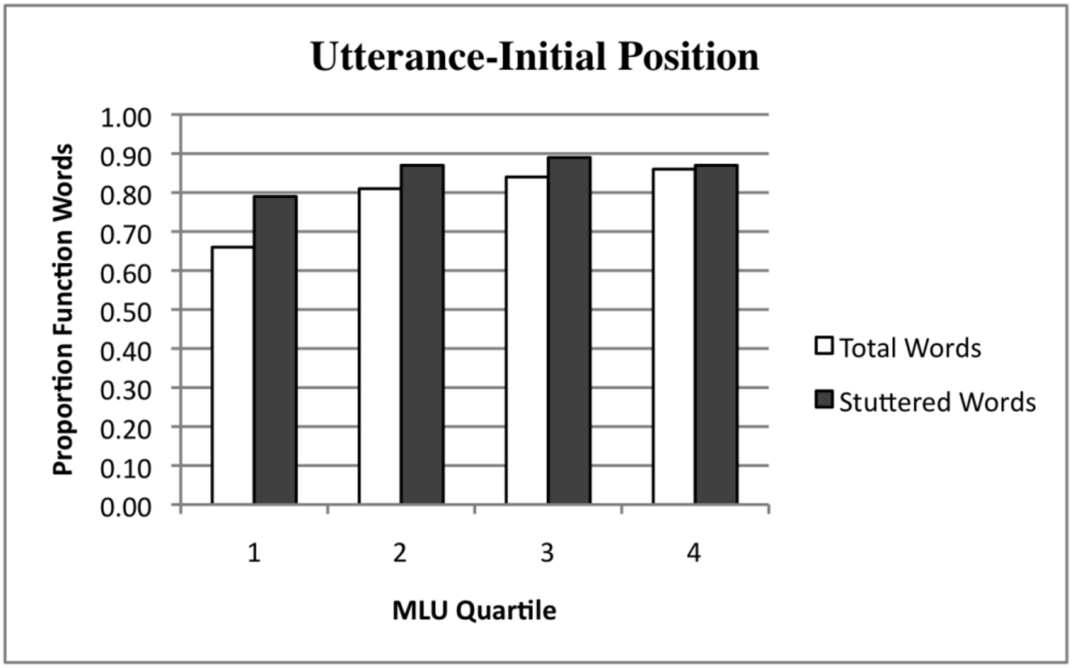

Figure 1.
Proportions of total and stuttered words that were function words at *utterance-initial* position across MLU quartiles for all participants (n=30).

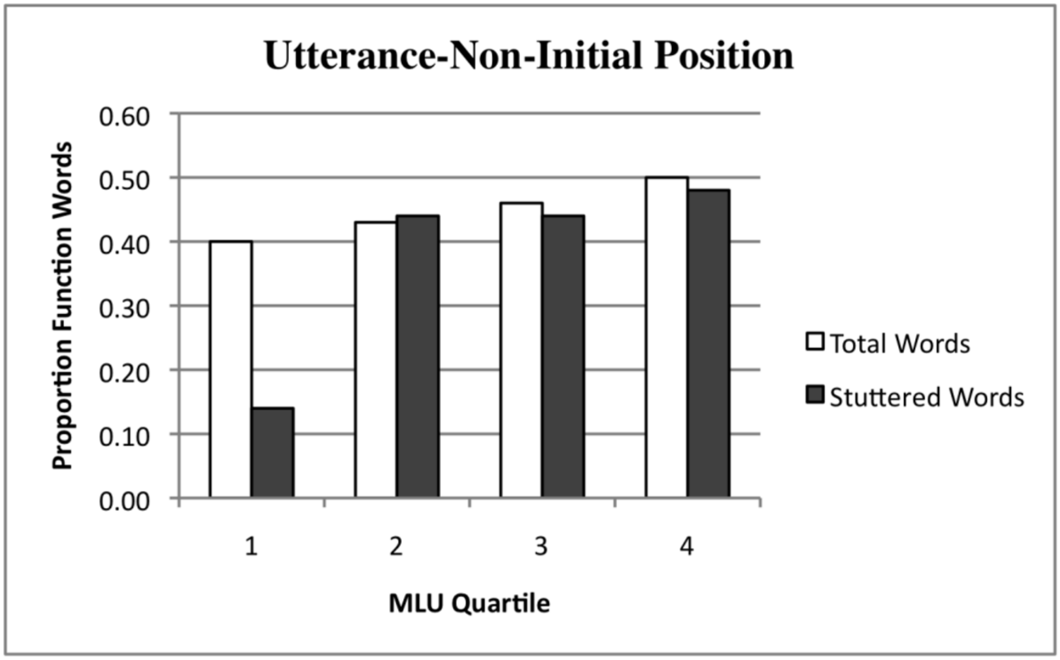

Figure 2.
Proportions of total and stuttered words that were function words at *utterance-non-initial* position across MLU quartiles for all participants (n=30).

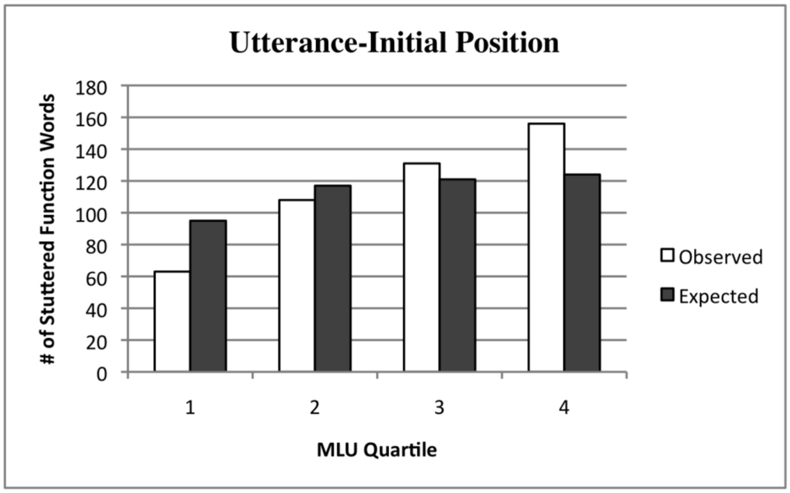

Figure 3.
Expected and observed numbers of stuttered function words across MLU quartiles at utterance-initial position for all participants (n=30).

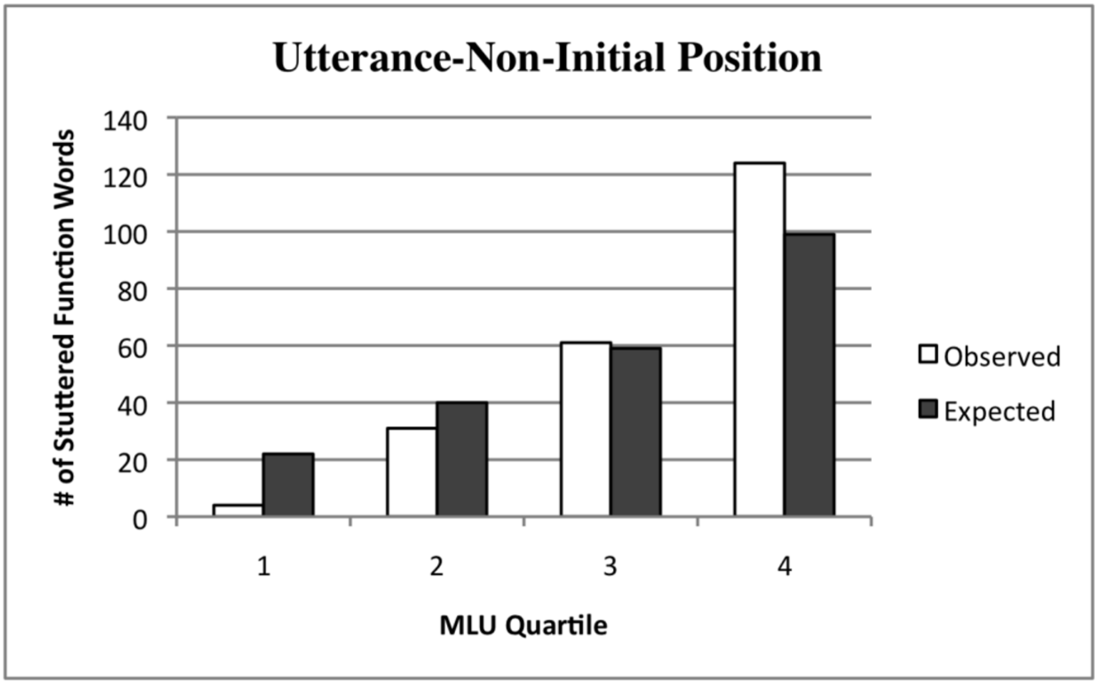

Figure 4.
Expected and observed numbers of stuttered function words across MLU quartiles at utterance non-initial position for all participants (n=30).

Table 1

Proportion of Function Words and Function Words that were Stuttered by Utterance Complexity for Study 1.

	Simple Utterances			Complex Utterances		
	Function	**Total**	**Proportion**	**Function**	**Total**	**Proportion**
Stuttered	735	1117	0.66	255	371	0.69
Total	5872	11,885	0.49	2350	4391	0.54
Proportion	0.13	0.09	-	0.08	0.08	-

Table 2

Proportions of Function Words and Function Words that were Stuttered by Utterance Position for Study 2.

	Initial Position			Non-Initial Position		
	Function	**Total**	**Proportion**	**Function**	**Total**	**Proportion**
Stuttered	458	540	0.85	220	495	0.44
Total	1972	2486	0.79	5106	11,067	0.46
Proportion	0.23	0.22	-	0.04	0.04	-