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Phonological Words and Stuttering on Function Words

James Au-Yeung, **Peter Howell**, and **Lesley Pilgrim**
University College, London, England

Abstract

Stuttering on function words was examined in 51 people who stutter. The people who stutter were subdivided into young (2 to 6 years), middle (6 to 9 years), and older (9 to 12 years) child groups; teenagers (13 to 18 years); and adults (20 to 40 years). As reported by previous researchers, children up to about age 9 stuttered more on function words (pronouns, articles, prepositions, conjunctions, auxiliary verbs), whereas older people tended to stutter more on content words (nouns, main verbs, adverbs, adjectives). Function words in early positions in utterances, again as reported elsewhere, were more likely to be stuttered than function words at later positions in an utterance. This was most apparent for the younger groups of speakers. For the remaining analyses, utterances were segmented into phonological words on the basis of Selkirk's work (1984). Stuttering rate was higher when function words occurred in early phonological word positions than other phonological word positions whether the phonological word appeared in initial position in an utterance or not. Stuttering rate was highly dependent on whether the function word occurred before or after the single content word allowed in Selkirk's (1984) phonological words. This applied, once again, whether the phonological word was utterance-initial or not. It is argued that stuttering of function words before their content word in phonological words in young speakers is used as a delaying tactic when the forthcoming content word is not prepared for articulation.

Keywords

stuttering; phonological words; function words; speech plan

Brown (1945) reported that adults who stutter are more likely to be dysfluent on content words (nouns, main verbs, adverbs, adjectives) than on function words (pronouns, articles, prepositions, conjunctions, auxiliary verbs). Content words are open class words that carry full lexical meanings, whereas function words are closed class words that do not carry a full lexical meaning but, rather, have a grammatical or functional significance (Hartmann & Stork, 1972; Quirk, Greenbaum, Leech, & Svartvik, 1985). Brown attributed the high rate of stuttering on content words to the greater semantic information carried by these words as opposed to function words.

Since Brown's original report, two main qualifications have been made: First, Wingate (1979) reported that there is a higher rate of stuttering on function words when they occur in one of the first three positions in a sentence, whereas content words are stuttered at the same rate across all sentence positions. Second, in contrast to Brown's finding for adults who stutter, Bloodstein and colleagues have found that children who stutter are more dysfluent on function words than on content words (Bloodstein & Gantwerk, 1967; Bloodstein & Grossman, 1981). The latter finding suggests that the inherent linguistic or articulatory properties associated with different word types trigger stuttering in different ways at points

Contact author: Peter Howell, PhD, Department of Psychology, University College London, Gower Street, London WC1E 6BT, U.K..

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during development of the disorder. However, this observation advances our understanding only slightly because relatively little is known about stuttering on function words in comparison with that on content words. This study examines, therefore, some determinants of stuttering on function, as compared to content, words in the speech of people who stutter who ranged in age from 2 to 40 years of age.

As a starting point, we use an account of why dysfluencies occur on function words formulated to explain data from fluent adult speakers. Maclay and Osgood (1959) reported that, for such speakers, 80% of all speech errors involve word repetition (e.g., the word *in* in the phrase *in, in school*). Clark and Clark (1977) interpreted this finding to suggest that such repetition of words when speakers restart sentences delays production of a subsequent word (e.g., *school* in our example) until its plan is available for articulation. On the basis of Clark and Clark's work, Au-Yeung and Howell (1998) suggested that repetition of function words by people who stutter could also be caused by the unavailability of the plan for the subsequent content word.

In order to test the hypothesis that stuttering of function words is caused by unavailability of instructions for the following content word, a principled procedure that allows every function word to be classified as either a pre- or post-content word is needed. In an utterance, the function words preceding the first content word are necessarily before any content word; the utterance-final function words must come after all content words. For example, in *He was well looked after, He* is necessarily pre-content word, whereas *after* is necessarily a post-content word in the utterance. However, other function words in an utterance are not so clear cut (e.g., *I look after my mother* or *Mary walked into the hall*). A scheme based on Selkirk's (1984) phonological word observations is employed for grouping the function words with nearby content words. According to Selkirk, a phonological word consists of a content word and any number of function words that serve as either prefixes or suffixes. Phonological words allow the position of a function word relative to its content word to be specified. Consequently, the prediction that function words that occur before content words should be more dysfluent than those that follow can be tested.

The main purpose of this study was to examine the effects of phonological word and utterance position on the stuttering rate of function words in people who stutter. In addition, we sought to examine these effects across a wide range of ages in order to confirm the changes in pattern of stuttering with age that have been described earlier in the literature (e.g., Bloodstein & Grossman, 1981). We predicted that stuttering on function words would be sensitive to their position within phonological words and that phonological word-initial function words would be related to stuttering irrespective of the position of the phonological words within an utterance. For stuttering rate on content words, we predicted no dependency on phonological word position. To accomplish the goals of the study, we conducted four separate, but related, analyses. In Analysis 1, we examined the effect of word type (i.e., content vs. function word) on stuttering rate. Following this, we analyzed the effect of utterance position on stuttering rate in both content and function words (Analysis 2). In the two subsequent analyses, we separately analyzed phonological words that appear in utterance-initial and non-initial positions to ensure that utterance position effects like those described by Wingate (1979) did not dominate the pattern of results. Specifically, in Analysis 3, we examined the effect of absolute position within phonological word on the stuttering rate of both content and function words. Finally, in Analysis 4, we studied the effect of function word position within a phonological word relative to the content word. That is, we compared the stuttering rates of pre-content and post-content function words.

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Method

Participants

All 51 participants were diagnosed as stuttering by a speech pathologist in a speech pathology clinic in their neighborhood. They were then seen by a second speech pathologist, who independently diagnosed each as a person who stutters. The 51 speakers were recorded in conversational speech with a speech pathologist. The speakers ranged in age from 2 years 7 months to 40 years. They were divided into five different age groups: young, middle, and older children; teenagers; and adults. The young child group had 6 members whose ages ranged from 2 years 7 months to 6 years (mean age was 4 years 2 months). There were 15 children in the middle age group ranging in age from 6 years to 9 years 6 months (mean age, 7 years 3 months). The age range of the 10 children in the older age group was 9 years 6 months to 12 years 7 months (mean age was 11 years 4 months). There were 8 teenagers whose ages ranged from 13 years 11 months to 17 years 1 month (with a mean age of 15 years 8 months). There were 12 adults who were aged between 20 and 40 years (the mean age was 28 years 4 months). The speech data for the young, middle, and older child age groups is the same as that employed by Howell and Au-Yeung (1995a, 1995b), and these also constitute part of the data employed by Kadi-Hanifi and Howell (1992). Additional information about the separate speakers is given in Table 1. The mean length of utterance (MLU) is calculated for each speaker as average number of words across all utterances (see Conti-Ramsden & Jones, 1997 for arguments supporting using MLU in words rather than MLU in morphemes).

Speech Material

Spontaneous speech recordings were made in a relaxed atmosphere after speakers had completed some standard assessment recordings (these involved reading a set-text and a period of dialogue interaction). Topics for conversation, such as family, friends, television, and so on, were suggested to the participants. These topics are suitable for all age groups. The recordings of the participants' speech were transcribed using a broad phonetic transcription in fluent regions and a narrow system in the region of dysfluencies (see Kadi-Hanifi & Howell, 1992 for a detailed description). Transcribers estimated the durations of pauses and prolonged segments to the nearest 50 ms, and these were entered in the transcriptions. Prosodic features including primary and secondary stress, tone levels, and tone unit boundaries were marked, and all words were classified as function or content words. Stuttering episodes marked included word and part-word repetition and segmental or syllabic prolongations. Single word answers such as *yes* or *no* were excluded from analysis. In the analyses, the data contained 3,764 words (1,630 content words, 2,134 function words) for the young group; 7,699 words (3,555 content words, 4,144 function words) for the middle group; 6,434 words (3,039 content words, 3,395 function words) for the older group; 3,647 words (1,742 content words, 1,905 function words) for the teenager group; and 19,201 words (8,546 content words, 10,655 function words) for the adult group.

Segmenting Phonological Words

According to Selkirk (1984), only content words are real words phonologically. Function words serve as affixes to content words. So a phonological word is defined as consisting of a content word and any number of function words that serve as prefixes or suffixes to it (F_nCF_m). All function words must be included within the phonological word containing either the last or the next content word. Because our definition of phonological words is based on Selkirk's phonological observations, they potentially offer a way of examining the speech formulation processes that, when they operate defectively, can lead to speech dysfluencies such as stuttering.

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In order to segment the phonological words, semantic sense unit rules[1] proposed by Selkirk (1984) are employed to decide whether a function word is a prefix to the subsequent, or suffix to the preceding, content word. The rules require that a function word must form a sense unit with the content word with which it is associated. The semantic sense unit rules employed to establish which phonological word a function word belongs to are as follows:

> Two constituents C_i and C_j form a sense unit if one of the following is true of the semantic interpretation of the utterance (C_k is another constituent in the same utterance):
>
> 1. C_i modifies C_j (a head)
> 2. C_i is an argument of C_j (a head).
> 3. both C_i and C_j modify C_k (a head).
> 4. both C_i and C_j are arguments of C_k (a head).
>
> Rules (1) and (2) are due to Selkirk (1984), and they have precedence over our extensions, (3) and (4).

To illustrate how these rules are applied, a preposition that forms part of a phrasal verb, as in *look after* in *I look after my mother*, is considered semantically part of the verb instead of part of the prepositional phrase that has the following noun phrase as an argument. For ordinary prepositional phrases such as *into the hall* in *Mary walked into the hall, the hall* is an argument of *into* and so *into the hall* forms a sense unit. Thus, the examples would have the following segmentations into phonological words: / *I look after* / *my mother* / and / *Mary* / *walked* / *into the hall* /.[2]

Reliability Measures

Interjudge reliability measures were carried out by asking a second transcriber to retranscribe speech materials from 8 speakers chosen at random. The agreement between the two judges on content/function word was 98% giving a kappa coefficient of .96, which is much higher than chance (Fleiss, 1971). Interjudge agreement of fluency was 96% on all words, with a kappa coefficient of .92.

All speech materials were segmented into separate utterances using intonation profiles. An utterance is defined as consisting of one or more tone units, and it is preceded and followed by a silent interval (Kreidler, 1997). Every tone unit has a coherent intonation and one accented nucleus syllable. Interjudge agreement for utterance segmentation calculated from the retranscription of speech materials from the second transcriber was 89% (the average of the percentage of utterances segmented by the first transcriber and agreed to by the second transcriber and vice versa). The speech materials were also segmented into phonological words according to the definition given above. The agreement between the two judges for

[1]Note that Selkirk's semantic sense unit for intonational phrasing can include more than one content word, whereas our definition of phonological word allows only one content word.

[2]It should be noted that phonological word-initial position does not necessarily correspond with clause (Wall, Starkweather, & Cairns, 1981) or syntactic unit (Bloodstein & Grossman, 1981) initial position, which are other linguistic contexts that are correlated with stuttering. The following examples illustrate these differences.

1. *The man* / *from the agency* / *was looking for* / *the fugitive*.

Here, *from* is not clause-initial but is phonological word-initial.

2. *I have* / *faith in him*.

Here *in* is prepositional phrase-initial but not phonological word-initial.

segmenting the speech material into phonological words was 98% (calculated in a similar way as the above calculation for utterance segmentation).

Results

Analysis 1

The total number of content and function words and the proportion of these that were stuttered were computed for all individual speakers irrespective of where the words were positioned in an utterance. Stuttering rate for the selected group of words—for example, content words—was calculated by dividing the total number of content words that were stuttered (dysfluent) by the total number of content words (fluent plus dysfluent) spoken for each speaker. In order to compare the stuttering rates of function words and content words, a Wilcoxon matched pairs signed-ranks test was carried out on stuttering rate for each age group. The young group had a significantly higher stuttering rate on function than on content words ($n = 6$, $T = 0$, $p < .05$). There was no significant effect for the middle group ($n = 15$, $T = 51$, $p = .629$) though the trend was that a higher proportion of function words were stuttered than content words. The older group ($n = 10$, $T = 12$, $p = .126$), teenager group ($n = 8$, $T = 9$, $p = .234$), and adult group ($n = 12$, $T = 33$, $p = .666$) showed the opposite trend (a higher proportion of content words than function words were stuttered) though these effects were not significant. When the data of the oldest three groups of speakers were pooled, a Wilcoxon matched pairs signed-ranks test showed that a higher proportion of content words were stuttered than function words ($n = 30$, $T = 130$, $p < .05$). Thus, the results showed that the younger speakers were more dysfluent on function words than content words, whereas the older speakers were more dysfluent on content words than function words.

Analysis 2

This analysis examined the utterance position effect on the stuttering of function and content words. It is similar to the one performed by Wingate (1979), but his study used read sentences rather than spontaneous material. The position and type of all lexical words within each utterance was obtained, which contrasts with Wingate's study. That study divided words into two groups: those that were in the first three positions in an utterance and those at other utterance positions. In the current analysis, content words were examined first, and the utterance position of all individual content words was established. All the content words that appeared in the first position in an utterance were collected together and similarly for positions two through five (giving six categories in all). All words that appeared in a position later than sixth in an utterance were assigned to the same group (seven plus).[3] Stuttering rate was then calculated for each of these seven utterance positions. The stuttering rate for content word in utterance position, i, was calculated by dividing the number of stuttered content words in this position, S_i, by the total number of content words (fluent plus dysfluent) found in this position, T_i.

Because stuttering rates varied between speakers within each age group (see Table 1), standard normal deviates (z scores) were calculated for stuttering rates for each speaker so that within age group analysis could be made. The z transformation was applied to each individual speaker and produces a mean stuttering rate across utterance positions of 0 and SD of 1. The z score for each utterance position represents the number of SDs away from his or her mean stuttering rate. After the transformation, statistical comparisons within age groups is possible. A one-way ANOVA was carried out across speakers within each age

[3]The number of word positions used was based on inspection of the data to ensure data are available for all speakers for the selected word positions to ensure that comparison can be made across speakers. Because of the nature of spontaneous speech, the number of content or function words at each word position could not be controlled and, therefore, cannot be made equal.

group with the *z* score as the dependent variable and the seven utterance positions as the independent variable. No significant result or trend was found except for the young group [$F(6, 35) = 2.56$, $p < .05$, mean square error (*MSE*) = .834]. Post hoc Tukey tests were performed for each age group over utterance positions which showed that the young group had a significantly higher rate of stuttering for content words in the first two utterance positions as opposed to the remaining positions. The mean *z* scores for each age group for the seven utterance positions are plotted in Figure 1. The comparative lack of position effects on content words that was found for all age groups is consistent with what Wingate (1979) found for adults.

A similar analysis was carried out for function words. The six utterance positions used here were one to five and six plus. Stuttering rates of function words at different utterance positions were calculated in a similar fashion to the content words. Speakers in all age groups had a higher stuttering rate on utterance-initial function words than function words found at other utterance positions. The different standardized stuttering rate over utterance position was significant in ANOVA tests for the young [$F(5, 30) = 42.78$, $p < .001$, *MSE* = .148], middle [$F(5, 84) = 14.82$, $p < .001$, *MSE* = .569], and older [$F(5, 54) = 3.48$, $p < .01$, *MSE* = .840] groups. The effect of utterance position approached significance for the adult speaker group [$F(5, 66) = 2.28$, $p < .06$, *MSE* = .930], but the teenager group showed only a slight trend in the same direction [$F(5, 42) = 1.56$, *NS, MSE* = .964]. Post hoc Tukey tests showed that stuttering rate was higher on utterance-initial function words than on function words in other utterance positions. The means of the standardized scores are shown in Figure 2 for each age group. The marked position effects on function words, found to apply across age groups, corresponds once again with what Wingate (1979) found on adults.

Analysis 3

In this analysis, the effect of absolute position of content and function words within a phonological word was assessed. Utterances were first segmented into phonological words. Analyses of the normalized stuttering rate (*z* score) over phonological word position (the four phonological word positions used were one to three and four plus) were then performed separately on phonological words occupying utterance-initial position and those at other utterance positions. For the utterance-initial phonological words, the stuttering rate for content word in phonological word position, i, was calculated by dividing the number of stuttered content words in this position, S_i, by the total number of content words (fluent plus dysfluent) found in this position, T_i. The *z* transformation was obtained for each individual speaker so that the mean stuttering rate across phonological word positions was 0 and the *SD* was 1. The calculation of the stuttering rates of function words at different phonological word positions was carried out in a similar fashion.

For the utterance-initial phonological words, function words at phonological word-initial positions had a higher rate of stuttering than those found at other positions within phonological words. One-way ANOVA tests were performed for each age group to test the effect of the four phonological word positions using the standardized stuttering rates. The results were highly significant for all age groups: young, [$F(3, 20) = 43.84$, $p < .001$, *MSE* = .158]; middle, [$F(3, 56) = 14.48$, $p < .001$, *MSE* = .603]; older, [$F(3, 32) = 12.59$, $p < .001$, *MSE* = .516]; teenager, [$F(3, 24) = 10.23$, $p < .001$, *MSE* = .512]; adult, [$F(3, 44) = 13.89$, $p < .001$, *MSE* = .560].[4] Post hoc Tukey tests were carried out for each age group, and the results showed that phonological word-initial function words were stuttered more than function words in other positions. This analysis indicates that the position of function words

[4]One of the 10 speakers from the oldest child group and one of the 8 speakers from the teenager group did not produce any function words in their utterance-initial phonological words. These speakers were dropped from this analysis.

has a determining effect on stuttering rate. The mean *z* scores across utterance positions are shown for each age group in Figure 3.

The corresponding analyses were carried out on the phonological words that were not in utterance-initial positions. All groups showed significantly higher rates of stuttering when the function words were in initial position in a phonological word: young, [$F(3, 20) = 26.93$, $p < .001$, $MSE = .238$]; middle, [$F(3, 56) = 15.39$, $p < .001$, $MSE = .587$]; older, [$F(3, 36) = 7.55$, $p < .001$, $MSE = .682$]; teenager, [$F(3, 28) = 4.28$, $p < .05$, $MSE = .784$]; adult, [$F(3, 44) = 6.44$, $p < .005$, $MSE = .758$]. The mean *z* scores over utterance positions for each age group are plotted in Figure 4.

In contrast to the function words, the corresponding analyses performed on content words obtained no significant effects of stuttering rate on content words with respect to the phonological word positions. This applied to both utterance-initial phonological words and the utterance non-initial phonological words. Therefore, position effects in phonological words occurs only for function words.

Although the current analysis showed that function words at phonological word-initial position were stuttered more than function words at other positions, it does not conclusively determine whether this is due to the effect of a word's position in an utterance as found in Analysis 2.[5] In order to establish that the phonological word position effect is the main determinant rather than utterance position, the raw (untransformed) stuttering rate of the function words at the phonological word final position (four plus) of the utterance-initial phonological words and the stuttering rate of the function words at the first position of the non utterance-initial phonological words were compared using the Wilcoxon matched pairs signed-ranked test. The result showed that stuttering rate of the function words that appeared late in utterance-initial phonological words had a lower stuttering rate than function words that appeared in initial position in utterance non-initial phonological words (young, $n = 6$, $T = 3$, $p = .142$; middle, $n = 14$, $T = 19$, $p < .05$; older, $n = 10$, $T = 10$, $p = .083$; teenager, $n = 8$, $T = 0$, $p < .05$; adult, $n = 12$, $T = 5$, $p < .01$). That is, given an utterance containing two function words F_1 (final in utterance initial phonological word) and F_2 (initial in utterance non-initial phonological word), [....F_1]....[F_2....]..., F_2 is stuttered more than F_1 in spite of F_1's earlier position in an utterance. This analysis shows that a pure utterance position effect cannot account for the effects of phonological word position.

Analysis 4

If the mechanism of delaying production of content words operates within phonological words, then a higher stuttering rate should occur for pre-content function words as opposed to post-content function words for all utterance positions. To test this, every function word was classified as being either pre- or post-content within a phonological word separately for utterance-initial phonological words and for those in other utterance positions. Stuttering rate was then calculated for each of the two classes of function word and two utterance positions. The stuttering rate of pre-content function words for individual speakers was calculated by dividing the number of stuttered function words that were found at pre-content word location within phonological words by the total number of function words (fluent plus dysfluent) found at such locations. Stuttering rates for post-content function words were calculated in a similar fashion. Separate calculations were carried out on utterance-initial phonological words and non-utterance-initial phonological words, as in Analysis 3.

[5]This analysis was suggested by one of the anonymous reviewers.

Separate Wilcoxon matched pairs signed-ranked tests were performed to test whether stuttering rates on the pre- and post-content function words differed and whether this applied across utterance positions. The Wilcoxon tests on utterance-initial phonological words showed that stuttering rates of pre- and post-content function words were significantly different for all age groups (young, $n = 6$, $T = 0$, $p < .05$; middle, $n = 15$, $T = 1$, $p < .005$; older, $n = 9$, $T = 0$, $p < .01$; teenager, $n = 7$, $T = 0$, $p < .05$; adult, $n = 12$, $T = 6$, $p < .05$).[6] Similar Wilcoxon tests on the non-initial phonological words were also significant for each group (young, $n = 6$, $T = 0$, $p < .05$; middle, $n = 15$, $T = 12$, $p < .01$; older, $n = 10$, $T = 0$, $p < .01$; teenager, $n = 8$, $T = 1$, $p < .05$; adult, $n = 12$, $T = 0$, $p < .005$). The percentage of stuttered function words that occurred before and after the content word are shown in Figure 5 for the utterance-initial phonological words for each age group. Similar data for non-initial phonological words are shown in Figure 6. These figures show that the percentage of function words that are stuttered in pre-content word positions is dramatically higher than post-content words for all age groups irrespective of utterance position.

Discussion

More stuttering occurred on content words than function words for older children, teenagers and adults as Brown (1945) reported. There was more stuttering on function words for the youngest and second youngest children, which is consistent with Bloodstein and Gantwerk's (1967) and Bloodstein and Grossman's (1981) findings. The ages of the children in the youngest group were almost the same as the ages of the children in the group used by Bloodstein and his colleagues. In the current analyses, the change of pattern of stuttering across age groups has been demonstrated for the first time within a single study. Such a developmental change was argued for strongly by Bloodstein, based on a comparison with Brown's (1945) and Bloodstein and colleagues' own studies. Here high stuttering rate switched over from function to content words between the middle and older children groups (around 9 years of age).

Position effects within utterances were examined in Analysis 2. Considering content words first (Figure 1), there was little dependency of stuttering rate over utterance positions for all age groups. Stuttering rate in early positions was only significantly higher for the youngest speakers tested. To the extent to which this analysis paralleled Wingate's (1979), this finding confirmed that for the majority of age groups, position of a content word in an utterance did not affect whether it was stuttered. For function words, in contrast, the three youngest age groups all showed a markedly higher stuttering rate on function words in initial position in an utterance, and such a trend existed for the adult speakers too. Thus, these analyses confirm Wingate's finding that stuttering rate on function words in early positions in an utterance was higher than in later positions. The developmental differences on function words may be interpreted as showing that as people who stutter get older (and presumably have persisted in the disorder for a longer time), utterance position-dependent influences on stuttering for function words becomes less marked. Alternatively, it may be the case that younger speakers start utterances more often with function words than do older speakers. The apparent decrease in stuttering rate on function words would be due, in the latter case, to spurious differences that arise because of decreases in function word usage as age increases. To check whether this happened, the proportion of utterances that started with a function word was calculated for each speaker in an age group and then averaged over speakers; 54% ($SD = 7\%$) of utterances for the youngest children started with function words, 60% ($SD = 17\%$) for the middle group of children, 53% ($SD = 5\%$) for the older children, 75% ($SD = 12\%$) for the teenagers, and 76% ($SD = 7\%$) for the adults. These data

[6]One subject was dropped from the oldest child group and one from the teenager group—in both cases because the differences in stuttering rates of pre- and post-content function words was 0.

show that there is a marked increase in the proportion of utterances starting with function words for the two oldest groups even though stuttering rate on function words decreases for these speakers. It appears, therefore, that stuttering rate differences cannot be explained by a change in usage of word types over age groups.

The rest of the analyses tested whether phonological word units can help explain the difficulties that people who stutter experience. Analysis 3 examined whether there was any dependence of stuttering rate on ordinal position within phonological words for function words and for the content words. Higher stuttering rates on words occupying early phonological-word positions occurred for function words in initial- and non-initial utterance position. This analysis demonstrated that the influence of position of a word in a phonological word applied across different utterance positions and was not restricted to phonological words that appear in utterance-initial position. The same analysis was carried out on content words, and the results showed that the stuttering rate of content words does not vary with their position within phonological words. This supports the hypothesis that there are different reasons for why dysfluencies occur on function words as opposed to content words; it also supports the usefulness of phonological words for dysfluency analysis.

Analysis 4 showed that stuttering rate was higher when function words occurred before the content word than when the function word appeared after the content word in a phonological word. This was true whether the phonological word was in utterance-initial position or not. The fact that only pre-content function words had a higher rate of stuttering once again supports the use of phonological work as a unit in stuttering analysis. The fact that the effects occurred whatever utterance position they occupied shows that segmentation of an utterance into phonological words is a more appropriate analysis procedure than treating the utterance overall. Wingate's (1979) result of higher stuttering rate in sentence-initial position may be accounted for assuming that speakers organize their speech in terms of phonological words or utterances. The phonological word effects in non-initial position, however, cannot be explained if only utterance- or sentence-initial effects are assumed.

The finding that the stuttering on function words depends on the position they occupy within a phonological word offers support to the theoretical position outlined in the introduction. The essential details of this are that the speech plan of a content word is unavailable because planning of such words is relatively slow because of their more complex semantic content, their phonetic composition, and their greater length when compared to function words. This does not mean people who stutter have inherently slower articulatory movement than normally fluent speakers. The difference is in the way these speaker groups respond when articulatory instructions are not completely available. In childhood stuttering, function words are repeated to gain time so that the speech plan for the upcoming content word has time to become available to the articulator and can be executed fluently. Dysfluency arising because the speech plan is unavailable has been supported in the self-repair literature on fluent speakers (Blackmer & Mitton, 1991), and repetition of words in fluent speakers has been explained as a tactic for delaying production of the following words until its speech plan arrives (Clark & Clark, 1977). In our theory, repetition occurs on function words, and this repetition is essential for maintaining fluency when a speech plan is not available. This essentially fluent mechanism of repeating function words is gradually replaced by some other process that triggers persistent stuttering on content words as the disorder develops. The exact nature of this process still needs to be investigated, but some clues already exist. Au-Yeung and Howell (1998) have highlighted that these changes reflect a shift from word-external determinants (e.g., a word's position relative to other words in the context of the utterance) to word-internal determinants (e.g., phonological composition of word). Related to this, Bernstein Ratner (1997) has suggested that the onset of stuttering in young children coincides with the same period at which children start making self-repairs. Generally

speaking, further work is needed to establish the relationship between types of stuttering and repairing over age groups in term of type variability and frequency. Our current data suggests that it is important to focus attention around age 9 years.

The theoretical view just proposed contrasts with Postma and Kolk's Covert Repair Hypothesis (CRH). CRH maintains that stuttering is a by-product of repairing covert phonemic errors in the speech plan (not yet executed) resulting from a defect in the phonological encoding process. When these errors are detected, speakers restart the phonological encoding process for the error word (Kolk & Postma, 1997; Postma, 1997; Postma & Kolk, 1992, 1993). Our explanation is fundamentally different from CRH in that it proposes that the speech plan is available for execution late as opposed to CRH's explanation that the speech plan is erroneous and, therefore, has to be recomputed. CRH cannot account for the high level of stuttering on function words in young children who stutter, whereas our theory on the stuttering on function words offers an explanation of this and how stuttering changes over time from occurring mainly on function words to content words.

The chosen definition of phonological word and its application to segmentation of the speech of speakers who stutter was made initially so that function words could be classified as either pre- or post-content words. The role of phonological words, as we define them, in the whole speech planning process needs further exploration. However, we believe that our phonological word segmentation procedure offers insight into the phonological encoding process as shown by the association of stuttering frequency at positions in this unit.

To summarize, this study is a first step in verifying Au-Yeung and Howell's (1998) hypothesis that stuttering on function words depends on their (lexical) word-external factors (i.e., position relative to content words within phonological words). Stuttering on content words, on the other hand, may be governed by (lexical) word inherent factors such as the phonetic composition (Howell, Au-Yeung & Sackin, 1998), semantic content, word length or frequency of occurrence. Therefore, our results call for future research into linguistic factors in stuttering and, in particular, to treat content and function words separately.

Finally, a word of caution is in order on the use of phonological words. Phonological words were defined in this study in terms of English phonology. Hence they may not be immediately portable to other languages. In other languages, there may not necessarily be a content word in every phonological word. In English, function words are usually shorter than content words and are not usually stressed. This may be different in other languages. For example, the first- and second-person pronouns in Japanese have three syllables, but a lot of nouns and verbs only have two syllables. Thus, it may be necessary to carry out further research in other languages to test the theory's general applicability. Although stuttering is a universal phenomenon, many linguistic characteristics are not language-universal. It is still certainly necessary to continue to seek factors common to many languages, bearing in mind the ubiquity of stuttering.

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References

Au-Yeung J, Howell P. Lexical and syntactic context and stuttering. Clinical Linguistics and Phonetics. 1998; 12:67–78.

Bernstein Ratner, N. Linguistic and self-monitoring skills at the onset of stuttering; Paper presented at the 2nd World Congress on Fluency Disorders; San Francisco, CA. 1997, August;

Blackmer ER, Mitton JL. Theories of monitoring and the timing of repairs in spontaneous speech. Cognition. 1991; 39:173–194. [PubMed: 1841032]

Bloodstein O, Gantwerk BF. Grammatical function in relation to stuttering in young children. Journal of Speech and Hearing Research. 1967; 10:786–789. [PubMed: 5586944]

Bloodstein O, Grossman M. Early stutterings: Some aspects of their form and distribution. Journal of Speech and Hearing Research. 1981; 24:298–302. [PubMed: 7265947]

Brown SF. The loci of stutterings in the speech sequence. Journal of Speech Disorders. 1945; 10:181–192.

Clark, HH.; Clark, E. Psychology and language: An introduction to psycholinguistics. New York: Harcourt; 1977.

Conti-Ramsden G, Jones M. Verb use in specific language impairment. Journal of Speech, Language, and Hearing Research. 1997; 40:1298–1313.

Fleiss JL. Measuring nominal scale agreement among many raters. Psychological Bulletin. 1971; 76:378–382.

Hartmann, RRK.; Stork, FC. Dictionary of language and linguistics. London: Applied Science Publishers; 1972.

Howell P, Au-Yeung J. Syntactic determinants of stuttering in the spontaneous speech of normally fluent and stuttering children. Journal of Fluency Disorders. 1995a; 20:317–330.

Howell P, Au-Yeung J. The association between stuttering, Brown's factors and phonological categories in child stutterers ranging in age between 2 and 12 years. Journal of Fluency Disorders. 1995b; 20:331–344.

Howell, P.; Au-Yeung, J.; Sackin, S. Internal structure of content words leading to lifespan differences in phonological difficulty in stuttering. 1998. Manuscript submitted for publication

Kadi-Hanifi K, Howell P. Syntactic analysis of the spontaneous speech of normally fluent and stuttering children. Journal of Fluency Disorders. 1992; 17:151–170.

Kolk, H.; Postma, A. Stuttering as a covert repair phenomenon. In: Curlee, RF.; Siegel, GM., editors. The nature and treatment of stuttering: New directions. 2nd ed.. New York: Allyn & Bacon; 1997.

Kreidler, CW. Describing spoken English: An introduction. London: Routledge; 1997.

Maclay H, Osgood CE. Hesitation phenomena in spontaneous English speech. Word. 1959; 15:169–182.

Postma, A. On the mechanisms of speech monitoring. In: Hulstijn, W.; Peters, HFM.; van Lieshout, PHHM., editors. Speech production: Motor control, brain research and fluency disorders. Amsterdam: Elsevier Science Publishers; 1997.

Postma A, Kolk H. Error monitoring in people who stutter: Evidence against auditory feedback defect theories. Journal of Speech and Hearing Research. 1992; 35:1024–1032. [PubMed: 1447913]

Postma A, Kolk H. The Covert Repair Hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. Journal of Speech and Hearing Research. 1993; 36:472–487. [PubMed: 8331905]

Quirk, R.; Greenbaum, S.; Leech, G.; Svartvik, J. A comprehensive grammar of the English language. London: Longman; 1985.

Selkirk, E. Phonology and syntax: The relation between sound and structure. Cambridge, MA: MIT Press; 1984.

Wall MJ, Starkweather CW, Cairns HS. Syntactic influences on stuttering in young stutterers. Journal of Fluency Disorders. 1981; 6:283–298.

Wingate ME. The first three words. Journal of Speech and Hearing Research. 1979; 22:604–612. [PubMed: 502517]

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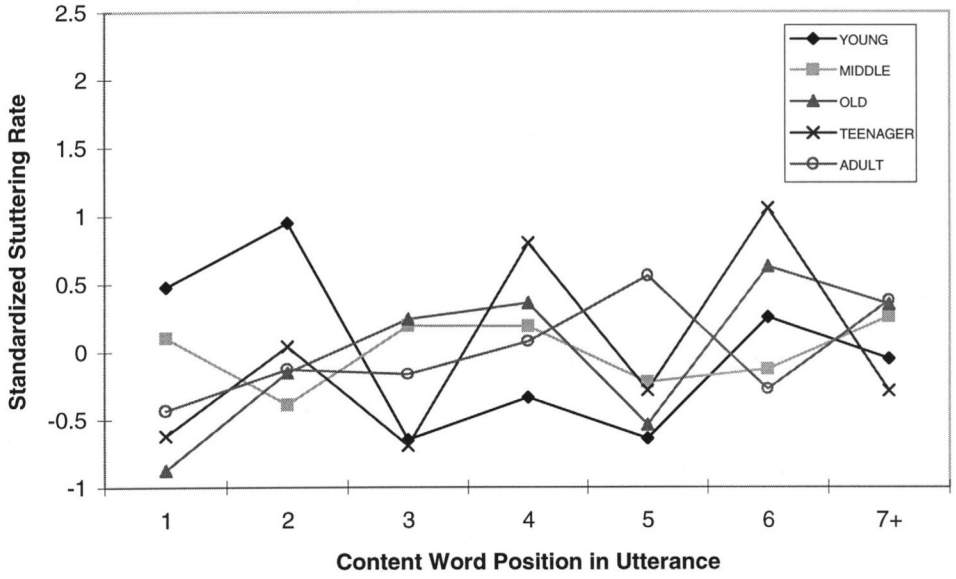

Figure 1.
The mean normalized scores for stuttering rates of content words across utterance positions for the five age groups (young, middle, older children; teenagers; and adults).

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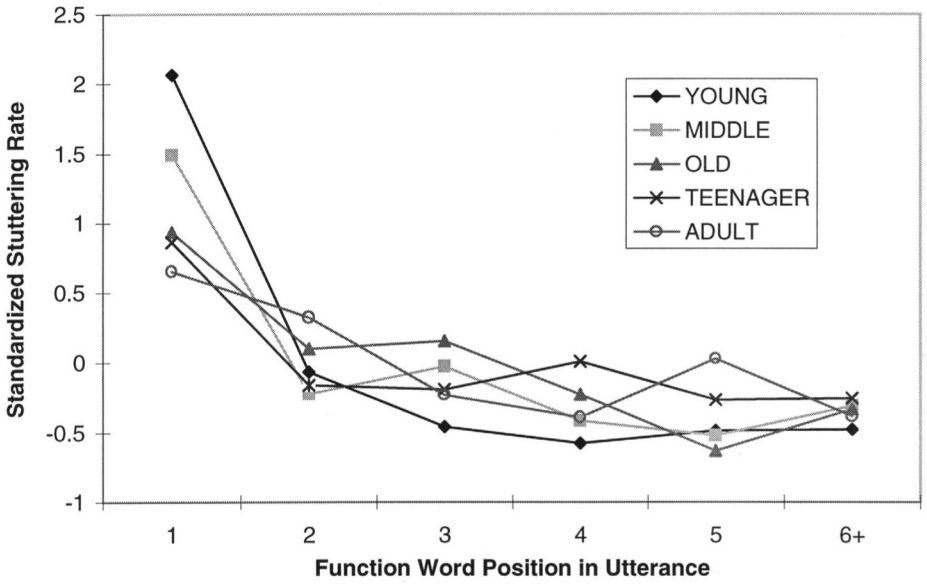

Figure 2.
The mean normalized scores for stuttering rates of function words across utterance positions for the five age groups (young, middle, older children; teenagers; and adults).

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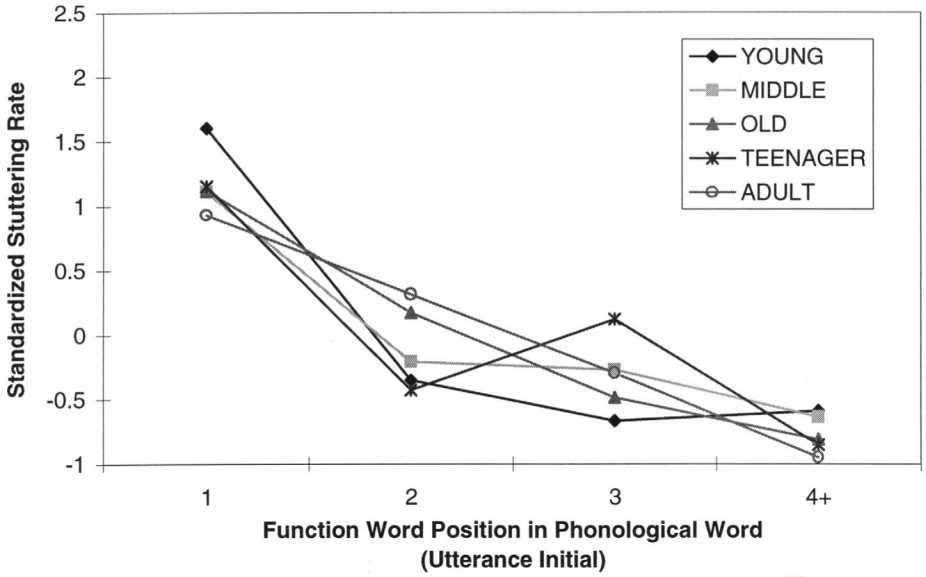

Figure 3.
The means of normalized scores for stuttering rates of function words across word positions within utterance-initial phonological words for the five age groups (young, middle, older children; teenagers; and adults).

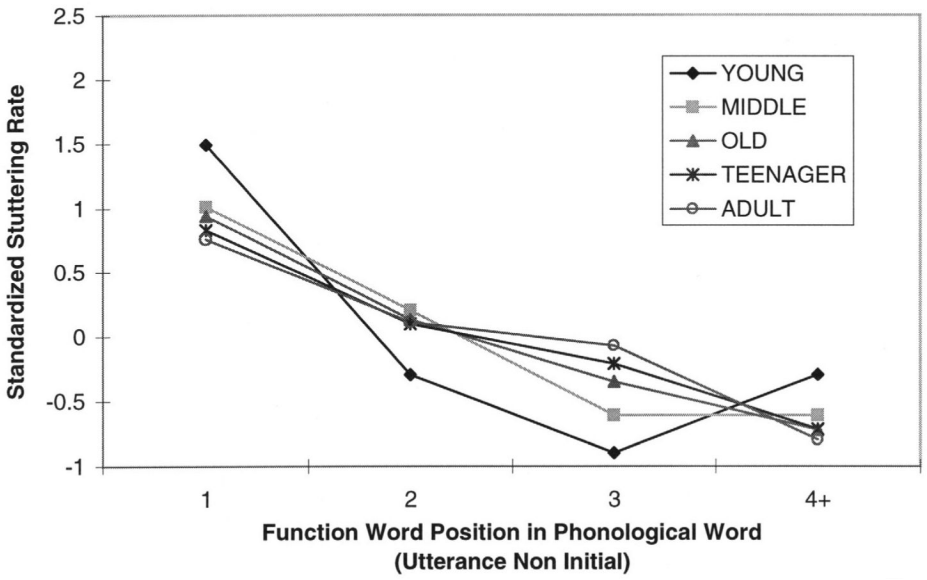

Figure 4.

The means of normalized scores for stuttering rates of function words across word positions within utterance non-initial phonological words for the five age groups (young, middle, older children; teenagers; and adults).

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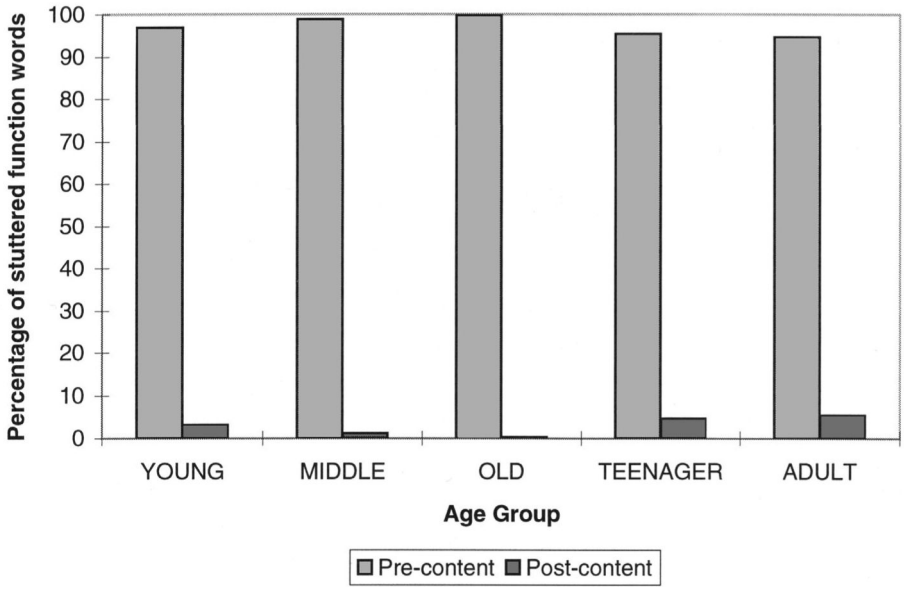

Figure 5.
Percentage of stuttering of function words in utterance-initial phonological words distributed according to pre- or post-content words for the five age groups (young, middle, older children; teenagers; and adults).

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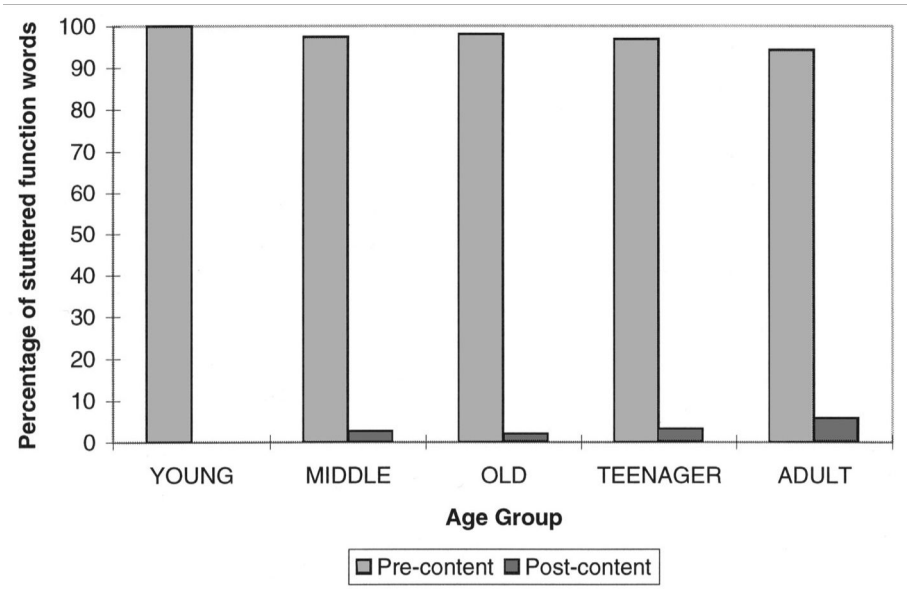

Figure 6.
Percentage of stuttering of function words in utterance non-initial phonological words distributed according to pre- or post-content words for the five age groups (young, middle, older children; teenagers; and adults).

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Table 1

Information on individual participants. Grouped according to age (year:month), gender, mean length of utterance (number of words per utterance), and stuttering rate (percentage of words stuttered).

Participant	Age	Gender	MLU	Stuttering rate
		Young		
Y1	6:9	M	9.03	15.82
Y2	4:2	F	8.41	13.01
Y3	5:0	M	4.11	5.49
Y4	6:0	M	7.21	6.10
Y5	5:0	M	3.57	11.06
Y6	3:0	F	4.12	7.19
		Middle		
M1	9:4	M	8.72	4.19
M2	9:6	F	3.51	15.36
M3	7:3	M	7.67	6.52
M4	8:0	M	7.12	9.28
M5	8:11	F	4.16	4.90
M6	9:0	M	11.47	5.96
M7	7:0	M	10.60	9.81
M8	8:9	M	4.74	6.87
M9	7:0	M	3.69	31.90
M10	8:0	M	7.24	13.62
M11	9:3	M	3.15	6.35
M12	8:0	F	5.61	9.38
M13	8:0	F	5.96	7.28
M14	8:0	M	7.40	15.62
M15	8:0	M	7.68	11.76
		Older		
O1	11:3	M	13.98	3.93
O2	10:4	F	4.65	8.44
O3	10:6	M	5.36	32.68
O4	11:3	M	17.25	8.62

Participant	Age	Gender	MLU	Stuttering rate
O5	12:0	M	6.47	17.31
O6	11:0	M	6.50	23.74
O7	11:1	F	7.82	4.57
O8	12:1	M	7.69	15.38
O9	10:3	M	6.56	20.12
O10	11:3	M	6.58	24.59
		Teenager		
T1	16:8	M	11.70	2.91
T2	16:4	M	14.05	1.05
T3	14:5	M	17.22	4.82
T4	13:11	F	13.47	35.94
T5	14:2	M	13.00	7.69
T6	17:1	M	10.22	11.91
T7	15:7	M	12.96	2.62
T8	16:11	M	10.33	39.92
		Adult		
A1	40:0	M	9.63	1.75
A2	26:0	M	14.79	10.48
A3	25:0	M	14.46	5.72
A4	30:0	M	9.38	15.23
A5	25:0	M	10.06	3.11
A6	28:0	M	9.53	8.51
A7	35:0	M	10.85	13.83
A8	24:0	M	9.34	2.70
A9	20:0	M	9.48	8.67
A10	40:0	M	10.90	20.81
A11	21:0	M	6.33	9.23
A12	25:0	M	7.42	11.53

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