The impact of word-end phonology and morphology on stuttering

Chloe Marshall
Centre for Developmental Language Disorders and Cognitive Neuroscience, Department of Human Communication Science, University College London, Chandler House, 2 Wakefield Street, London WC1N 1PF
c.marshall@ucl.ac.uk

Abstract. This paper investigates whether stuttering rates in English-speaking adults and children are influenced by phonological and morphological complexity at the ends of words. The phonology of English inflection is such that morphological and phonological complexity are confounded, and previous research has indicated that phonological complexity influences stuttering. Section 1 of this paper considers how to disentangle phonological and morphological complexity so that the impact of each on stuttering can be tested. Section 2 presents an analysis of some adult corpus data, and shows that phonological and morphological complexity at the word end do not influence stuttering rates for English-speaking adults, at least in spontaneous speech. Section 3 presents results from a non-word repetition task and a past tense elicitation task which reveal that while word-end phonological and morphological complexity do not affect stuttering rates in most of the adults and children tested, a small proportion of adults and children do stutter over morphologically complex words in an elicitation task. Taken as a whole, these results suggest that morphology has an impact on stuttering for some individuals in certain circumstances. **Keywords:** Developmental stuttering, word-end phonology, word end morphology.

1.1 Introduction

Several recent models of stuttering hypothesise that the linguistic characteristics of the word being attempted can trigger stuttering (e.g. Au-Yeung & Howell, 1998; Packman, Onslow, Richard & van Doorn, 1996). While the role of phonological factors in stuttering has received some attention in the literature, the impact of word-end phonology has not been studied independently from other aspects of phonology. Nor has the role of inflectional morphology (plural marking on nouns; tense, agreement and aspectual marking on verbs) in stuttering been investigated. Word-end phonology and inflectional morphology are considered together in this paper for the following reason: In English, inflectional morphology occurs at the ends of words, and changes the phonology of the word end. For example, the plural form of '*cat*', *cats*, ends in a cluster, whereas the singular form, *cat*, does not. Similarly the verb '*lie*' ends in a vowel in the forms *I lie* and *you lie*, but in a consonant in the past tense forms *I lied* and *you lied*. As a consequence of this close relationship between phonology and morphology, the impact of morphology on the production of words is best studied alongside that of phonology.

The research questions addressed in this paper are as follows: (1) does phonological complexity at the ends of words influence stuttering rates, (2) does inflectional morphology influence stuttering rates, and (3) if morphology does influence stuttering, is this effect independent of phonological complexity? The paper attempts to respond to Demuth's plea that the role of phonology and morphology in stuttering be investigated (Demuth, 2004).

1.2 The impact of phonology on stutttering

Researchers use differing measures of what constitutes phonological or phonetic complexity, and therefore they differ in what phonological and phonetic characteristics they consider are likely to cause stuttering. As a rule these measures are based on what typically developing children find hard to acquire. For example, Throneburg, Yairi and Paden (1994) investigated the impact of late developing sounds, consonant clusters and multisyllabicity. A more comprehensive metric is the Index of Phonetic Complexity (IPC; Jakielski, 1998; Weiss & Jakielski, 2001), whereby words are scored according to how many 'difficult' structures they contain, with the most difficult words being those that get a high score. The IPC is outlined in Table 1 below.

Table 1. Index of Phonetic Complexity (Jakielski, 1998)

Factor	No score	One point each
1. consonant by place	Labials, coronals, glottals	dorsals
2. consonant by manner	stops, nasals, glides	fricatives, affricates, liquids
3. singleton consonants by place	Reduplicated	variegated
4. vowel by class	monophthongs, diphthongs	rhotics
5. word shape	ends with a vowel	ends with a consonant
6. word length (syllables)	monosyllables, disyllables	three or more syllables
7. contiguous consonants	no clusters	consonant clusters
8. cluster by place	Homorganic	heterorganic

Results from these studies have been mixed. Throneburg et al. (1994) found that neither late-developing sounds, consonant clusters nor multisyllabicity had any effect on stuttering rates in children aged between two and a half and five years. Howell and Au-Yeung (1995) confirmed this finding for a wider range of ages, up to twelve years old.

The IPC has been used in various investigations (Dworzynski & Howell, 2004; Howell, Au-Yeung, Yaruss & Eldridge, submitted; Weiss & Jakielski, 2001). Weiss and Jakielski (2001) studied children between the ages of six and eleven and a half. They found a trend for prosodic complexity to influence stuttering rates more in younger children than in older children, although this difference was not significant. In contrast, Howell et al. (submitted) found that phonetic complexity only influenced stuttering rates in children older than eleven and in adults. Studies using the IPC have revealed different patterns cross-linguistically. For example, Dworzynski and Howell (2004) found that for German people who stutter (PWS), words ending in consonants are more likely to be stuttered than words ending in a vowel, and that this effect was present for both adults and children over the age of six. This effect was not found for English speakers (Howell et al., submitted), a finding that Dworzynski and Howell (2004) put down to the fact that words ending in consonants are more frequent in English than in German.

One of the disadvantages of the IPC is that, apart from the factor ‘word shape’ (i.e. whether the word ends in a consonant or a vowel), it does not specify where in the word phonetic complexity occurs. It is well-established that word-initial sounds trigger disfluencies (e.g. Conture, 1990; Howell, Au-Yeung & Sackin, 2000; Natke, Sandreiser, van Ark, Pietrowski & Kalveram, 2004; Wingate, 1982, 1988), but the aim of this paper is to investigate the impact of the word end. Dworzynski and Howell (2004) suggest that word-final factors might indeed play a role in the planning and retrieval time of words, given that word shape affects German PWS. Otherwise, there is as yet little evidence that word-end phonology influences stuttering.

1.3 The relationship between phonology and inflectional morphology

In this paper I consider the impact not only of phonological complexity at the word end, but also that of inflectional morphology. English morphology is sparse, with a mere two forms for nouns (*cat*, *cats*) and a maximum of five for verbs (*sew*, *sewed*, *sews*, *sewing*, *sewn*). I am concerned only with suffixes that add a consonant – past tense *t*/*d* (e.g. *hoped*, *sewed*), plural *s*/*z* (e.g. *cats*, *dogs*) and third person singular *s*/z (e.g. *hopes*, *sews*). By adding a consonant, these suffixes increase phonological complexity at the word end, and may create clusters (compared *sewed* with *hoped*). I leave aside the syllabic suffixes -*ed* (e.g. *wanted*, *needed*), -*ez* (e.g. *horses*, *reaches*) and -*ing*.

Any theory of phonological and morphological complexity should mirror what we know happens developmentally. Children’s first words end in a vowel (e.g. *mama*) and only later, at about the age of one and half or two do they produce words ending in a consonant, e.g. *man*. Only later still will they produce words ending in a consonant cluster. Therefore word-final clusters are more complex in some way than word-final singleton consonants. In terms of children's early word productions, their first words are generally uninflected, and only later are inflections produced. -*Ing* and plural –*s* are among the first inflections used, while third person singular –*s* and past tense –*ed* take longer to become reliably established (see Bernhardt & Stemberger, 1998, for an overview of phonological development).

Howell et al. (submitted) investigated the effect that a word-end consonant has on stuttering rates in adults, and found that words ending in a consonant were actually stuttered less frequently than those ending in a vowel. The first indications would therefore appear to be that word-end morphology that adds a consonant might not actually be relevant to stuttering, at least in adults. However, the possibility that morphology does affect stuttering cannot be ruled out on the basis of Howell et al.'s (submitted) data. To do so, a systematic analysis of phonological and morphological factors at the word end is needed.

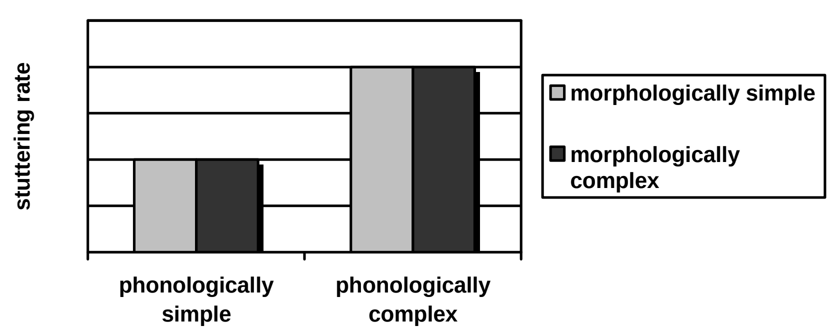
In the analyses presented in this paper, word forms that end in a singleton consonant are termed 'phonologically simple'[1] and those that end in a cluster 'phonologically complex'. Uninflected words are termed 'morphologically simple' and inflected words 'morphologically complex'. This classification enables four types of words to be contrasted:

1. phonologically simple, morphologically simple (e.g. *bad*, *mouse*)
2. phonologically simple, morphologically complex (e.g. *died*, *days*)
3. phonologically complex, morphologically simple (e.g. *month*, *think*)
4. phonologically complex, morphologically complex (e.g. *looked*, *wants*)

Such a classification enables the following questions to be raaised: (1) does phonological complexity at the ends of words influence stuttering rates independent of morphology, and (2) does inflectional morphology influence stuttering rates independent of phonology?

The pattern of results that might plausibly be expected to arise are now discussed. If phonological complexity at the ends of words influences stuttering rates independently of morphology, the following pattern of results would be predicted – higher stuttering rates on 3+4 (i.e. phonologically complex words) than on 1+2 (i.e. phonologically simple words), but no difference between 1 and 2 (i.e. between morphologically simple and complex words that are phonologically simple) and no difference between 3 and 4 (i.e. between morphologically simple and complex words that are phonologically complex) (see Figure 1a). If morphological complexity influences stuttering rates then higher stuttering rates would be seen on 2+4 (i.e. morphologically complex words) than on 1+3 (i.e. morphologically simple words). If morphological complexity influences stuttering independently of phonology, then stuttering rates would be expected to be equivalent for 2 (i.e. phonologically simple) and 4 (i.e. phonologically complex) (see Figure 1b). A third possibility is that there may be an interaction between phonological and morphological complexity, with stuttering rates highest for those words that are both phonologically and morphologically complex (Figure 1c).

Figure 1a. Phonological complexity influences stuttering independent of morphology



[1] Of course, even more phonologically simple would be a word that ends in a vowel rather than a consonant, but there are no inflected words of this shape with which to compare it.

Figure 1b. Morphological complexity influences stuttering independent of phonology

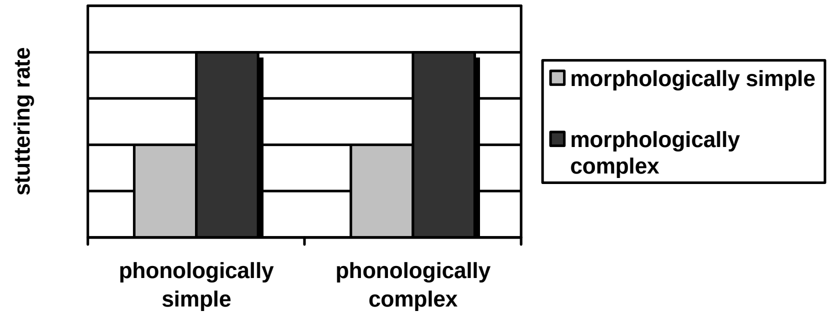
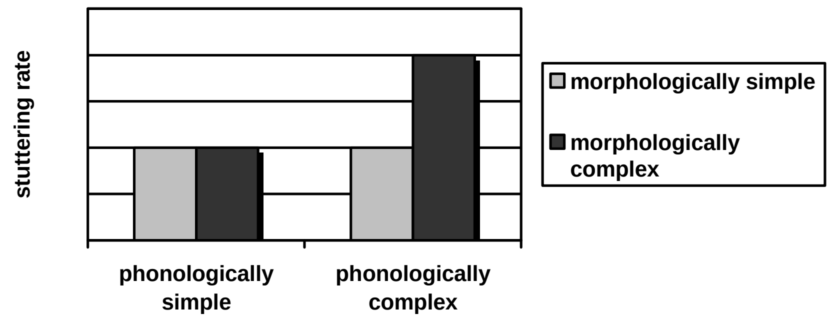


Figure 1c. Interaction between phonological and morphological complexity



In order to investigate which of these patterns of performance is found amongst PWS, two types of data are considered. In Study 1, a corpus of teenage and adult speech is analysed, looking at the patterns of relative performance on phonologically and morphologically complex forms (as outlined above). In Studies 2 and 3, some experimental data from children and young adults, from a non-word repetition task and from a task designed to elicit inflected verbs are analysed. The non-word repetition task allows phonologically simple and complex non-words to be compared in a context that is by its very nature morphologically simple. The elicitation task allows comparison between phonologically simple and complex words in the presence of morphological complexity.

2.1 Study 1.

This study is an analysis of words selected from the University College London Archive of Stuttered Speech (UCLASS) data base (Howell & Huckvale, 2004). The material was produced spontaneously in response to prompt questions by an interviewer and conforms to "casual" speech in terms of Labov's (1978) stylistic continuum in sociolinguistics. The speech was recorded from 16 male participants, diagnosed as showing signs of stuttering by a speech pathologist in a clinic in the United Kingdom. They were then independently diagnosed by a second speech pathologist as a person who stutters. They ranged in age from 16 to 47 years, with a mean age of 24.93 years (sd = 9). Number of words in the sample, the percentage of these words that were stuttered, and their age at the time of recording are given for each participant in Table 2 below. The samples of speech were heterogeneous so as to reflect a wide variety of stuttering profiles. The material was transcribed according to the conventions outlined in Howell and Huckvale (2004). The transcriptions indicate where stuttering was located (see Kadi-Hanifi & Howell, 1992, for an indication what events were considered to be stutterings and estimates of reliability for this type of material).

Table 2. Details of speakers, total number of words in the sample, number of words stuttered, percentage stuttering rate in the sample and age in years

Participant number	Number of words	Number of words stuttered	% stuttered	Age
1	1420	37	2.61	47
2	1720	46	2.70	25
3	1016	31	3.10	38
4	1255	61	4.90	26
5	1390	76	5.47	28
6	188	11	5.90	24
7	219	14	6.40	18
8	221	15	6.80	16
9	338	23	6.80	17
10	1315	125	9.51	20
11	272	28	10.30	16
12	763	85	11.10	25
13	1593	179	11.24	21
14	378	43	11.40	16
15	943	154	16.33	35
16	1082	220	20.33	40

In this analysis stuttering rates are compared across four different types of words, whose characteristics (and some examples) are set out in Table 3 below. Phonologically, words differ only in whether they contain a word-final cluster. The words selected have either the shape Consonant-Vowel-Consonant (CVC) or Consonant-Vowel-Consonant-Consonant (CVCC), i.e. none contain onset clusters, and none consist of more than one syllable.

Table 3. Characteristics of the words being analysed and some examples

		Morphology	
		simple	complex
phonology	simple	*bad,* *house*	*died,* *days*
	complex	*month,* *think*	*looked,* *wants*

A Perl program (Brown, 2001) identified words ending in the letters s, z ,d and t. These were then hand-coded as being morphemic or otherwise. Irregular verbs were then removed from the data set, again by hand. These included irregular past tenses (e.g. *hit*, *had*, *got*, *was*), irregular third person singular *has*, and past participles (e.g. *done*). They were removed because irregulars are not strictly speaking decomposable into verb stem + suffix in the way that regular verbs are (e.g. *lies* = *lie* + *s* but *has* ≠ *ha* + *s*; therefore *lies* is clearly morphologically complex, but *has* is not).

Scoring

Each word was classified as stuttered (1) or not stuttered (0), based on such events marked in the original transcriptions (see Howell & Huckvale, 2004 for details).

2.2 Results

Table 4 shows the total number of words of each type that were extracted from the database, and then in brackets the number that were stuttered.

Table 4. Total number of words in each type (number of stuttered words in brackets); M = mean number of words stuttered, expressed as a percentage

		morphology	
		simple (uninflected)	complex (inflected)
Phonology	simple (CVC)	509 (48) M = 9.43%	23 (2) M = 8.70%
	complex (CVCC)	94 (7) M = 7.45%	190 (16) M = 8.42%

Overall, 8.95% of words were stuttered. Differences in the percentage of stuttered items in each cell were very small, and chi-square analysis shows them to be statistically insignificant (for phonologically simple words, Cramer's V = 0.005, p = 0.906; for phonologically complex words, Cramer's V = 0,017, p = 0.777; for morphologically simple words, Cramer's V = 0.025, p = 0.539; for morphologically complex words, Cramer's V = 0.003, p = 0.964).

Ideally it would be desirable to analyse individual performance, in order to determine whether any speakers were significantly affected by phonological and/ or morphological complexity. However, this analysis was not possible because the speakers produced greatly different numbers of words in the different categories of interest, and some speakers produced no tokens within a particular category, either fluent or stuttered.

From these results it can be concluded that for English-speaking adults and adolescents the presence of a cluster at the end of a word does not influence stuttering rates in natural speech. Nor is there an effect of inflectional morphology on stuttering. However, it is stressed that the data are not amenable to individual analysis because often speakers did not produce any tokens within a particular category. The possibility remains that for certain speakers either or both types of complexity might have an effect. Experimental studies provide an opportunity to elicit a larger number of tokens of the particular word shapes that are of interest.

3.1. Studies 2 and 3: Experimental data from children and young adults.

In this section two experimental studies are reported. Study 2 uses a repetition task, which is designed to elicit nonsense words with or without clusters at the word end. Study 3 uses an elicitation task, and is designed to elicit third person singular (e.g. *weighs*, *wraps*) and past tense forms (e.g. *weighed*, *wrapped*) with or without word-final clusters. These tasks permit an investigation of the impact of phonological complexity on stuttering rates, first within morphologically simple, and then within morphologically complex, words.

As was seen in Study 1, samples of spontaneous speech might not contain enough tokens of the sort that are of interest, so that even if group analyses are possible, individual analyses are not. Elicitation tasks have been used previously for investigating syntactic effects on stuttering. For example, Silverman and Bernstein Ratner (1997) asked children to repeat sentences with differing types of complex syntactic structures, such as WH questions and centre embedded sentences. A standard technique used in the atypical phonological development literature involves children playing with toys that have particular names so that the experimenter can elicit the phonological forms of interest (e.g. Chiat, 1989). This technique offers a halfway house between free spontaneous speech and formal elicitation methods, but as far as is known, it has not been used for studying the phonological development of children who stutter (although it has been used to ascertain whether such children have awareness of their speech problem, Yairi & Ambrose, 2004).

Experimental studies allow balanced numbers of the types of words that are of interest to be gathered, controlled for factors such as lexical frequency, in a short period of time. A disadvantage is that if very different results are obtained as compared to analyses of spontaneous speech, then these would need to be interpreted. For example, if higher rates of stuttering were discovered for certain classes of words in experimental studies compared to spontaneous speech, is that because the experimental task is forcing speakers to make errors that they wouldn't normally make, or is it because in spontaneous speech speakers can avoid using words that they are aware they might stutter over? And yet, even if errors are forced in an experimental situation, that can still give us valuable information about the cognitive processes underlying stuttering. The merits of analyzing spontaneous material versus material obtained experimentally in young children have been discussed at length by Savage and Lieven (2004), who conclude that both are essential research tools.

3.2.1 Study 2 – non-word repetition

In non-word repetition tasks the participant hears nonsense words and repeats them. These tasks have been widely used with children with specific language impairment (SLI) and dyslexia. Children with SLI and dyslexia typically make repetition errors as the non-words get longer (Bishop, North & Donlan, 1996; Gathercole & Baddeley, 1990; Martin & Schwartz, 2003). Controversy still exists over the precise locus of the deficit that gives rise to non-word repetition difficulties. The evidence was initially interpreted as revealing that children with SLI have verbal short-term memory limitations, but this interpretation has been challenged from many quarters.

Marshall, Harris and van der Lely (2003) contend that non-word repetition tasks can be used to probe the status of phonological skills in children. Manipulating the phonological structure of non-words allows investigation of which structures are easy to repeat (and hence which are easily represented/ processed) and which are hard to repeat (less easily represented/ processed). Marshall et al. (2003) and Gallon, Harris and van der Lely (submitted) used the Test of Phonological Structure (TOPhS, van der Lely & Harris, 1999) to reveal that SLI children have difficulty repeating non-words that contain clusters and unfooted syllables (a real word example of an unfooted syllable would be the initial unstressed syllable in *gorilla*). Note that the children in van der Lely and colleagues' studies did not have verbal dyspraxia or disfluencies – their articulation was clear and fluent for known words.

The aim of the non-word repetition task included here is to investigate whether phonological complexity at the end of nonwords, as indexed by the presence of a consonant cluster, influences stuttering rates. Note that other studies of non-word repetition (e.g. Hakim & Bernstein Ratner, 2004) have investigated both whether PWS make more repetition errors than people who do not stutter, and whether stuttering rates increase as the length of the non-word increases. Hence they have investigated both the non-word repetition accuracy of PWS and whether the properties of non-words trigger stuttering. In this analysis, interest is solely in the latter question.

3.2.2 Method

Participants

19 speakers participated, and their details are presented in Table 5. Their average age is 14;0. For the purposes of analysis they were divided into 2 groups: the participants in Group 1 are aged 14 years and younger, and those in Group 2 are 15 and older. The motivation for dividing the group at 14 years of age was that around this age, stuttering changes form (the type of

stuttering that occurs and the words on which the stuttering is located differ from before to after teenage). Thus the two age groups might operate differently with respect to stuttering.

Table 5. Details of speakers who participated in the experimental tasks

Participant number	Age	Group	Gender
9	8;0	1	M
10	9;10	1	M
11	9;8	1	M
12	10.5	1	M
14	10;5	1	F
15	10;10	1	M
13	11;4	1	M
3	12;10	1	M
1	13;5	1	M
16	14;2	1	F
19	14;4	1	F
4	14;5	1	M
18	15;5	2	M
6	15;8	2	M
17	17;3	2	F
2	17;4	2	M
5	17;7	2	F
8	19;5	2	M
7	21;10	2	M

Items

There were two experimental conditions and one filler condition, with items adapted from the TOPhS (van der Lely & Harris, 1999). For Experimental Condition 1, one-syllable items (N=8) were chosen that ended in a singleton consonant. Half of these items have a simple onset (e.g. *kɛt*) and half have a complex onset (e.g. *klɛt*). For Condition 2, one-syllable items (N=8) were chosen that end in a two-consonant cluster. Again, half have a simple onset (e.g. *kɛst*) and half have a complex onset (e.g. *klɛst*). The TOPhS was designed to allow investigation into the impact of word-final clusters on the repetition of non-words that are otherwise segmentally identical. This match for segmental content is rarely possible when using real word stimuli. A further point is that, by the very nature of the task, these stimuli are morphologically simple. For the Filler Condition (N = 12), three and four syllable (i.e. multisyllabic) items were chosen, none of which contains a cluster (e.g. *dɛpəri*, *səpɪfi*; stressed vowel underlined). The filler condition was chosen to contrast with the monosyllabic experimental items, with the aim of adding variety and maintaining participants' attention to the task.

Procedure

The experimenter tells the participant '*In this game I'm going to say some funny, made-up words which I would like you to repeat after me. We'll start with some practice ones so you can see what you have to do. Can you say '**zɪk**'?'* The experimenter gives the participant time to repeat the non-word, and repeats it if necessary. The experimenter carries on down the list of practice items, just saying the non-word with no introduction.

Before the experimenter starts the experimental items, he or she says '*Those were the practice words. You did really well with those. Now we're going to start for real.*' The experimenter says each experimental item with no introduction, and this time does not repeat any of them if the participant is unsure about them – he or she just moves on to the next item.

Scoring

Answers were scored for the presence (1) or absence (0) of stuttering. Note that repetition accuracy is not of concern in this analysis.

Predictions

If phonological complexity at the word end influences stuttering, we predict higher stuttering rates for non-words ending in a cluster.

3.2.3 Results

The results are shown in Table 6 below.

Table 6. Total number of words in each type (number of stuttered words in brackets); M = mean number of words stuttered, expressed as a percentage; SD_i = standard deviation by items; SD_p = standard deviation by participant

	Experimental conditions		Filler condition
Participant group	no word-final cluster (e.g. *kɛt*, *klɛt*)	word-final cluster (e.g. *kɛst*, *klɛst*)	multisyllabic (e.g. *səpɪfi*)
1 (14 years and younger)	96 (1) M = 1.04% SD_i = 4.42 SD_p = 2.41	96 (2) M = 2.08% SD_i = 3.24 SD_p = 3.24	144 (21) M = 14.58% SD_i = 10.74 SD_p = 20.41
2 (15 years and older)	56 (1) M = 1.79% SD_i = 4.42 SD_p = 5.40	56 (1) M = 1.79% SD_i = 4.42 SD_p = 5.40	84 (11) M = 13.10% SD_i = 2.41 SD_p = 59.39

The data in Table 6 indicate that very few of the experimental items are stuttered, and that these are fairly evenly distributed between those that end in a cluster and those that do not. Obviously, with such low numbers of stuttered items, it is not possible to test for a significant difference between non-words with and without final clusters. However, multisyllabic filler items were stuttered much more frequently than the monosyllabic experimental items, and a chi-square analysis shows that across participant group this difference is significant (Cramer's V = 0.241, $p < 0.001$). Caution is expressed on interpreting these results, however, because they hide a range of individual patterns, as indicated by the very large figures for the standard deviations by participant (SD_p). Only one participant from Group 2 (participant 2) stuttered on multisyllabic words, whereas five from Group 1 (participants 3, 10, 13, 16 and 19) stuttered at least once on these items. These details are shown in Table 7.

Table 7. The number of multisyllabic items stuttered by individual speakers

Participant number	Group	Number multisyllabic items stuttered
9	1	0
10	1	4
11	1	0
12	1	0
14	1	0
15	1	0
13	1	3
3	1	2
1	1	0
16	1	5
19	1	7
4	1	0
18	2	0
6	2	0
17	2	0
2	2	11
5	2	0
8	2	0
7	2	0

As for which multisyllabic items were stuttered most, these data are shown in Table 8. As the standard deviations in Table 6 indicate, there is little variability across items.

Table 8. Multisyllabic items and how often they were stuttered

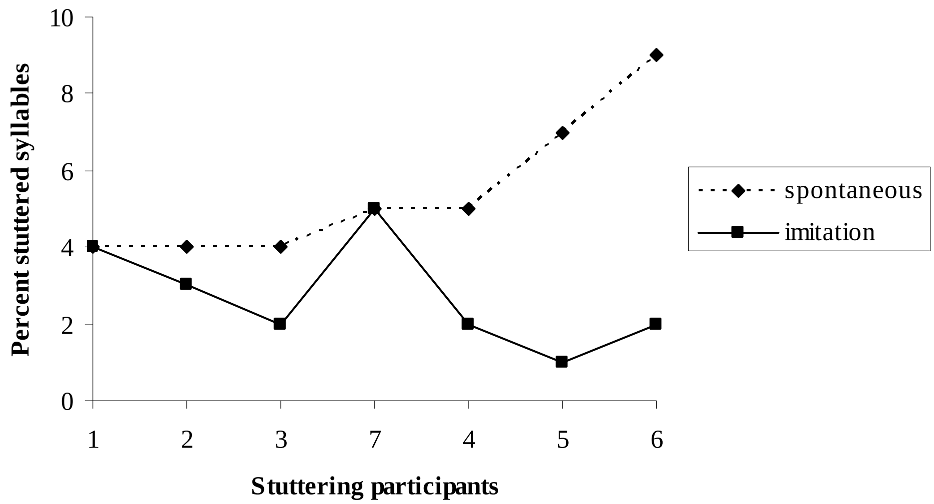
	Number of times item was stuttered	
Item	Group 1	Group 2
dɛ̠pəri	2	1
fɪ̠pələ	0	1
kɛ̠tələ	3	1
pɪ̠fətə	2	1
bədɛ̠pə	2	1
dəfɪ̠pl	2	1
fəkɛ̠te	1	1
səpɪ̠fi	0	1
bədɛ̠pəri	4	1
dəfɪ̠pələ	0	1
fəkɛ̠tələ	3	0

səpɪfətə	2	1

3.2.4 Discussion

The fact that a non-word repetition task is capable of inducing stuttering is shown by the high stuttering rates for multisyllabic items. Yet rates of stuttering are lower for those same phonological forms that were produced in spontaneous speech (see Table 3)[2]. Is there something about direct repetition of a model's speech that reduces stuttering rates? Howell and Dworzynski (in press) have raised a related question with respect to meaningful material: they examined the results from Silverman and Bernstein Ratner's (1997) study and showed that those speakers who had a higher rate of stuttering in spontaneous speech tended to have lower stuttering rates in an imitation task (see Figure 2, reproduced with their permission). Howell and Dworzynski speculate that this may arise because the participant has an opportunity of previewing and preplanning material in an imitation task. Thus, it may not only be that direct repetition reduces stuttering rate, but also, the reduction is greater in speakers who have more severe problems as measured from their spontaneous speech.

Figure 2. Percent syllables stuttered in spontaneous speech and imitation tasks for individual participants who stutter. Redrawn from Silverman and Bernstein Ratner (1997) with participants ordered in increasing percentage of syllables stuttered in spontaneous speech. Participants have the same numbers as in Silverman and Bernstein Ratner (1997).



Given the high rate of stuttering in this experiment on multisyllabic words, it would be interesting to compare this rate with the rate of stuttering for multisyllabic words in spontaneous speech samples, but that particular issue is beyond the scope of this paper.

3.3.1 Study 3

Elicitation tasks have been widely used to probe inflectional abilities, particularly in children with SLI who are known to have difficulties with inflectional morphology (Berko, 1958; Leonard, Eyer, Bedore & Grela, 1997; Rice, Wexler & Cleave, 1995; van der Lely & Ullman, 2001). Many of these tasks use real verbs, but some use nonsense verbs as a way of investigating whether the child's knowledge of morphology is truly productive (as opposed to the child just supplying a memorised inflected form).

[2] We are not quite comparing like for like – half the non-words in the repetition task contain onset clusters, whereas those in spontaneous speech sample did not

As the non-word repetition task (Study 2) gave such low stuttering rates compared to real words (as measured from spontaneous speech, Study 1), real verbs were used for this task. The aim is to determine whether phonological complexity affects stuttering rates for inflected words by comparing inflected words that end in a cluster (e.g. *wrapped*) with those that end in just a single consonant (e.g. *weighed*)

3.3.2 Method

Participants

The same speakers participated as in Study 2. See Table 5 for their details.

Items

Two experimental conditions (no fillers) were selected. Condition 1 consists of 5 verbs whose 3rd person singular and past tense forms both end in a single consonant (e.g. *weighs*, *weighed*). Condition 2 consists of five verbs whose inflected forms end in a two-consonant cluster (e.g. *wraps*, *wrapped*). The aim is to compare stuttering rates on the phonologically simple (no cluster) and phonologically complex (cluster) forms. None of the verbs has an onset cluster. Therefore the effect of complexity is investigated only at the verb end. Hubbard and Prins (1994) report frequency effects on stuttering rates, so we ensured that both conditions consisted of high frequency verbs that were matched for frequency[3].

Procedure

The items are presented verbally, and the response is requested verbally (i.e. the participant is not required to read or write anything). The experimenter says to the participant *'In this game we're going to talk about things that I like to do, and that my friend also likes to do. You're going to help me to say those things. For example, if I say 'Everyday I go to school', this is something my friend does too. So you can tell me 'Your friend also goes to school'. Can you say that? And you can also tell me what we both did yesterday: 'Yesterday you both went to school'. Can you say that?*

'Let's do another one to practice. 'Everyday I eat ice cream.' So you can say 'Your friend also (leave blank for the participant to fill in). *And you can also say 'Yesterday you both* (leave blank for the participant to fill in). *That's it. Let's do one more practise one before we start for real.'*

Most participants get the hang of this procedure very quickly. The experimenter gives the participant as much prompting as they need with the initial part of the sentence, but always lets them fill in the verb. If the participant can't remember the verb, then the experimenter repeats the first sentence (Everyday I …). Verbs are based on those used in Marshall (2004).

Scoring

Responses were scored for the presence (1) or absence (0) of stuttering. Accuracy of inflection itself is not of concern.

Predictions

If phonological complexity is a factor influencing stuttering on morphologically complex words, then more items ending in a consonant cluster would be predicted to be stuttered.

3.3.3 Results

The results are set out in Table 9 below.

---

[3] Natural log of lemma frequency, according to the English frequency count in the CELEX database (Baayen, Piepenbrock & van Rijn, 1993) was 4.5 and above.

Table 9. Total number of words in each type (number of stuttered words in brackets); M = mean number of words stuttered, expressed as a percentage; SD_i = standard deviation by items; SD_p = standard deviation by participant

	Experimental condition	
Participant group	No cluster (e.g. *weighs*, *weighed*)	Cluster (e.g. *wraps*, *wrapped*)
1 (14 years and under)	120 (14) M = 11.67% SD_i = 5.16 SD_p = 22.90	120 (14) M = 11.67% SD_i = 6.99 SD_p = 20.65
2 (15 years and older)	70 (3) M = 4.29% SD_i = 4.83 SD_p = 7.87	70 (4) M = 5.71% SD_i = 5.16 SD_p = 15.12

An examination of the data in Table 9 indicates that the presence of a cluster at the inflected verb end has no influence on stuttering rates. The standard deviations by items (SD_i) in each cell are low, reflecting that there is little variability across verbs. The only item for which none of the 19 speakers stuttered was *hums*. The items that were stuttered most were *wrapped*, *hummed* and *sews*, each stuttered by 3 of the 19 speakers.

Variability across speakers, as revealed by SD_p, is much greater, and the scores for each speaker are presented in Table 10. Only three of the twelve participants in Group 1 stutter on more than one item (participants 3, 10 and 16), and eight stutter on none of the items. One participant in Group 2 (participant 2) is responsible for all the items stuttered by his group, and he is the only one who stutters more on items containing a final cluster. Interestingly, he was the participant who stuttered on the multisyllabic non-words in the repetition task in Study 2. Although it appears that participants in the younger group stutter more on the items in the elicitation task than the older group, this difference was not tested for significance because of the large individual differences in performance in both groups.

Table 10. Number of morphologically complex items stuttered by individual speakers

Participant number	Group	Number items stuttered – no final cluster	Number of items stuttered – final cluster
9	1	0	0
10	1	7	6
11	1	0	0
12	1	0	0
14	1	0	0
15	1	0	1
13	1	0	0
3	1	4	4
1	1	0	0
16	1	3	3
19	1	0	0
4	1	0	0
18	2	0	0

6	2	1	0
17	2	0	0
2	2	2	4
5	2	0	0
8	2	0	0
7	2	0	0

3.3.4 Discussion

A few individuals stutter on morphologically complex forms, but they are in a minority. For those individuals, with the possible exception of Participant 2, there was no effect of phonological complexity upon stuttering: the presence of a cluster at the verb end did not influence stuttering rates.

4. Conclusions

The analysis of spontaneous speech (Study 1) revealed no differences in stuttering rates within words that are either phonologically complex (as indexed by the presence of a word-final cluster), morphologically complex (as indexed by the presence of inflection) or both. In a non-word repetition task (Study 2), where items are by their very nature morphologically simple, the presence of a word-end cluster has no influence on stuttering rates. In a task designed to elicit inflected words (Study 3), phonological complexity has no effect either, with the possible exception of one of the speakers in the older group. However, a small proportion of individuals do stutter on inflected forms, indicating that for certain PWS morphological complexity can affect their stuttering.

These preliminary results reveal that phonological complexity at the word end has no effect on stuttering amongst speakers of English, while morphological complexity affects only a minority of PWS. However, this is by no means the full story. For example, these studies did not consider inflections that add a syllable, e.g. *ed*, *ez* and *–ing*. The higher rates of stuttering on multisyllabic words in the non-word repetition test suggest that syllabic inflections might cause fluency difficulties, particularly for verb stems that are themselves more than one syllable long, e.g. *oranges*, *recorded*, *balancing*. Also beyond the scope of this paper, but perhaps worth investigating in future work, is the impact of derivational morphology, as this adds one or more syllables to either the beginning or the end of words (e.g. *heavi**er***, *muddi**est***, ***un**real*, ***sub**standard*, ***over**cater*). Certainly, on the non-word repetition task presented in Study 2, stuttering rates were high in the repetition of multisyllabic non-words with similar metrical shapes to derived words, e.g. *səpɪfi*, *pɪfətə*.

It would also be worth investigating the effects of cumulative complexity. It is possible that word final clusters only have a measurable effect on stuttering rates when they occur in words that contain other complex phonological structures, such as unfooted syllables and onset clusters. In support of this hypothesis, research using the IPC metric suggests that the effects of phonological complexity are indeed cumulative (e.g. Howell et al., submitted).

Nor can we conclude from the results presented here that effects of word-end phonology and of inflectional morphology will not be among the factors implicated at the onset of stuttering, which is most common at the age of 3. Tasks requiring children to repeat non-words and produce morphologically complex words have been carried out successfully with children this young (e.g. Roy & Chiat, 2004, non-word repetition; Rice & Wexler, 2001, inflection), and experimental material similar to that presented in Studies 2 and 3 of this paper would be suitable for this purpose.

Finally, one of the main aims of this paper has been to instruct the experimenter on how to tease apart phonology and morphology, so that the effects of each can be studied independently. It is my hope that it will stimulate further work in this field, improving our understanding of how word-end factors affect stuttering both at its onset and in persistent stutterers.

Acknowledgements

I would like to thank Pete Howell, for encouraging me to think about the issues raised in this paper and for his support during every stage of the writing process. Huge thanks are also due to Jenny Hayes, for writing the computer program that selected words from the corpus of spontaneous speech, and for carrying out experimental tasks. I am grateful to Heather van der Lely and John Harris for letting me use items from the Test of Phonological Structure. The bulk of this work was carried out while I was in receipt of an ESRC studentship, which is gratefully acknowledged.

Appendix 1. Non-words used in the repetition task.

Practice items

zɪk, bənɛ̱li, fɪ̱nəri, wɛf

Experimental items – no word-final cluster

frɪp, kɛt, pɪf, prɪf, dɛp, drɛp, fɪp, klɛt

Experimental items –word-final cluster

dɛmp, klɛst, kɛst, frɪmp, fɪmp, drɛmp, pɪlf, prɪlf

Filler items

dɛ̱pəri, səpɪ̱fətə, kɛ̱tələ, dəfɪ̱pl, pɪ̱fətə, bədɛ̱pəri, bədɛ̱pə, dəfɪ̱pələ, səpɪ̱fi, fəkɛ̱tələ, fəkɛ̱tə, fɪ̱pələ

Appendix 2. Stimuli for the third person singular and past tense elicitation task

Practice items

Everyday I go to school. Your friend also (goes) to school. Yesterday you both (went) to school.
Everyday I eat ice cream. Your friend also (eats) icecream. Yesterday you both (ate) ice cream.
Everyday I swim in the sea. Your friend also (swims) in the sea. Yesterday you both (swam) in the sea.

Experimental items – no word-final cluster

Everyday I pour a drink. Your friend also (pours) a drink. Yesterday you both (poured) a drink.
Everyday I pay a bill. Your friend also (pays) a bill. Yesterday you both (paid) a bill.
Everyday I sew a shirt. Your friend also (sews) a shirt. Yesterday you both (sewed) a shirt.
Everyday I weigh a parcel. Your friend also (weighs) a parcel. Yesterday you both (weighed) a parcel.
Everyday I lie a little bit. Your friend also (lies) a little bit. Yesterday you both (lied) a little bit.

Experimental items – word-final cluster

Everyday I lick a lollipop. Your friend also (licks) a lollipop. Yesterday you both (licked) a lollipop.
Everyday I cough a lot. Your friend also (coughs) a lot. Yesterday you both (coughed) a lot.
Everyday I wrap a present. Your friend also (wraps) a present. Yesterday you both (wrapped) a present.
Everyday I pack a suitcase. Your friend also (packs) a suitcase. Yesterday you both (packed) a suitcase.
Everyday I hum a tune. Your friend also (hums) a tune. Yesterday you both (hummed) a tune.

References

Au-Yeung, J. & Howell, P. (1998). Lexical and syntactic content and stuttering. *Clinical Linguistic and Phonetics*, **12**, 67-78.

Baayen, H., Piepenbrock, R. & van Rijn, H. (1993). *The CELEX lexical database, CD-ROM*. University of Pennsylvania: Linguistic Data Consortium.

Berko, J. (1958). The child's learning of English morphology. *Word*, **14**, 150-177.

Bernhardt, B. & Stemberger, J. (1998). *Handbook of phonological development*. San Diego: Academic Press.

Bishop, D., North, T. & Donlan, C. (1996). Nonword repetition as a behavioural marker for inherited language impairment: Evidence from a twin study. *Journal of Child Psychiatry*, **4**, 391-403.

Brown, M. C. (2001). *Perl: The complete reference second edition*. New York: McGraw-Hill.

Chiat, S. (1989). The relation between prosodic structure, syllabification and segmental realization: evidence from a child with fricative stopping. *Clinical Linguistics and Phonetics*, **3**, 223-242.

Conture, E.G. (1990). *Stuttering*. Englewood Cliffs, NJ: Prentice-Hall.

Demuth, K. (2004). Production approaches to stuttering. *Stammering Research*, **1**, 297-298.

Dworzynski, K. & Howell, P. (2004). Predicting stuttering from phonetic complexity in German. *Journal of Fluency Disorders*, **29**, 149-173.

Gallon, N., J. Harris & van der Lely, H.K.J. (submitted). Nonword repetition: An investigation of phonological complexity in children with G-SLI.

Gathercole, S. &, Baddeley, A. (1990). Phonological memory deficits in language disordered children: Is there a connection? *Journal of Memory and Language*, **29**, 336-360.

Hakim, H.B. & Ratner, N.B. (2004). Nonword repetition abilities in children who stutter: An exploratory study. *Journal of Fluency Disorders*, **29**, 179-199.

Howell, P. Au-Yeung, J. (1995). 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*, **20**: 331-344.

Howell, P., Au-Yeung, J. & Sackin, S. (1999). Exchange of stuttering from function words to content words with age. *Journal of Speech, Language and Hearing Research*, **42**, 345-354.

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

Howell, P., Au-Yeung, J., Yaruss, S. & Eldridge, K. (submitted). Phonetic difficulty and stuttering in English. *Journal of Fluency Disorders*.

Howell, P., & Dworyznski, K. (in press). Planning and execution processes in speech control by fluent speakers and speakers who stutter. *Journal of Fluency Disorders*.

Howell, P. & Huckvale, M. (2004). Facilities to assist people to research into stammered speech. *Stammering Research*, **1**, 130-242.

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

Jakielski, K.J. (1998). *Motor organization in the acquisition of consonant clusters*. Dissertation/PhD thesis, University of Texas Austin.

Kadi-Hanifi, K., & Howell, P. (1992). Syntactic analysis of the spontaneous speech of normally fluent and stuttering children. *Journal of Fluency Disorders*, **17**, 151-170.

Labov, W. (1978). *Sociolinguistic patterns*. Oxford: Blackwell.

Leonard, L.B., Eyer, J.A., Bedore, L.M. & Grela, B.G. (1997). Three accounts of the grammatical morpheme difficulties of English-speaking children with Specific Language Impairment. *Journal of Speech, Language and Hearing Research*, **40**, 741-753.

Marshall, C.R. (2004). *The morpho-phonlogical interface in children with Specific Language Impairment*. Unpublished doctoral dissertation, University of London.

Marshall, C.R., Harris, J. & van der Lely, H.K.J. (2003). The nature of phonological representations in children with Grammatical-Specific Language Impairment (G-SLI). In D. Hall, T. Markopoulos, A. Salamoura & S. Skoufaki (eds) *Proceedings of the University of Cambridge First Postgraduate Conference in Language Research*, **1**, 511-517

Marton, K. & Schwartz, R. (2003). Working memory capacity and language processes in children with Specific Language Impairment. *Journal of Speech, Language and Hearing Research*, **46**, 1138-1153.

Natke, U., Sandreiser, P., van Ark, M., Pietrowski, R. & Kalveram, K.T. (2004). Linguistic stress, within-word position and grammatical class in relation to early childhood stuttering. *Journal of Fluency Disorders*, **29**, 109-122.

Packman, A., Onslow, M., Richard, F. & van Doorn, J. (1996). Syllabic stress and variability: A model of stuttering. *Clinical Linguistics and Phonetics*, **10**, 235-263.

Rice, M.L. & Wexler, K. (2001). *Test of Early Grammatical Impairment*. Psychological Corporation.

Rice, M.L., Wexler, K. & Cleave, P.L. (1995). Specific Language Impairment as a period of extended optional infinitive. *Journal of Speech and Hearing Research*, **38**, 850-863.
Roy, P. & Chiat, S. (2004). A prosodically controlled word and nonword repetition task for 2- to 4-year-olds: evidence from typically developing children. *Journal of Speech, Language, and Hearing Research*, **47**, 223-234.
Savage, C. & Lieven, E. (2004). Can the Usage-based approach to language development be applied to analysis of developmental stuttering? *Stammering Research*, **1**, 83-111.
Silverman, S., & Bernstein Ratner, N. (1997). Syntactic complexity, fluency, and accuracy of sentence imitation in adolescents. *Journal of Speech, Language, and Hearing Research*, **40**, 95-106.
Throneburg, R.N., Yairi, E. & Paden, E.P. (1994). Relation between phonologic difficulty and the occurrence of disfluencies in the early stage of stuttering. *Journal of Speech and Hearing Research*, **37**, 504-509.
van der Lely, H.K.J. & Harris, J. (1999). *The Test of Phonological Structure*. Unpublished test available from the first author, Centre for Developmental Language Disorders and Cognitive Neuroscience, Department of Human Communication Science, University College London, London UK.
van der Lely, H.K.J. & Ullman, M. (2001). Past tense morphology in specifically language impaired and normally developing children. *Language and Cognitive Processes*, **16**: 177-217
Weiss, A. & Jakielski, K. (2001). Phonetic complexity measurement and prediction of children's disfluencies: a preliminary study. *Proceedings of the 4th International Speech Motor Control Conference*, Nijmegen, the Netherlands: Univeristy of Nijmegen, Nijmegen Medical Centre.
Wingate, M. (1982). Early position and stuttering occurrence. *Journal of Fluency Disorders*, **7**, 243-258.
Wingate, M. (1988). *The structure of stuttering: A psycholinguistic analysis*. Berlin: Springer-Verlag.
Yairi, E., & Ambrose, N. G. (2004). *Early childhood stuttering*. AustinTX: Pro-Ed.