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Stuttering on function and content words across age groups of German speakers who stutter

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Abstract

Recent research into stuttering in English has shown that function word disfluency decreases with age whereas content words disfluency increases. Also function words that precede a content word are significantly more likely to be stuttered than those that follow content words (Au-Yeung, Howell and Pilgrim, 1998; Howell, Au-Yeung and Sackin, 1999). These studies have used the concept of the phonological word as a means of investigating these phenomena. Phonological words help to determine the position of function words relative to content words and to establish the origin of the patterns of disfluency with respect to these two word classes. The current investigation analysed German speech for similar patterns. German contains many long compound nouns; on this basis, German content words are more complex than English ones. Thus, the patterns of disfluency within phonological words may differ between German and English. Results indicated three main findings. Function words that occupy an early position in a PW have higher rates of disfluency than those that occur later in a PW, this being most apparent for the youngest speakers. Second, function words that precede the content word in a PW have higher rates of disfluency than those that follow the content word. Third, young speakers exhibit high rates of disfluency on function words, but this drops off with age and, correspondingly, disfluency rate on content words increases. The patterns within phonological words may be general to German and English and can be accounted for by the EXPLAN model, assuming lexical class operates equivalently across these languages or that lexical categories contain some common characteristic that is associated with fluency across the languages.

Keywords

Stuttering; German; function and content words

Introduction

Speakers who stutter do not have problems on every word they speak. The linguistic characteristics of words may determine which words these speakers who stutter have problems with. Investigations have established that the lexical category of a word (Brown, 1945; Howell, Au-Yeung and Sackin, 1999), its phonological structure (Brown, 1945; Howell and Au-Yeung, 1995; Howell, Au-Yeung and Sackin, 2000), word frequency (Hubbard and Prins, 1994), and the context in which words occur (Brown, 1945; Silverman

and Ratner, 1997; Yaruss, 1999; Logan, 2001) all help determine whether or not adults who stutter experience problems on a stretch of speech. Researchers have given precedence to different factors. Dayalu, Kalinowski, Stuart, Holbert and Rastatter (2002), for instance, have emphasized the importance of word frequency (words with low frequency are more prone to stuttering than those that occur with high frequency). This factor, like lexical stress and phonological structure, is correlated with lexical class, making it difficult to establish what is the operative property and what is epiphenomenal.

To explain the latter point more fully, the two gross lexical categories of words, function and content, are considered. Linguistically, function words are a closed class of words that do not carry full lexical meaning, but have a grammatical or functional role. This class includes pronouns, articles, prepositions, conjunctions and auxiliary verbs. Function words contain a set of highly practised high frequency words that are usually short (predominantly monosyllabic) in both English and German. A content word's main role is to convey semantic information and it has the property of being open class. Content words comprise nouns, main verbs, adverbs, and adjectives (see Hartmann and Stork, 1972; Quirk, Greenbaum, Leech and Svartvik, 1985). Brown's research into lexical category (summarized in Brown, 1945) has been interpreted by subsequent researchers as demonstrating the importance of the function – content distinction in establishing whether or not a word will be stuttered. In English, the words that are stuttered are mainly content words, compared to function words, these have complex phonological properties (Howell et al., 2000), are low in frequency (Quirk and Stein, 1990) and carry lexical stress (Wingate, 1984).

Wingate (2002) recognized the usefulness of the content/function distinction as a characteristic that, stochastically, reflects several of the known determinants of stuttering. At the same time, however, he emphasized the importance of stress. Stress indicates the importance of a word in the meaning of a sentence and Wingate noted that stress occurs differentially on words of the various grammatical types that make up the content word category (and can even occur on some grammatical types in the function word category in specially contrived circumstances). This perspective on the function – content distinction as it pertains to stuttering incidence corresponds with Howell and Au-Yeung's (2002) view that the content – function distinction should be regarded, at least at present, as a heuristic device that incorporates several known determinants of stuttering.

The words on which disfluency is observed in childhood are principally function words (Bloodstein and Grossman, 1981; Bloodstein and Gandtwerk, 1967). This would also mean that these are unstressed words that have a high frequency and are simpler phonologically in English than content words. There is also a change in the locus of stuttering from repetition of the whole of a function word (or sequence of function words) in children to the first part of a content word in adults (Conture, 1990). Disfluency on function words is at odds with the findings for adults who stutter, that difficult words cause these speakers problems. Two explanations of this apparent anomaly have arisen: Wingate (2002) dismisses function word repetition in childhood as not being proper stuttering. Support in favour of this position is that fluent children show this same characteristic (though at a much lower rate, Howell, Au-Yeung and Sackin, 1999). Opposing this position, leading researchers and professionals who have specialized in the treatment of childhood stuttering (Conture, 1990) have repeatedly observed function word repetition in the speech of children who stutter. The experience of these experts makes it unlikely that children with normal non-fluent patterns have been misdiagnosed as stuttering.

Howell, Au-Yeung and their associates have raised the question of whether there could be a common underlying problem in all age groups where the response problem leads to different patterns of stuttering at different ages. Their view can be illustrated with the example 'I split

it'. 'Split' is going to be a difficult locus because it is a content word, is the only stressed word in this utterance, is low in frequency of occurrence, or has a three-consonant cluster. All these (or some selected combination) make 'split' more difficult than the other words in the example. These properties of this content word lead directly to adults who stutter having difficulty at the onset of words with these properties. Research on fluent speech development may hold a clue to the speech patterns seen in young speakers who stutter. It has been observed that young fluent speakers often repeat the function word that precedes the content word, a result of what Clark and Clark (1977) describe as delaying the attempt of the subsequent word (the difficult content word in this case). Clark and Clark (1977) suggested that the hesitations and repetitions that frequently occur in fluent speakers' speech indicate that the speech plan for a later word is not ready for execution.

Au-Yeung, Howell and Pilgrim (1998) noted that word repetitions in well-known corpora like that of Maclay and Osgood (1959), occur predominantly on function words. Au-Yeung et al. (1998) took the 'delaying' explanation and hypothesized that while young children who stutter delay by repeating function words (albeit at a higher rate than fluent children), older speakers do not delay but attempt the difficult content word that follows. As the content word is not fully prepared, this results in disfluency on the part that is ready (part of the onset). This focus on timing aspects of planning and execution is also consistent with a recent study investigating the neuronal basis of developmental stuttering (Sommer, Koch, Paulus, Weiller and Büchel, 2002). The study by Sommer et al. (2002) involved a comparison between speakers with persistent developmental stuttering and a control group using diffusion tensor imaging. One of their conclusions was that persistent developmental stuttering results from disturbed timing of activation in speech-relevant brain areas.

To investigate the locus where disfluency is observed in continuous utterances, Au-Yeung et al. (1998) introduced phonological words (PWs) as a unit for segmental analysis. The concept of the PW originates in phonology and reflects the asymmetry of function/content words with regard to word stress (Selkirk, 1984, 1996). According to this initial definition, a content word serves as the nucleus of a PW and function words can (optionally) precede and follow the content word. This allowed Au-Yeung et al. (1998) to examine the prediction, that follows from the delaying hypothesis, that only initial function words are repeated as these are the only function words that can serve the delaying role. This prediction was confirmed (Au-Yeung *et al.*, 1989). They also examined disfluency rate over different positions in PW, separately for function and content words. Function words had higher disfluency rates the earlier they occurred in PW, this being most apparent for the younger speakers. This is consistent with a delaying role of initial function words. Content words showed no differential disfluency rate across PW positions for any age group. This is also consistent with the view that content words are the locus that is difficult and that this difficulty is experienced whatever the position of the content word.

In a further study, Howell et al. (1999) examined the proposal that speakers change the way they deal with the locus of disfluency over ages. Disfluency rate was computed separately for function and content words for five different age groups. It was found that disfluency rate was highest at the youngest age on function words and that the disfluency rate decreased with age. The high rate at the youngest age indicates the widespread use of function word repetition in this age group, and the decrease over age shows that this happens less often as speakers get older. The pattern was the opposite with content words (disfluency rate on these words was low initially and increased with age). The complementary pattern appears to indicate that as young speakers repeat function words less frequently as they get older, content word disfluencies emerge (this pattern is referred to as an exchange relation to capture the reciprocity in how speakers tackle the locus of disfluency).

There is a growing body of cross-linguistic work on the determinants of disfluency that has been conducted to address issues of linguistic determinants. Such research is motivated by two concerns: to test specific hypotheses about what linguistic determinants are paramount; and, more generally, to establish whether languages that have similar structures to English have corresponding patterns of disfluency. The first area has not been investigated to the same extent as the second, to date. What research there is has involved comparison between patterns in Spanish and English (Howell, submitted). Spanish has stressed function words, so stress can be dissociated to some extent from lexical word class. Nevertheless, an exchange relation occurred when analysis was based on function and content words (Au-Yeung, Vallejo Gomez and Howell, 2003). PW can be segmented in Spanish using stressed words (either function or content) as nuclei. When PW segmentation is made according to word type and, separately, according to stress patterns, the data can be allocated into disjoint sets where the segmentation differs for the two types of PW. The stress-based segmentation then has stressed function words as the nucleus for stuttering, and the lexical-class based segmentation has unstressed content words as nuclei. If stress is paramount, the first of these methods alone should show an exchange relation, whereas if lexical status is paramount, the second of these methods alone should show an exchange relation. Howell (submitted) has shown that both segmentation methods lead to an exchange relation. This suggests that both lexical status and stress can be a focus of stuttering in PW or that some factor that is common to these segmentation methods mediates these patterns.

There is a greater body of work comparing determinants across different languages. Brown's four factors have been reported to operate in Norwegian (Preus, Gullikstad, Grøtterød, Erlandsen and Halland, 1970), Kanada, a Dravidian language (Jayaram, 1981) and German (Dworzynski, Howell and Natke, 2003). Minor differences between the languages have also been found. Rommel and colleagues have observed that stuttering in German children occurred more frequently in longer sentences and words, and on vowels and vowel – consonant transitions (Rommel, Häge, Johannsen and Schulze, 1997; Rommel, Häge, Kالهne and Johannsen, 2000; Rommel, 2001). Interestingly, they found that consonant – consonant transitions were not significantly associated with disfluencies. It was also observed for these German children that stuttering occurred more frequently in the middle of sentences and words (Rommel et al., 1997). With regards to this unusual last finding, they state in their discussion that this result 'may have its origin in the language itself and related grammatical regularities' though they do not give an explicit account as to how.

The current paper mainly addresses whether general characteristics found in English also occur in German using lexically-defined PW. While German and English are in some ways similar languages, there are some structural differences that may be relevant to the level of stuttering. The question arises as to whether these should be treated as one locus of difficulty, or more than one, when they comprise more than one content word. It can be argued that German phonology treats the individual segments as separate units. In a word such as 'Obstand' (fruit stall), for instance, the double 'st' in the middle would be pronounced /st/ then after a short pause /ft/. This is the case because 'st' at the beginning of words/syllables would always be /ft/ whereas at the end the would be spoken as /st/. There is also the issue of whether the components of compound words are treated as separate words (as argued here) or not. As compound words (as a class) occur with high frequency in German, and given the arguments for their division into their constituents, it was decided that the context in which to analyse stuttering in German PW should divide compound words into their individual components. This means that one orthographic item can appear in more than one PW in German. The effect of not segmenting compound words might make the PW longer (for German compared to English), an effect that will probably disappear once the individual units are divided. The following study examined the pattern of disfluencies within PWs in German. Comparison of PW length for two different

segmentation methods (based on whether or not compound words are treated as single lexical items) is reported, and it is found that when compound words are decomposed the length is similar to English. The PW where compound words are decomposed are used to test predictions that German will produce a similar pattern to English. Similar to the English phonological word analysis, it is predicted that function words that precede content words would be more likely to be disfluent than those that are positioned after a content word. A serial position effect should occur for function words, but not for content words. There should be a decrease of function word disfluency with age and the reverse for content words. The findings, and their implications for current models of fluency failure, are considered in the discussion.

Method

Participants

All of the subjects included in this study (43 English subjects and 50 German speakers) were diagnosed as exhibiting stuttering behaviour by a speech therapist. Speakers of both language groups were recorded in conversational speech with a researcher or speech pathologist. Details of the English speech samples are given in Au-Yeung et al. (1998), Kadi-Hanifi and Howell (1992) and Howell et al. (1999). The speakers of each language group were divided into different age groups (the details of which are given below). Speakers in the youngest German age group were each recorded, in a standardized play situation, with their individual care giver, in most cases their mother.

German adults—All of the fifteen participants had been diagnosed as exhibiting stuttering behaviour. Five were female and ten male. Their ages ranged from 16 years 3 months to 47 years 1 months, with a mean age of 29 years and 8 months. They were all voluntary participants—please refer to Table 1 for details.

German children—Speech samples of thirty-five children were used. Eight were female and twenty-seven male. Their ages ranged from 2 years 10 months to 11 years 11 months with a mean age of 7 years 10 months. These were divided into three subgroups: 2 – 6 years 5 months, 6 years 6 months – 8, 9 – 11 years. The division into these groups is similar to that in Howell et al. (1999). There were eleven children, two girls and nine boys, in the first group (with a mean age of 4 years and 7 months). Ten children, two girls and eight boys, ranged from 6 years and 7 months to 8 years and 11 months (with an average age of 7 years and 4 months) were in the second group. The remaining 14 children, four girls and 10 boys, were aged between 9 years 2 months and 11 years 11 months (with a mean age of 10 years 9 months). The details of each individual speaker in the German sample (subject identifier, gender, age, number of words and stuttering rate as a percentage) are given in Table 1. Length of the sample was determined by the subject's willingness to talk about the topic (with the proviso that the samples had to be at least 2 min in duration). This resulted in some short samples. This also applies to the Spanish data of Au-Yeung et al. (2003). As in that study, it was deemed preferable to use short spontaneous samples that were representative of the speaker's speech rather than forcing more, less spontaneous, material.

These German speakers were compared to the English disfluent speakers used in the paper by Howell et al. (1999), with the exception of the teenage group since no comparable age group was included in the German data. Details of the ages of the English speakers are given here again since the current study is using different groupings to those in the Howell et al. (1999) reference. The following groups were used:

English speakers (adults)—These were 12 male adults aged between 20 and 40 years (the mean age being 28 years and 4 months).

English speakers (children)—These were divided into three different subgroups: 2 – 6-year-olds, 7 – 9-year-olds and 10 – 12-year-olds. Four boys and two girls were in the first age group (mean age of 4 years and 2 months). Fifteen children (11 boys and four girls) made up the second group, which had a mean age of 7 years and 3 months. There were 10 children aged 10 – 12 (8 boys and 2 girls with a mean age of 11 years and 4 months).

Speech Material

For all age groups recordings of speakers in spontaneous speech were used for assessment and analysis. These were a minimum of 2 min in duration and were made in a quiet, relaxed environment. A number of the recordings of German children were taken in sessions with their speech therapist, in speech therapy centres in Bad Salzdetfurth and Werscherberg. Topics that were suggested to the adult speakers and older children were family, friends, favourite films, sports and such like. Fourteen of the children were collected by Rommel and colleagues in Ulm (Germany) (indicated in Table 1). This consisted of spontaneous speech which was videotaped in individual standardized play situations. These children were taped with their mothers whilst jointly playing with a toy farm. These recordings were on average 30 min long. Transcriptions were carried out according to the guidelines of MacWhinney (1995) using the CLAN/CHILDES analysis system. They were originally orthographically transcribed using a non-standard form of German (the local Swabian dialect). Prolongations, monosyllabic whole- and part-word repetitions and blocks were marked. These files were then adapted to conform to the transcriptions of the other age groups and segmented into phonological words (described below). Only words that were stuttered were coded for word type in the CLAN system whereas with the other German age groups all words were coded according to their word class (function or content words). The CLAN-coded words were all coded into function and content types. The speech was orthographically transcribed for CLAN (including pronunciation deviations). The Swabian dialect has a more or less one-to-one grapheme to phoneme conversion and these were transformed into the phonetic transcription scheme used with English (see Howell et al., 1999, and next section below for details). Particular attention was given to checking for final devoicing, and whether consonants transcribed as ‘r’ were converted into a vowel.

Transcription Procedure

Both the orthographic and phonetic transcriptions were coded using the Speech Filing System (SFS) software. For the phonetic transcriptions, rather than the standard International Phonetic Alphabet (IPA), a machine readable transcription alphabet was used (the Joint Speech Research Unit alphabet – JSRU). This is an alphabet developed for text-to-speech synthesis (please refer to the University College London's speech group's homepage: <http://www.speech.psychol.ucl.ac.uk/> for further information). The English and German data were transcribed according to Kadi-Hanifi and Howell's (1992) method. In other words, this constituted a broad transcription for the fluent regions and a narrow system in the region of disfluencies. The transcriber estimated the duration of pauses and prolonged segments to the nearest 50 ms, and these were entered in the transcriptions. This was mainly done to assess disfluencies and make judgments about whether a disfluency was a repetition or a revision in the case of long pauses, for instance. In longer words, syllables were partitioned and all words were classified as content or function in type. Stuttering episodes marked included word (monosyllabic) and part-word repetitions, and blocks as well as segmental or syllabic prolongations.

Segmentation into Phonological Words

The PW used here consisted of a single content word (C) plus adjacent function words (F), leading to the general form $[F_nCF_m]$ where n and m are integers greater than or equal to zero. First the content words that constitute the nuclei of the PWs were located. It was necessary to determine the position of each individual function word in the PW. In order to gauge whether a function word was a prefix to the subsequent, or a suffix to the preceding, content word, Selkirk (1984) developed rules that define which constituents of an intonational phrase form a so-called 'sense unit', i.e. are semantically related. Au-Yeung and Howell (1998) and Au-Yeung et al. (1998) extended these in order to apply them for the segmentation of PWs. These rules were as follows (Selkirk, 1984: 291):

'Two constituents C_i , C_j form a sense unit if (a) or (b) is true of the semantic interpretation of the sentence:

- a. C_i modifies C_j (a head)
- b. C_i is an argument of C_j (a head).'

Au-Yeung et al. (1998) made the following additions:

- c. both C_i and C_j modify C_k (a head)
- d. both C_i and C_j are arguments of C_k (a head).

The first two rules (Selkirk's original ones) can produce both segmentations into an intonational phrase and a PW. They are therefore given precedence over the two additional rules (Au-Yeung et al., 1998) that deal with cases for PW segmentations that do not conform to rules a and b. These rules are illustrated, for a selected utterance from the samples used in the current analyses. The utterance used is:

And he said to her that he would get on the next boat.

First the content words are marked as the nuclei of the PWs:

And he [said] to her that he would [get] on the [next] [boat.]

In the next step the status of the function words is determined, according to the rules given above. The first nucleus or head is the verb 'said', which has two arguments—'he' (the subject of the sentence) and 'her' (the object). Thus the first PW segmentation is:

[And he said to her] that he would [get] on the [next] [boat.]

The next PW starts with 'that', which is the beginning of an embedded clause and is grouped as such. A further PW is the prepositional phrase 'on the next' in which 'on the' is linked indirectly to 'next' via 'boat' (the last PW). The two additional rules c. and d. govern the segmentation of such indirect links, in which a PW can be formed via a third part outside the PW. As such 'boat' is the outside part, 'on the' is an argument and 'next' a modifier:

[And he said to her] [that he would get] [on the next] [boat.]

The same segmentation process is used for the German samples, for example:

Und dann fange ich an zu schminken und zu frisieren...

'And then I start to do the make-up and the hair styles'

Step one:

Und dann [fange] ich an zu [schminken] und zu [frisieren...]

The head of the first PW is the verb 'fange' which is a word stem, having a separable prefix 'an' and subject 'ich'. Thus the first PW segmentation would look as follows:

[Und dann fange ich an] zu [schminken] und zu [frisieren...]

The other two PW are verb phrases:

[Und dann fange ich an] [zu schminken] [und zu frisieren...]

The individual PWs were then coded as to the fluency, number of words, position of content word, and in case of disfluencies, location of the disfluency and whether the disfluent word was a function or content word. Filled pauses as well as 'er' or 'um', were excluded from the word count (e.g. 'she erm she said' would be counted as two words). In the case of compound words in German these were divided into individual segments each as their own PW. An example of that would be a word like 'Obststand' (fruit stall) which would be classified as two PWs ('Obst' and 'stand' respectively).

Reliability measures

The researcher received training for the acquisition of transcription skills. In this respect English stuttered speech samples were transcribed and cross-checked by more experienced speech researchers until the given sections could be transcribed without error. This was done by introducing first fluent, and then stuttered, samples. For the speech data in the current study a number of completed samples were also rechecked by more experienced staff. For the transcription of the German speech sample the researcher with a background in psychology rather than linguistics took a German phonology course at University College London's Linguistics Department which involved training (and assessment) in transcriptions of German. Due to the unavailability of experienced German transcribers, rather than taking inter-judge reliability values, a measure of consistency rather than reliability was taken. This meant that the same researcher re-transcribed and coded 20% of the samples, which were then analysed using alpha reliability analyses. The effects of training and experience on judgements of stuttering have been recently investigated by Cordes and Ingham (1999) who found that with experience and training both intra- as well as inter-judge agreement was improved. An alpha analysis was carried out meaning that a higher alpha coefficient signifies better consistency. Nunnally (1978) has indicated 0.7 to be an acceptable reliability/consistency coefficient but some of the literature uses lower thresholds. For the re-transcribed and re-coded samples (both in respect of PW segmentation codes and fluency codes) alpha values ranged from 0.87 to 0.98, indicating a high level of consistency. Reliability measures for the youngest age group were reported by Rommel et al. (1997) to be between 96 and 100%.

Results

Disfluency rate was calculated as the number of words with marked stuttering events divided by the overall number of words, both fluent and stuttered. Initial examination of the data proceeded by analysing disfluency rate across the different age groups for the German speakers showed highest rates for the 9 – 11-year-old children, which was significantly different when compared to the group with the lowest stuttering rate (the youngest age group) ($F(3, 46) = 4.15, p < 0.05$, follow up Tukey HSD $p < 0.01$) (see figure 1).

It was therefore decided that whenever effects of disfluency rates were analyzed individual stuttering rate would be treated as a covariate. The overall disfluency rate for each individual was taken out as a covariate because of the difference in disfluency rate for one of the age groups. This means that the effect of differences in overall disfluency rate across participants (which would include group differences) is dealt with in the analyses by partialling out each participant's overall disfluency rate. The output will then give the adjusted rates for each factor after the effects of the covariate (here the speaker's overall disfluency rate) have been removed.

Structure of PW in German compared to English in the adult age group

First of all the phonological words were segmented orthographically, each content word being classed as a nucleus of the PW regardless whether it was a compound noun or not—for details see the Method section. In the second segmentation method, compound nouns were then divided into the individual word segments. An overall percentage of the number of compound words was then calculated by dividing the number of PWs which included a compound word by the overall number of all PWs. Compound words were found in 14.2% of all PWs. One structural aspect that would be affected by such frequent compound words would be the length of a PW. It was found that the variability in the German data was significantly higher than in the English (Levene (2) = 7.24 $p < 0.05$)—see error bars in figure 2. The larger variability could have been due to the fact that there were three more adults in the German adult group than the English one. Thus two non-parametric Mann – Whitney U -tests were used to analyse the difference, comparing the English PW method with each of the German segmentation methods. This revealed that when compared individually to the English group, only the segmentation that treated compound words as single units was significantly longer than the English (PW with compounds treated as single units ($U(15, 12) = 31$ corrected for ties $z = -2.88$, $p < 0.01$; PW with compounds treated as their components $U(15, 12) = 57$, corrected for ties $z = 1.61$, $p > 0.10$ respectively). As it is desirable to have equivalent length PW (because word length itself affects disfluency rate), together with the other justifications for treating compounds as multiple nuclei (introduction), meant that the PW method where compounds were divided was chosen for the analyses below.

Another structural aspect that might be affected by the number of compound words is the proportion of post-content function words within each PW. It was found that this proportion was slightly higher in the two German segmentation methods. However this difference was not significant ($F(2, 39) < 1$ —in this case Levene's test for equality of variance was not significant).

Serial position

Function words that were positioned after the content word within a phonological word were significantly less likely to be spoken disfluently than those that were before the content word. The proportions of PWs with stuttering on post-content function words were below 5% for the four age groups (four t tests were carried out—all $p < 0.05$ with Bonferroni correction). The left-hand side of figure 3 shows disfluency rate of function words for different age groups separately for pre-content and post-content positions.

For the serial position analysis a mixed model ANCOVA was carried out with word type (function/content) position within the PW (first, second or third; there were few instances of stuttering in positions four onwards) as the repeated measures factors and age group (young, middle, old, adults) as the between subjects factor. The main effect for word type was not significant. The main effect for position was significant ($F(2, 70) = 3.21$, $p < 0.05$). This indicated that first position had the highest likelihood of being stuttered, followed by the second, and then the third, as seen in figure 4.

In addition to the main effect of word position, there were interactions both with word type ($F(2, 70) = 5.08$, $p < 0.01$) and age group ($F(6, 70) = 3.12$, $p < 0.01$) but the three-way interaction between all these factors was not significant. (The remaining two-way interaction, the age group by word type interaction ($F(3, 35) = 8.46$ $p < 0.01$) was also significant in this analysis. (This reflects the exchange pattern and a non-positional analysis on this is the subject of the analyses reported in the final section of the results.) The word type by position interaction showed that whereas the serial position effect mentioned earlier

(as main effect) occurred for function words, content words were stuttered at more or less the same rate in any of the three positions. This is shown in figure 5, and a similar effect has been observed for English (Au-Yeung et al., 1998) and Spanish (Au-Yeung et al., 2003).

Figure 6 shows the word position by age group interaction. Age group is along the abscissa and word position is the parameter of the connected points (the three serial positions can be identified from the inset). The youngest children showed a clear trend of stuttering rate decreasing from first to third serial position. In middle and older child groups stuttering rate in the first serial position was highest, with virtually no difference between second and third serial positions. By adulthood, there was a non-significant reversal, with the third serial position having highest disfluency rate and first position having lowest disfluency rate. Simple interaction analysis on this two-way interaction revealed that the position effect was only present in the youngest age group. (The mean differences for both first–third ($p < 0.002$) and second–third ($p < 0.02$) positions were significant and the first–second difference just missed significance ($p = 0.063$), adjusted for multiple comparisons using Bonferroni correction.) Another feature to note is that the disfluency rate in third position increased over age groups. The serial position effects for youngest children are clearest, and this is consistent with a major role of word repetition in young children. The progressive loss of differential disfluency rate between position three and other positions is the clearest sign that the serial position effect disappeared over age groups.

Exchange analysis

As reported previously for the English data the following pattern was observed in respect of function and content word disfluency across age groups. In the analysis by Howell et al. (1999) a main effect for word type was reported which was not present in the current re-analysis when the teenage group was excluded from the investigation ($p = 0.161$). The interaction between word type and age group was significant across the four age groups ($F(3, 38) = 2.92, p < 0.05$). Both of these tests took overall PW stuttering rate as a covariate between the age groups. The results of this reanalysis are given in figure 7.

The same analysis as that on English was conducted for German. The main effect of Word type was not significant. The interaction between Age Group and Word type (content and overall function words) that reflects the exchange, was significant ($F(3, 41) = 4.698, p < 0.01$). Both of the word types show a significant linear trend when analyzed individually (content: $F(3, 45) = 6.205, p < 0.001$ pre-content function words: $F(3, 45) = 7.374, p < 0.001$). The left-hand side of figure 3 shows that the function word disfluencies across age groups decrease, whilst disfluency rate for content words (right-hand side) increases.

Discussion

There are three main findings on the pattern of stuttering in PW in German, all of which correspond with those in English (Au-Yeung et al., 1998; Howell et al., 1999) and Spanish (Au-Yeung et al., 2003). First, function (but not content) words that occupy an early position in a PW have higher rates of disfluency than those that occur later in a PW, this being most apparent for the youngest speakers. Second, function words that precede the content word in a PW have higher rates of disfluency than those that follow the content word. Third, young speakers exhibit high rates of disfluency on function words, but this drops off with age and, correspondingly, disfluency rate on content words increases. The first two positional findings refer to overall disfluency rates within any PW regardless of utterance position. It would be interesting to investigate further whether there are also positional and length effects of PWs in the wider context of utterance position.

Differences in the processing of grammatical word classes are now increasingly found both for the activation of their neural substrates using EEG studies (for example see Brown, Hagoort and ter Keurs, 1999; Bastiaansen, Van Der Linden, ter Keurs, Dijkstra and Hagoort, 2002; Osterhout, Allen and McLaughlin, 2002), in terms of lexical access (Segalowitz and Lane, 2000) and their role in cross linguistic examination of speech errors (Wells-Jensen, 2000). Additionally it was reported that infants prefer open-class to closed-class words (Shi and Werker, 2001). The function/content word distinction has also been investigated in an EEG study with individuals who stutter (Weber-Fox, 2001). Her results indicated that the event-related potentials (ERPs) of people who stutter were characterized by reduced negative amplitudes for closed-class words, open-class words, and semantic anomalies in a temporal window of approximately 200 – 400 ms after word onsets.

However, none of these studies considered the way these two word classes are affected when the words are pronounced in context. Considering the results of the current investigation in respect of current theories, the positional findings for function words can be explained either by Kolk and Postma's (1997) covert repair hypothesis (CRH) or Howell and Au-Yeung's (2002) EXPLAN theory. CRH starts from the assumption that speakers who stutter have a phonological deficit that leads to errors in the speech plan, resulting in disfluency (Postma and Kolk, 1993; Kolk and Postma, 1997).

One of the proposals of the Covert Repair Hypothesis (CRH; Postma and Kolk, 1993; Kolk and Postma, 1997) is that in speakers who stutter the activation of phonological targets takes a long time. To show how a slower system can result in speech errors (consistent with the above definition) Kolk and Postma (1997) draw on Dell and O'Seaghdha's (1992) connectionist model. This model assumes that when a speaker intends to say the word 'cat' (the target unit), phonologically-related competing units (e.g. 'rat') are also activated. In the early stages activation for the target and competing units follow similar trajectories, but later they level off at different states of activations. When it reaches asymptote, the target unit has a higher activation level that generates this (the appropriate) word as the speech output. Under time pressure (such as when speech has to be produced rapidly) a speaker has to speak words in the period when the two words have similar activation trajectories. The word that is generated is again the one with highest activation but, as the activation is being built up, the target and competing options have similar activation slopes in the early stages, so by chance one of the competing options may have highest activation and be triggered (resulting in a speech error) if word selection is made in this time-region. Furthermore, the build-up phase would also be longer in a slower phonological system. This again leads to a higher chance of a speech error arising under time pressure, because the speaker has to generate a word in the extended build-up phase of activation. The selection of a wrong word unit usually occurs with content words. These can be produced overtly (e.g., saying 'rat' for 'cat') or covertly, i.e. errors are repaired internally before they are pronounced. Evidence for these covert errors are disruptions in the surface form of speech without overt errors. In this respect, (1) prolongation and repetition of part of a content word and (2) disfluencies on and around function words that involve interruptions (filled and unfilled pauses) or word and phrase repetitions, could both reflect covert repair activity (Howell, Kadi-Hanifi and Young, 1991). Such covert repairs can take place on words that precede the error, thus CRH could explain why function word repetition and hesitation occur most frequently on pre-content function words (where the content word is assumed to be the word that has generated the error). The serial position effects in PW may also reflect the fact that function words that precede a content word are most likely to be used in covert repairs.

The EXPLAN model regards function and content word disfluencies as two different ways of dealing with situations where the content word's plan is correct as far as it is generated but not complete after the preceding word was first produced (Howell, 2002; Howell and

Au-Yeung, 2002). In this sense, the problem is one of timing, not an error-prone phonological system as in CRH. Function words are repeated for the purpose of gaining more time for completing the plan of the content word. As only function words that precede the content word can serve the delaying role, EXPLAN accounts for why disfluency rate is higher on initial than final function words. The serial position effect on function words in PW would then reflect a position-dependent tendency for initial function words to be used for delaying onset of the content word. Thus, both CRH and EXPLAN can explain ordinal and serial position effects on function words on different premises (reflecting a covert repair in CRH and a way of gaining time for planning in EXPLAN).

CRH does not appear to offer an account of the exchange relationship between function and content word disfluencies (assuming that both are the result of covert repair processes). CRH would have to supply an answer to (1) why the incidence of covert repairs on function words is highest in childhood; (2) why covert repairs on function words are complementary to covert repairs on content words; (3) why the incidence of the covert repair option depends on the speaker's age (referring to point 2 above). The principal problem is the age-dependent changes that occur (as referred to in point 3).

According to EXPLAN, only the first part of a content word is produced as this is the only part for which the plan is complete. When the plan runs out, the part that is available may be prolonged or repeated until the remainder of the plan is ready. In this account, disfluencies on function and content words are in complementary distribution (repeating function words prevents content word disfluencies, and content words disfluencies ensue when speakers do not repeat function words at points they could have). This accounts for the exchange relation originally found in English (Howell et al., 1999) and Spanish (Au-Yeung et al., 2003), and found here to apply to German. The EXPLAN (execution and planning processes are assumed to be independent processes operating in parallel—thus EXPLAN) model appears to account for the developmental exchange relationship while the tenets of the CRH would appear to provide no ready explanation for this exchange.

The results show that the patterns for English and German are quite similar. Both languages show that with increasing age function word disfluency decreases whereas content word stuttering increases. In German it is the case that these lines appear to be steeper, and in the adult age group content word stuttering is actually shown to be more likely than function word disfluencies. This is consistent with previous findings in respect of adult stuttering patterns (e.g. Brown, 1945; also see Bloodstein, 1995, and Wingate, 1988). One possibility for the German data is that content words are often longer and therefore more complex in German (e.g. compound words).

As to whether the phonological word provides a good context to analyse disfluencies in German, several points can be raised. First of all the structure of the phonological words need to be analyzed further. It was observed that there may be a higher incidence of post-content function words in PWs in German (such as 'spiel ich', 'geb ich'—I play, I give, respectively). However, the same patterns of function word disfluency were observed as in English, i.e. post-content function words were very unlikely to be stuttered. This would further strengthen the EXPLAN interpretation of findings. Another aspect is the phonological difficulty of the content words. It is possible that German content words have a more complex structure and therefore lead to a considerably higher disfluency rate for adults who stutter. An analysis focusing on these factors is currently in progress.

To sum up, people who stutter from both English and German speaking background show more or less identical patterns of disfluency. Regardless of language, young speakers are predominantly disfluent on function words. As speakers get older there is an exchange from

function to content word disfluency. Results such as this exchange pattern are readily explained by the EXPLAN model but not by such theories as CRH.

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References

- Au-Yeung J, Howell P, Pilgrim L. Phonological words and stuttering on function words. *Journal of Speech, Language, and Hearing Research*. 1998; 41(5)
- Au-Yeung J, Vallejo-Gomez I, Howell P. Exchange of disfluency with age from function words to content words in Spanish speakers who stutter. *Journal of Speech, Language, and Hearing Research*. 2003; 46(3):754–765. [PubMed: 14697001]
- Bastiaansen, M.; Van Der Linden, M.; ter Keurs, M.; Dijkstra, T.; Hagoort, P. Open-class words produce a larger theta power increase than closed-class words; *Cognitive Neuroscience Ninth Annual Meeting*; San Francisco. 14-16 April, 2002; 2002.
- Bloodstein, O. *A Handbook on Stuttering*. 5th edn.. Chicago: The National Easter Seal Society; 1995.
- Bloodstein O, Gandwerk BF. Grammatical function in relation to stuttering in young children. *Journal of Speech and Hearing Research*. 1967; 10(4):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(2):298–302. [PubMed: 7265947]
- Brown CM, Hagoort P, ter Keurs M. Electrophysiological signatures of visual lexical processing: Open- and closed-class words. *Journal of Cognitive Neuroscience*. 1999; 11(3):261–281. [PubMed: 10402255]
- Brown SF. The loci of stutterings in the speech sequence. *Journal of Speech Disorders*. 1945; 10:181–192.
- Clark, H.; Clark, E. *Psychology and Language: An Introduction to Psycholinguistics*. New York: Harcourt Brace; 1977.
- Couture, EG. *Stuttering*. 2nd edn.. Englewood Cliffs, NJ: Prentice-Hall; 1990.
- Cordes AK, Ingham RJ. Effects of time-interval judgment training on real-time measurement of stuttering. *Journal of Speech, Language, and Hearing Research*. 1999; 42(4):862–879.
- Dayalu VN, Kalinowski J, Stuart A, Hobert D, Rastatter MP. Stuttering frequency on content and function words in adults who stutter: A concept revisited. *Journal of Speech, Language, and Hearing Research*. 2002; 45:871–878. [PubMed: 12381045]
- Dell GS, O'Seaghdha PG. Stages of lexical access in speech production. *Cognition*. 1992; 42:287–314. [PubMed: 1582160]
- Dworzynski K, Howell P, Natke U. Predicting stuttering from linguistic factors for German speakers in two age groups. *Journal of Fluency Disorders*. 2002; 28(2):95–113. [PubMed: 12809747]
- Hartmann, R.R.K.; Stork, F.C. *Dictionary of Language and Linguistics*. London: Applied Science Publishers; 1972.
- Howell P. Phonological difficulty and stuttering in Spanish. *Journal of Multilingual Communication Disorders*. submitted.
- Howell, P. The EXPLAN theory of fluency control applied to the treatment of stuttering by altered feedback and operant procedures. In: Fave, E., editor. *Current Issues in Linguistic Theory series: Pathology and therapy of speech disorders*. Amsterdam: John Benjamins; 2002. p. 95-118.
- Howell P, Au-Yeung J. The association between stuttering, Brown factors, and phonological categories in child stutterers ranging in age between 2 and 12 years. *Journal of Fluency Disorders*. 1995; 20:331–344.

- Howell, P.; Au-Yeung, J. The EXPLAN theory of fluency control and the diagnosis of stuttering. In: Fave, E., editor. *Pathology and Therapy of Speech Disorders*. In Current Issues in Linguistic Theory series. Amsterdam: John Benjamins; 2002. p. 74-94.
- Howell P, Au-Yeung J, Sackin S. Internal structure of content words leading to lifespan differences in phonological difficulty in stuttering. *Journal of Fluency Disorders*. 2000; 25:1–20. [PubMed: 18259599]
- Howell P, Au-Yeung J, Sackin S. Exchange of stuttering from function words to content words with age. *Journal of Speech, Language, and Hearing Research*. 1999; 42(2):345–354.
- Howell, P.; Kadi-Hanifi, K.; Young, K. Phrase revisions in fluent and stuttering children. In: Peters, HFM.; Hulstijn, W.; Starkweather, CW., editors. *Speech Motor Control and Stuttering*. Amsterdam: Elsevier; 1991. p. 409-414.
- Hubbard CP, Prins D. Word familiarity, syllabic stress pattern, and stuttering. *Journal of Speech and Hearing Research*. 1994; 31:228–233. [PubMed: 3294506]
- Jayaram M. Grammatical factors in stuttering. *Journal of the Indian Institute of Science*. 1981; 63:141–147.
- 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*. Boston, MA: Allyn & Bacon; 1997.
- Logan KJ. The effect of syntactic complexity upon the speech fluency of adolescents and adults who stutter. *Journal of Fluency Disorders*. 2001; 26(2):85–106.
- Maclay H, Osgood CE. Hesitation phenomena in spontaneous English speech. *Word*. 1959; 15:169–182.
- MacWhinney, B. *The CHILDES Project. Tools for Analyzing Talk*. Hillsdale, New Jersey: Lawrence Erlbaum Associates; 1995.
- Nunnally, JC. *Psychometric Theory*. New York: Mc-Graw Hill; 1978.
- Oosterhout L, Allen M, McLaughlin J. Words in the brain: Lexical determinants of word-induced brain activity. *Journal of Neurolinguistics*. 2002; 15(3 – 5):171–187.
- Postma A, Kolk H. The covert repair hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. *Journal of Speech and Hearing Research*. 1993; 36(3):472–487. [PubMed: 8331905]
- Preus A, Gullikstad L, Grøtterød H, Erlandsen O, Halland J. En undersøkelse over forekomst av stamming I en lest tekst. *Nord.Tidsskr.Logoped*. 1970; 16(22):11–18.
- Quirk, R.; Greenbaum, S.; Leech, G.; Svartvik, J. *A Comprehensive Grammar of the English Language*. London: Longman; 1985.
- Quirk, R.; Stein, G. *English in Use*. Harlow: Longman; 1990.
- Rommel, D. The influence of psycholinguistic variables on stuttering in childhood. In: Bosshardt, H-G.; Yaruss, JS.; Peters, HFM., editors. *Fluency Disorders: Theory, Research, Treatment and Self-help*. Proceedings of the Third World Congress of Fluency Disorders in Nyborg, Denmark; Nijmegen: Nijmegen University Press; 2001. p. 195-202.
- Rommel, D.; Häge, A.; Johannsen, HS.; Schulze, H. Linguistic aspects of stuttering in childhood. In: Hulstijn, W.; Peters, HFM.; van Lieshout, PHHM., editors. *Speech Production: Motor Control, Brain Research and Fluency Disorders*. Amsterdam: Elsevier Science Publishers; 1997. p. 603-610.
- Rommel, D.; Häge, A.; Kolehne, P.; Johannsen, HS. Development, maintenance, and recovery of childhood stuttering: Prospective longitudinal data 3 years after first contact. In: Baker, KL.; Rustin, L.; Cook, F., editors. *Proceedings of the Fifth Oxford Dysfluency Conference*; Leicester, UK: Kevin L. Baker; 2000. p. 168-182.
- Segalowitz SJ, Lane KC. Lexical access of function versus content words. *Brain and Language*. 2000; 75(3):376–389. [PubMed: 11112292]
- Selkirk, E. *Phonology and Syntaz: The Relation Between Sound and Stucture*. Cambridge, MA: MIT Press; 1984.

- Selkirk, E. The prosodic structure of function words. In: Morgan, J.L.; Demuth, K., editors. *Signal to syntax: Bootstrapping from Speech to Grammar in Early Acquisition*. Mahwah NJ: Lawrence Erlbaum Associates Publishers; 1996. p. 187-215.
- Shi R, Werker JF. Six-month old infants' preference for lexical words. *Psychological Science*. 2001; 12(1):70–75. [PubMed: 11294231]
- Silverman SW, Ratner NB. Syntactic complexity, fluency, and accuracy of sentence imitation in adolescents. *Journal of Speech, Language, and Hearing Research*. 1997; 40(1):95–106.
- Sommer M, Koch M, Paulus W, Weiller C, Büchel C. Disconnection of speech-relevant brain areas in persistent developmental stuttering. *Lancet*. 2002; 360:380–383. [PubMed: 12241779]
- Weber-Fox C. Neural systems for sentence processing in stuttering. *Journal of Speech, Language, and Hearing Research*. 2001; 44(4):814–825.
- Wells-Jensen SB. Cognitive correlates of linguistic complexity: A cross-linguistic comparison of errors in speech. *Dissertation Abstracts International Section A: Humanities and Social Sciences*. 2000; 60(8A):2899.
- Wingate ME. Stutter events and linguistic stress. *Journal of Fluency Disorders*. 1984; 9:295–300.
- Wingate, ME. *The Structure of Stuttering*. New York: Springer-Verlag; 1988.
- Wingate, ME. *Foundations of Stuttering*. San Diego CA: Academic Press; 2002.
- Yaruss JS. Utterance length, syntactic complexity, and childhood stuttering. *Journal of Speech, Language, and Hearing Research*. 1999; 42:329–344.

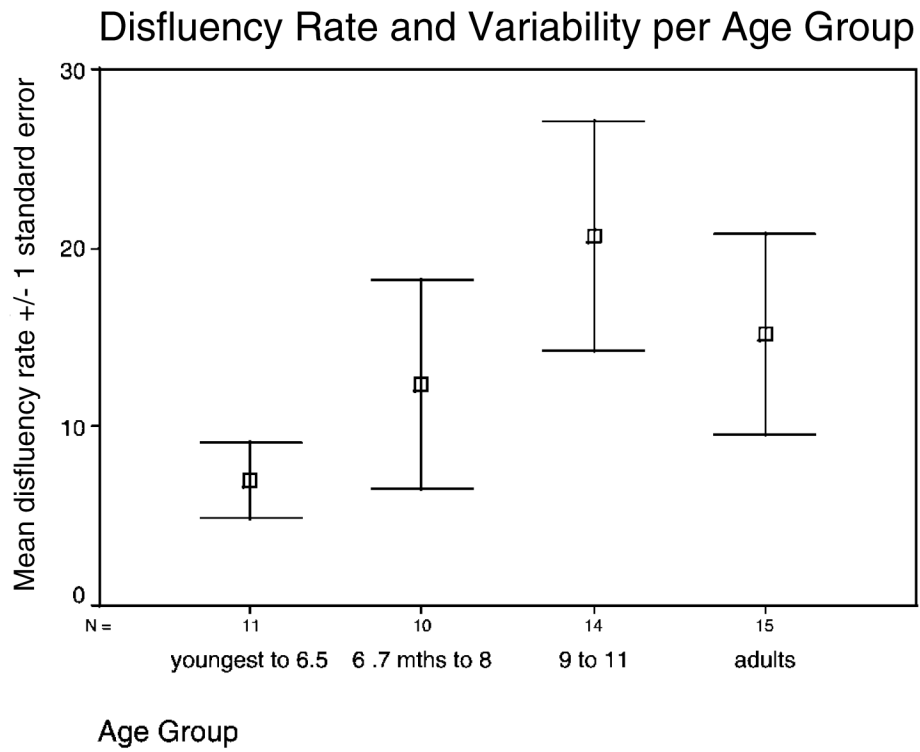


Figure 1. The mean disfluency rate (plus/minus one standard error) per age group. Age groups and number of subjects are indicated along the abscissa. Mean values and standard errors are represented by individual bars

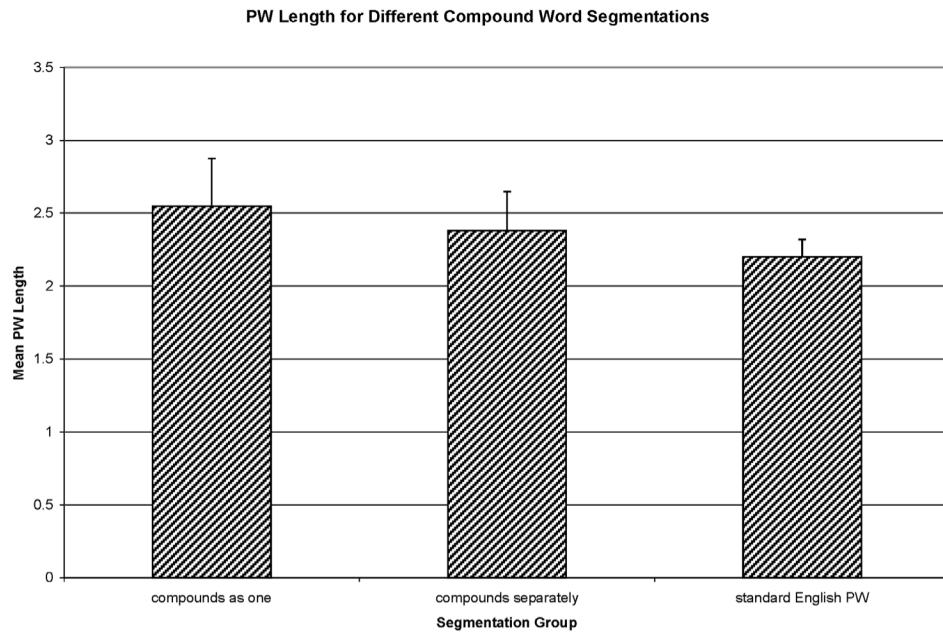


Figure 2. Histogram showing the mean length of PW (number of words) for the two segmentation methods in German (the left and middle bar) and the standard English method (the bar on the right). Variability is indicated by standard error bars

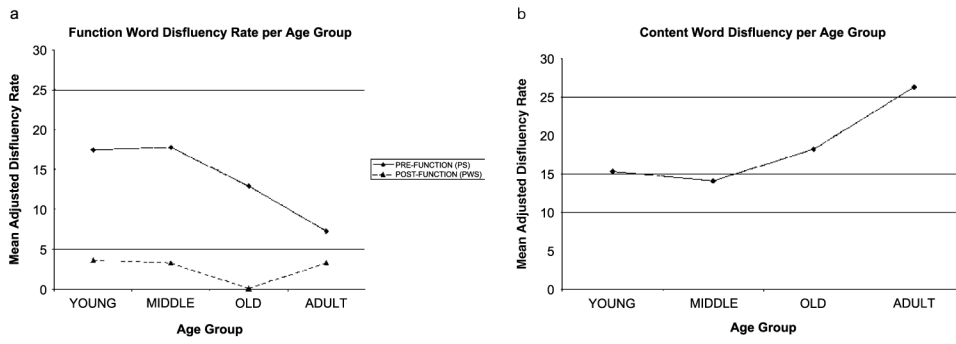


Figure 3. (a) Percentage of disfluencies for pre and post content function words. (b) Content word disfluencies in PWs across age groups. Both graphs have an adjusted stuttering rate which is the percentage disfluencies once overall individual stuttering rate is controlled for

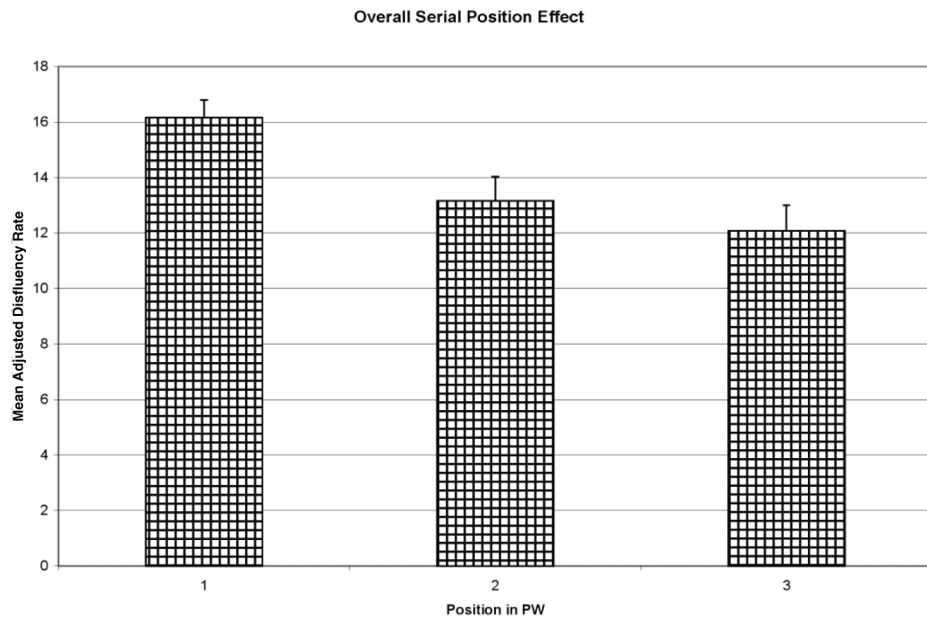


Figure 4. The histogram shows the effect of serial position on disfluency rate. Each bar represents the mean disfluency rate (variability is indicated by standard error bars) for the position as indicated on the x-axis

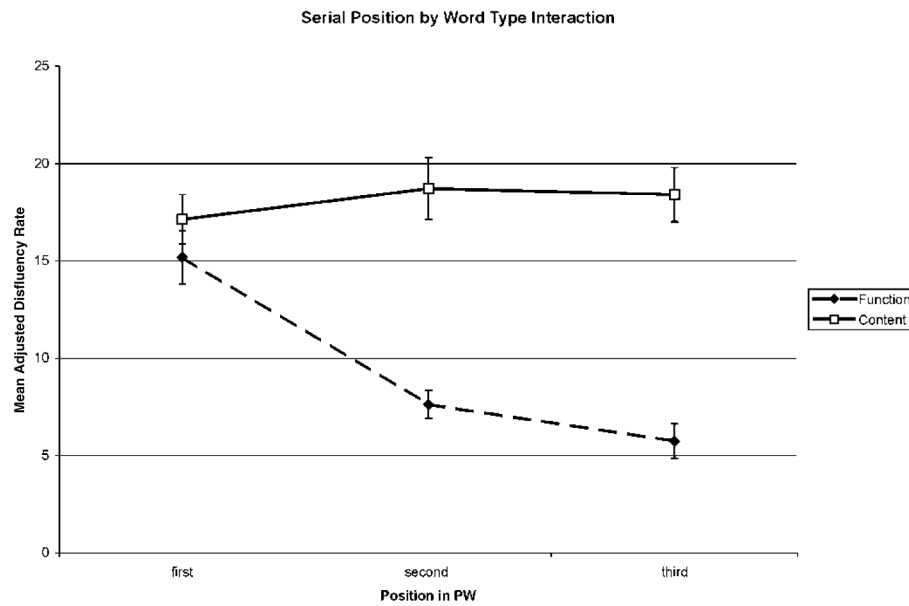


Figure 5.

The position of the word within a given PW is indicated along the x-axis. Values along the y-axis represent percentage disfluency rate which has been adjusted by taking individual disfluency rates as a covariate across age groups. The two lines indicate different word types with content words being represented by the solid line and function words by the dashed line (see legend). Standard error bars indicate variability around each mean

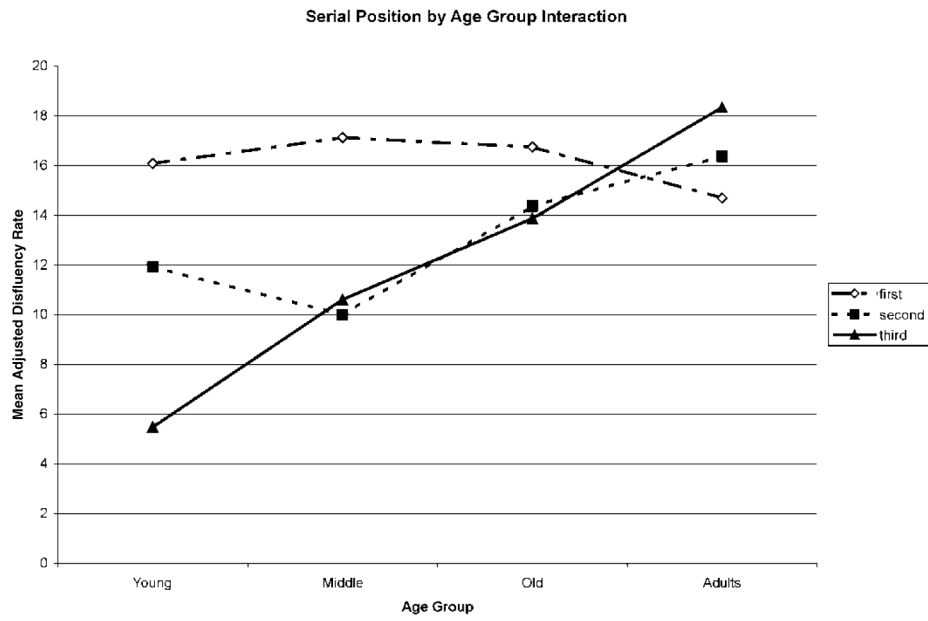


Figure 6. Along the x-axis the different age groups are indicated. The y values represent disfluency rates that have been adjusted by partialling out individual disfluency rates. Different lines indicate first, second and third position within a PW (see legend)

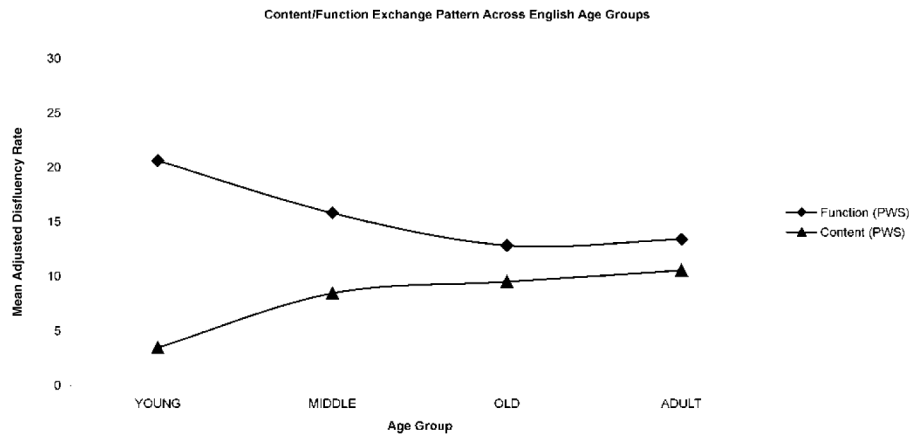


Figure 7. The mean disfluency rate of function and content words for English subjects. Percentage disfluency rate has been adjusted with the overall disfluency rate taken as covariate across the four age groups

Table 1

Details of German speakers

| Subject | Subject information | | | Disfluency rate % |
|---|---------------------|---------|-----------------|-------------------|
| | Gender | Age | Number of words | |
| Adult group | | | | |
| 1 | F | 31 : 8 | 210 | 10.48 |
| 2 | F | 21 : 6 | 151 | 5.30 |
| 3 | F | 29 : 11 | 135 | 10.37 |
| 4 | F | 30 : 1 | 210 | 20.48 |
| 5 | M | 18 : 4 | 153 | 9.80 |
| 6 | M | 16 : 11 | 173 | 39.31 |
| 7 | M | 17 : 9 | 208 | 18.75 |
| 8 | M | 16 : 3 | 256 | 1.95* |
| 9 | M | 23 : 7 | 330 | 8.79 |
| 10 | M | 28 : 5 | 85 | 28.24 |
| 11 | M | 46 : 5 | 185 | 22.70 |
| 12 | M | 47 : 1 | 125 | 9.60 |
| 13 | M | 33 : 10 | 143 | 7.69 |
| 14 | F | 47 : 3 | 200 | 33.50 |
| 15 | M | 31 : 6 | 290 | 3.81 |
| Children | | | | |
| Age Group 1 (2 years 10 months—6 years 5 months) | | | | |
| 1 | F | 3 : 9 | 456 | 10.53 |
| 2 | F | 5 : 8 | 458 | 1.53* |
| 3 | M | 3 : 5 | 236 | 8.90 |
| 4 | M | 2 : 10 | 378 | 14.55 |
| 5 | M | 4 : 10 | 553 | 3.98 |
| 6 | M | 6 : 2 | 369 | 6.23 |
| 7 | M | 4 : 4 | 217 | 5.53 |
| 8 | M | 6 : 0 | 177 | 3.95 |
| 9 | M | 5 : 3 | 275 | 6.91 |

| Subject information | | | |
|---------------------|--------|-------|-------------------|
| Subject | Gender | Age | Disfluency rate % |
| 10 | M | 4 : 7 | 6.62 |
| 11 | M | 4 : 7 | 7.64 |

All of Age Group 1 were recorded in Ulm by Rommel and colleagues.

| Age Group 2 (6 years and 6 months—8 years and 12 months): | | | |
|---|--------|--------|-------------------|
| Subject | Gender | Age | Disfluency rate % |
| 1 | M | 6 : 6 | 4.82 |
| 2 | M | 7 : 4 | 10.32 |
| 3 | M | 7 : 8 | 20.00 |
| 4 | F | 8 : 4 | 9.10 |
| 5 | F | 7 : 6 | 8.92 |
| 6 | M | 7 : 5 | 7.54 |
| 7 | M | 7 : 9 | 4.34 |
| 8 | M | 6 : 8 | 13.98 |
| 9 | M | 7 : 11 | 9.15 |
| 10 | M | 6 : 7 | 34.83 |

| Age Group 3 (9 years—11 years and 11 months): | | | |
|---|--------|---------|-------------------|
| Subject | Gender | Age | Disfluency rate % |
| 1 | M | 10 : 3 | 7.99 |
| 2 | M | 9 : 9 | 15.20 |
| 3 | M | 10 : 8 | 20.11 |
| 4 | M | 10 : 9 | 42.35 |
| 5 | F | 11 : 11 | 42.47 |
| 6 | M | 10 : 8 | 24.72 |
| 7 | M | 9 : 2 | 26.75 |
| 8 | M | 10 : 0 | 18.97 |
| 9 | M | 11 : 9 | 15.29 |
| 10 | F | 11 : 1 | 32.86 |
| 11 | M | 11 : 2 | 10.98 |
| 12 | M | 11 : 11 | 8.30 |

| Subject information | | | |
|---------------------|--------|--------|---|
| Subject | Gender | Age | Number of words Disfluency rate % |
| 13 | F | 11 : 5 | 484 6.00 |
| 14 | F | 10 : 7 | 283 12.01 |

All of the adult speakers were recorded in Düsseldorf in the Heinrich Heine University.

Note. The two cases indicated by ** had quite low disfluency rates. They were excluded from the rate analyses, but their values were used in the analyses referring to structural PW language differences.

** Recording Places were U = Ulm (Rommel and colleagues), BS = Sprachheilzentrum Bad Salzdetfurth, W = Sprachheilzentrum Werscherberg, A = Aachen University Clinic.