Title: An analysis of thematic and phrasal structure in people with aphasia: what more can we learn from the story of Cinderella?

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Abstract

Sentence production difficulties are a common feature of aphasia. The aim of the current study was to investigate the processes involved in sentence production and to identify whether consistent patterns of difficulties are associated with non-fluent and fluent aphasic speech. An analysis of sentence production was designed which described thematic, phrasal and morphological structure. The sentence production of 22 speakers with aphasia was compared to that of 20 normal speakers. The study investigated: i) the consistency of difficulties across individual speakers with aphasia ii) the patterns associated with non-fluent and fluent speech and iii) the relationship between different aspects of sentence production. Extensive variability was seen in the group of people with aphasia. Individual non-fluent and fluent speakers had widely varying patterns of performance suggesting that speech fluency is not a useful diagnostic measure. The production of thematic structure was independent of phrasal structure suggesting that distinct processes are involved in their specification. The processes involved in the elaboration of phrasal structure and the production of grammatical morphemes were more closely associated. Some independence was seen between the measures associated with particular levels of structure suggesting there may be sub-processes involved which can also be selectively impaired in aphasia.

Keywords: aphasia, agrammatism, paragrammatism, sentence production, verbs.

1. Introduction

1.1. Sentence Production Deficits in Aphasia

Sentence production deficits are a commonly reported feature in aphasia. Kleist (1916) described two distinct types of sentence difficulties, agrammatism and paragrammatism and it is this distinction which has continued to dominate. Saffran, Berndt & Schwartz (1989) describe agrammatism as 'non-fluent and dysprosodic speech output, simple and poorly realised sentence structures and frequent omission of bound and free grammatical morphemes' and paragrammatism as 'fluent speech, better realised but still non-normal sentence structure with misuse of grammatical markers' (p441). The majority of subsequent research has been concerned with agrammatism, focusing on a characterisation of its features and investigations into the nature of the underlying problem. Fewer studies have looked at the sentence production deficits of fluent speakers and the nature of the relationship between agrammatism and paragrammatism.

Agrammatic speakers as a group have been shown to differ from normal speakers in a number of ways. At a syntactic (structural) level, agrammatic speakers produce a reduced proportion of words within sentences (Rochon, Saffran, Berndt, & Schwartz, 2000; Saffran et al., 1989), a reduced proportion of well-formed, grammatical sentences and a reduced proportion of sentences with embedding (Rochon et al., 2000; Saffran et al., 1989; Thompson et al., 1995). The omission of bound and free grammatical morphemes results in a increased proportion of open class (content) words (Rochon et al., 2000; Saffran et al., 1989; Thompson et al., 1995) and poorly realised phrasal structure (Menn & Obler, 1990). Difficulties retrieving verbs often co-occur alongside agrammatic speech (Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser &

Berndt, 1990). In an analysis of spontaneous speech, Thompson et al. (1995) found that speakers with agrammatism produced a similar variety of verb types as normal speakers but verbs were used in their simplest syntactic form.

Agrammatic speech production also co-occurs with syntactic comprehension difficulties, with patients having difficulty understanding the meaning conveyed by function words and inflections (Goodenough, Zurif, & Weintraub, 1977; Parisi & Pizzamiglio, 1970) and understanding complex sentences e.g. relative clauses (Goodglass et al., 1979). Caramazza and Zurif (1976) showed that agrammatic speakers could understand semantically non-reversible sentences where the meaning could be derived from the lexical items but found it difficult to comprehend semantically reversible sentences. The comprehension of reversible sentences has since been very extensively investigated in this group of speakers (see Beretta, 2001; Berndt, Mitchum, & Haendiges, 1996; Grodzinsky, Pinango, Zurif, & Drai, 1999 for reviews). Agrammatic speakers as a group have been shown to have a good understanding of 'canonical' sentences e.g. actives, subject relatives, but poor comprehension of 'non-canonical' sentences e.g. passives, object relatives; these structures contain moved arguments and there is a lack of transparency between the syntactic structure and the underlying meaning.

There has been extensive debate regarding whether agrammatism should be considered as a syndrome; this would suggest that the features co-occur with a frequency greater than chance (Caplan, 1985). Caplan proposed that there are two types of syndrome, functional and non-functional syndromes. In functional syndromes, features co-occur due to a common underlying impairment; individual speakers should therefore show a very similar pattern of impairment as the features should not be

dissociable. In non-functional syndromes, symptoms co-occur due to neuro-anatomical proximity, predicting that there is the potential for dissociations between features. The possibility of dissociations and the underlying assumption that the features are no longer due to the same underlying impairment, however, questions the clinical relevance of grouping individual speakers in this way. If it is a non-functional syndrome, the label of agrammatism is unlikely to provide an accurate characterisation of an individual's speech and will certainly provide limited direction in terms of treatment.

The presence of extensive variability between individual speakers has questioned the validity of characterising agrammatism as a functional syndrome and has undermined the search for a unitary linguistic explanation of the deficits. Kean (1995) described two types of agrammatic speakers, one group whose output was restricted to single content words and another group whose speech had some sentence structure and some appropriate morphology, although other morphemes were omitted. Similarly, Miceli et al. (1989) reported extensive variability between individual speakers in the amount of errors produced overall and between particular morphemes, with some speakers producing substitution errors as well as the omission errors which are the defining feature of agrammatism. Whilst these differences might be a consequence of varying severity, other dissociations question whether agrammatism results from a single underlying impairment. Tissot, Mounin and Lhermitte (1973) identified dissociations between the omission of morphemes and the structural/syntactic features of agrammatism, suggesting that they arise from distinct impairments. He identified three groups of speakers, one group in which morphological errors predominated, one group in which syntactic deficits were prominent and a group where both features were impaired. Dissociations have also been identified between the production of bound and

free morphemes (Miceli et al., 1989) . Therefore, agrammatic speakers are not a coherent group and there is an increasing recognition that agrammatic sentence production is a multi-faceted condition with difficulties arising from different underlying impairments (Schwartz, Fink, & Saffran, 1995).

Similar variability has been identified in relation to the comprehension of agrammatic speakers. Speakers with agrammatic production do not always have asyntactic comprehension (e.g. Mrs K, Kolk, Van Grunsven, & Keyser, 1985) and individual speakers do not have the same comprehension difficulties (Caramazza, Capitani, Rey, & Berndt, 2001). Whilst there is extensive debate regarding the impact of this individual variation on theories attempting to explain these difficulties (see Caramazza et al., 2001; Drai, Grodzinsky, & Zurif, 2001), it should be recognised that 'agrammatic Broca's aphasia is not associated with a single pattern of comprehension performance' (Caramazza et al., 2001, p183). This means that there is the possibility that the comprehension difficulties in agrammatic speakers may also arise from a number of different underlying impairments.

There have been less comprehensive studies of the sentence production of fluent speakers, but again variability has been identified between individual people with aphasia. Goodglass and Kaplan (1983) suggested that fluent paragrammatic speakers are not impaired in the constructional aspects of speech and that clausal and phrasal complexity is preserved. However, some analyses of speech production have identified the use of less complex syntactic structures and fewer embedded and relative clauses compared to normal speakers (Bastiaanse, Edwards, & Kiss, 1996; Edwards, 1995 ; Gleason et al., 1980), a decreased range of grammatical structures (Gleason et al., 1980)

and difficulty using grammatical devices to link clausal and phrasal structure (Edwards, 1995).

The characterisation of agrammatism and paragrammatism as discrete, functional syndromes has also been questioned by the apparent overlap between the two groups of speakers. A reliance on simple sentences is seen in some non-fluent and fluent speakers (Bird & Franklin, 1996). Goodglass (1968) found no difference in the number and type of errors made by the two groups of speakers in the production of bound and free grammatical morphemes. Agrammatic speakers make some substitution errors (Kolk & Heeschen, 1992) and some fluent speakers omit rather than substitute grammatical morphemes (Butterworth & Howard, 1987). In addition, there are speakers who have some similar sentence production difficulties but who would be not classified as having agrammatism or paragrammatism. Saffran et al (1989) describe 'non-fluent, non-agrammatic speakers'. As a group, these people with aphasia do not differ from normal speakers in their production of grammatical morphemes but still produce a high proportion of sentences that are not grammatically well-formed (due to the omission of obligatory arguments) and a low proportion of embedded sentences (Rochon et al., 2000; Saffran et al., 1989) in the context of dysrhythmic and hesitant speech.

The various studies described above have highlighted the variety of sentence production difficulties seen in aphasia and the variability seen between individual speakers. The characterisation of agrammatism and paragrammatism as discrete functional syndromes, with a common underlying impairment accounting for each group of symptoms, has thus been questioned. The syntactic, phrasal and morphological deficits evident in an individual speaker seem to be independent of speech fluency and, at least to some extent, independent of each other. It remains important to describe the

features of sentence production in an individual speaker but in determining a diagnosis and planning treatment, it is important to consider the nature of the underlying impairments as well. A cognitive neuropsychological approach aims to relate the observed symptoms to a model of normal processing; it assumes the difficulties seen in people with aphasia reflect disruption or damage to processes involved in normal sentence production. As these processes can be selectively impaired, specific deficits can be identified which may or may not occur alongside other difficulties (Caramazza & Hillis, 1989). The description of the features of an individual's speech compared to normal speakers and then relating those features to the processes involved in normal sentence production may thus provide an invaluable clinical tool.

1.2. Normal Sentence Production and the Characterisation of Sentence Production Deficits in Aphasia

Garrett's (1980; 1982) model of normal sentence production is based on the analysis of normal speech errors. The model conceives sentence production as a series of relatively independent levels of processing. The message level representation corresponds to a non-linguistic, conceptual specification of the event. The functional level representation corresponds to the thematic structure of the sentence; this is an abstract semantic representation of the utterance. The positional level representation corresponds to the syntactic frame and then subsequent processes are involved in phonological encoding and the articulation of the sentence. Schwartz (1987) elaborated Garrett's model by specifying the processes thought to be involved in the production of the functional and positional levels of representation. She suggests that three sub-processes may be involved in the production of the functional level representation. First, the semantic representations of the main lexical items are retrieved, the predicate

argument structure (PAS) is then specified around the verb and finally, the lexical items are assigned to thematic roles within that argument structure. The positional level representation specifies the syntactic and phrasal structure of the sentence. Schwartz suggests that it is formed as the phonological representations of the content words are retrieved and a syntactic planning frame is created. The planning frame specifies word order and phrasal structure. The phrasal structure is produced as free morphemes, for example auxiliaries and determiners, are retrieved and bound morphemes are added.

Even with the elaborations suggested by Schwartz (1987), the model remains grossly underspecified but does present a framework for considering the types of difficulties seen in people with aphasia. If sentence production involves these independent levels of processing, individual speakers may present with selective impairments in the specification of the functional and positional levels of representation. Thus dissociations should be seen between the ability to specify the thematic structure of a sentence and the ability to produce phrasal structure and free and bound morphemes. If, however, multiple sub-processes are involved in the creation of each level of representation, additional dissociations may be seen as these sub-processes also have the potential to be selectively impaired. In their model of sentence production, Lapointe and Dell (1989) elaborate the processes involved in the production of the syntactic planning frame. Phrasal fragments which are structural frames of a particular phrasal category are retrieved from a store. These fragments have slots for free morphemes but have bound morphemes as an integral part of the frame. Free morphemes are then retrieved from a separate store and slotted into the frame. This elaborated model can account for the dissociations seen in the production of free and bound morphemes and between different phrasal categories.

Whilst Bock and Levelt (1994) agree with the broad levels of processing suggested within Garrett's model, a number of distinctions are made regarding the nature of processing at each level. Within their conceptualisation of sentence production, grammatical encoding (considered to reflect both functional and positional level processing) is lexically driven, with lexical concepts (lemmas) containing semantic and syntactic information. As lemmas are retrieved at the functional level, they are assigned syntactic functions rather than thematic roles and corresponding syntactic frames become available. It is then the unification of these syntactic frames which produces the ordered sentence at the positional level (Levelt, 1999). The syntactic frame is then elaborated to encode grammatical morphemes. Their model highlights the importance of lexically specified information in sentence production rather than general processes and procedures. The relationship between lexical and syntactic deficits remains a matter of debate (see Faroqi-Shah & Thompson, 2003 for discussion) but it is not clear to what extent a study of spontaneous speech can contribute to this. The study of thematic, phrasal and morphological structure is, however, equally valid when considering this model. Although functional processing involves the assignment of syntactic functions, Bock and Levelt (1994) still suggest that the syntactic functions may be linked together via the argument structure of the verb. There remains a separation between overall sentence structure and the specification of phrases (although the suggested mechanisms are different) and the extent to which the same processes are involved in the specification of free and bound grammatical morphemes remains unclear.

There have been attempts to characterise the symptoms that arise from difficulties at different stages of sentence production. Problems with verb retrieval and the production of the PAS impact the specification of the functional level representation. Difficulties retrieving the semantic representation of verbs have been reported to result in the production of semantic paraphasias or the production of semantically 'light' verbs e.g. 'have', 'do' and 'make' (Berndt, Mitchum, Haendiges, & Sandson, 1997). Failure to retrieve the verb at this level may also result in a reliance on single phrases and a limited use of sentence structure (Berndt, Haendiges, Mitchum, & Sandson, 1997). Problems specifying the PAS may also result in a reliance on single phrases, as well as a reduced number of complex two and three argument structures and a high percentage of sentences in which obligatory verb arguments have been omitted (Byng & Black, 1989). Difficulties assigning lexical items to thematic roles within the PAS are generally identified only in the production of reversible sentences and are thus difficult to identify in spontaneous speech. Word order problems may also reflect problems mapping the abstract functional level representation onto syntactic structure at the positional level (Saffran, Schwartz, & Marin, 1980). Inadequate activation of the syntactic frame at the positional level is thought to account for the poor production of grammatical morphemes seen in both agrammatism and paragrammatism (Goodglass, Christiansen, & Gallager, 1993). Failure to activate the free morphemes results in poor phrasal elaboration (Berndt & Caramazza, 1980). These studies have focused on a particular aspect of sentence production and have not considered the production of thematic, phrasal and morphological structure within individual speakers; this has meant that the relationship between the processes involved in each aspect of production has not been investigated.

1.3. Analysis of Spontaneous Speech in Patients with Aphasia

The description of sentence production difficulties using Garrett's model as a framework requires us to characterise and quantify the specification of the functional and positional levels of representation in people with aphasia, compared to that of normal speakers. A number of analyses of sentence production during spontaneous speech have been reported but no analysis adequately describes thematic, phrasal and morphological structure and provides comprehensive normal data.

The most widely used analysis of aphasic sentence production is the Quantitative Production Analysis (QPA) developed by Saffran et al. (1989). The QPA describes the structural characteristics and morphological content of utterances produced during the telling of a fairy story. It has been shown to be reliable for describing the features of agrammatic speech, distinguishing agrammatic speech from normal speech and non-fluent, non-agrammatic speech and in highlighting differences between individual agrammatic speakers. The QPA has also been used to quantify some of the features of fluent aphasic speech (Bird & Franklin, 1996; Edwards, 1995) and for monitoring changes in sentence production due to recovery or as a consequence of treatment (Bird & Franklin, 1996; Schwartz, Saffran, Fink, Myers, & Martin, 1994). The QPA has many strengths and with the publication of further data (Rochon et al., 2000), normal variability across the parameters has been captured. There are, however, a number of important features of sentence production that are not investigated by the QPA. The analysis adopts a frequency of use approach rather than an error based approach and whilst this captures the difficulties of speakers who omit morphemes, it does not allow the characterisation of substitution errors. The QPA also focuses predominantly on the specification of the positional level representation. Whilst it can

capture some of the difficulties that would be associated with functional level difficulties, for instance, the proportion of narrative words produced within sentences, it does not investigate the range of verbs and argument structures used. In addition, the proportion of well-formed sentences may reflect impairments to processes at different levels of production depending on whether the sentences are ill-formed due to the omission of arguments or morphology.

Thompson et al. (1995) advance a system for quantifying lexical and morpho-syntactic aspects of agrammatic sentence production in narrative and conversational speech. This analysis uses syntactic and morphological measures similar to the QPA but also incorporates an analysis of the types of verbs and argument structures used and the proportion of verbs of each type produced with the correct arguments. The analysis thus considers production of the functional level representation in greater depth than the QPA but still characterises frequency of use rather than quantifying errors. Other studies have focused on the detailed description of a particular aspect of sentence production. For example, Byng & Black (1989) analysed the syntactic realisation of the PAS during narrative production, describing the type and number of verb arguments and non-arguments. Whitworth (1995) described the type of thematic structures and thematic roles produced during conversational speech. These more restricted analyses are diagnostic in terms of the specific features analysed but do not provide a complete profile of sentence production. These studies also report limited data from normal speakers; this may or may not be sufficient to capture normal variability in production.

1.4. Aim of Study

The aim of the current study was to carry out a comprehensive investigation of sentence production deficits in aphasia. An analysis of sentence production during

narrative speech was designed; this described the thematic, phrasal and morphological aspects of sentence production, capturing both frequency of use and the errors produced. These aspects correspond to the information specified at the functional and positional levels of representation in Garrett's model. The study investigated the relationship between thematic, phrasal and morphological deficits within and between individual speakers, allowing consideration of the processes involved in these aspects of normal sentence production. The extent to which there are consistent patterns of difficulties associated with non-fluent and fluent aphasic speech was also considered.

2. Method

2.1. Participants

The study investigated the performance of 20 normal control subjects and 22 people with chronic aphasia. The normal group consisted of 4 men and 16 women, mean age of 54.85 years (range 18 to 90 years). The normal subjects had no history of language or cognitive difficulties and came from a wide range of social/educational backgrounds. The people with aphasia consisted of 10 men and 12 women, mean age of 60.64 years (range 40 to 80 years). Their aphasia was predominantly a consequence of a single left hemisphere CVA, with the exception of two people, one whose aphasia resulted from surgery and one who had had two previous strokes; he had had no language difficulties following these previous two episodes. They were all at least six months post-onset (mean of 3 ½ years, range 7 months to 10 years) and had no significant motor speech disorders or showed any evidence of cognitive impairment. The people with aphasia were selected on the basis of them being able to produce a narrative sample and showing some evidence of sentence production difficulties.

Appendix A shows extracts from the narratives of some of the individual people with aphasia in order to highlight the range of participants included.

2.2. Analysis of Narrative Samples

The samples of speech were obtained by asking people to tell the story of Cinderella. The samples were obtained and transcribed as in Saffran et al. (1989) but even if the sample was limited in length, only the Cinderella story was used in order to keep the propositional content constant. The narrative core was extracted by the elimination of repair, repetitions etc. and the utterances were segmented, again as in the Saffran et al. (1989) analysis, with two exceptions. Firstly, utterances like 'when she arrived at the ball, she danced with the prince' were divided into their two component sentences. Secondly, direct speech was included in the narrative core although the discourse markers 'she said' were still eliminated (see discussion in 3.1). In addition, it was decided to use the whole samples (as in Bird & Franklin, 1996) rather than the first 150 narrative words. Rate of speech for each of the speakers was determined by recording the total time taken to produce the narrative and dividing it by the number of words produced (as in Saffran et al. 1989). The percentage narrative was also calculated; this measure looked at the proportion of the total sample that remained once the narrative words had been extracted.

The thematic structure of the utterances was analysed according to a framework based on the 'Thematic Role Analysis of Spontaneous Output' (Whitworth, 1995). Utterances were broadly divided into those with an undetermined thematic structure (UTS), one, two and three argument structures and utterances containing thematic embedding (TE). UTS utterances included those that contained no verb and utterances composed of a single phrase. Utterances with a definite argument structure were

subdivided into one, two and three argument structures depending on the number of phrasal components used in association with the verb. The number of phrasal components used alongside the verb was taken as a measure of predicate argument structure (PAS) complexity. The category of thematic embedding was defined by Whitworth (1995 p390) as 'those utterances where thematic roles are embedded in more complex syntactic and thematic structures'. Examples of each type of utterance can be found in table 1.

Insert Table 1

A mean PAS complexity score was calculated to allow an easy comparison of speakers. One, two and three argument structures were given a value of one to three respectively and a total score was obtained. A mean score was then calculated by dividing this total by the total number of these structures. No distinction was made between those phrasal components that were arguments of the verb and those that were non-arguments (additional, optional information related to time, manner or place, Byng and Black, 1989). The status of phrasal components had not been found to be a significant factor influencing thematic or phrasal complexity in a previous study (Webster, Franklin, & Howard, 2001). However, the proportion of two and three component sentences that contained non-arguments was noted.

The omission of obligatory arguments in two and three argument structures was analysed. Byng and Black (1989, p263) defined an obligatory argument as 'an argument that must be realised syntactically if the sentence is to be grammatical'. The percentage argument omission was calculated as the number of two and three argument structures with omitted arguments compared to the total number of two and three argument

structures. If arguments were omitted from one argument structures, a single verb utterance resulted and it was thus coded as UTS.

The type of phrase i.e. noun phrase or prepositional phrase, used to realise each argument was coded (as in Byng and Black, 1989). Each phrase was then broken down into its constituent parts e.g. ‘the ugly sisters’ was coded as determiner, adjective and noun. The number of constituents in the phrase was taken as a measure of the complexity of the phrase i.e. a verb phrase containing a main verb and an auxiliary was considered more complex than one containing only a main verb. The categories were grouped into one, two and three constituent phrases and complex phrases. Complex phrases included those with four or more components and phrases containing post-modifying phrases. A mean complexity score was generated for each of the phrasal types and then overall. Phrases with one, two and three components were given a value of one to three respectively and complex phrases were given a value of four. The total complexity score was then divided by the total number of phrases to obtain a mean score.

Errors involving the omission or inappropriate use of prepositions, determiners, pronouns and auxiliaries were coded in the error section. A percentage phrasal error score was calculated for the use of each class of free morphemes and then overall. The percentage phrasal error reflected the number of errors compared to the number of times the item was correctly used within the sample. The presence of bound morphemes and the production of irregular plural and past tense forms were coded in the morphological analysis to allow their frequency of use within the sample to be determined. Errors involving the omission or inappropriate use of morphemes were also coded. A

percentage morphological error score was calculated for each form individually and then an overall mean score was obtained.

2.3. Analysis

The analysis of the narrative samples was completed for each of the normal speakers and speakers with aphasia. The performance of the two groups was then compared using two sample t tests. The performance of individual speakers with aphasia was then compared to the normal group; performance was considered to differ from normal if it was more than two standard deviations from the normal mean. Sentence parameters within the normal range were considered not to be different from normal speakers; parameters which fell outside the normal range reflected a likely impairment to this aspect of sentence production. Finally, correlations between the summary parameters in the group of people with aphasia were carried out in order to investigate the relationship between rate of speech and the features of sentence production and between different aspects of production.

2.4. Predictions

It was predicted that the group of people with aphasia would differ from the normal group on all of the parameters but that the direction of difference (above or below normal performance) would vary according to the parameter. The speakers with aphasia were expected to produce less complex structures and to produce more errors; the following patterns were thus predicted:

- Reduced rate of speech
- Increased percentage of UTS
- Reduced mean PAS complexity
- Increased percentage of argument omission

- Reduced phrasal complexity
- Increased percentage of phrasal errors
- Increased percentage of morphological errors

Extensive individual variability has been reported in previous studies and it was thus important to compare each individual speaker with aphasia with normal performance. It was predicted that for each speaker, performance on some parameters would fall within the normal range whereas other aspects would differ from normal performance. It was felt that any consistency between speakers in terms of parameters falling within/outside the normal range may depend either on their rate of speech or the relationship between the processes involved in those aspects of sentence production.

The features of non-fluent and fluent speech were considered by investigating the relationship between rate of speech and sentence production and by looking at the performance of individual speakers. The traditional description of agrammatism in some non-fluent speakers would predict reduced rate of speech alongside an increase in percentage UTS, reduced mean PAS complexity, reduced phrasal complexity and in increase in omission errors. In contrast, it would be predicted that in fluent paragrammatic speakers, a normal rate of speech would be seen alongside a normal percentage of UTS, normal PAS and phrasal complexity but an increase in argument omission and substitution errors. If the variability within the group of people with aphasia was a consequence of the inclusion of both fluent and non-fluent subjects, consistent patterns of performance would still be expected within the fluent and non-fluent speakers.

The relationship between thematic, phrasal and morphological structure was investigated in order to determine whether the processes involved in these aspects of

production are independent. Garrett's model of sentence production specifies independent levels of processing and it was thus predicted that there would be some independence between the production of thematic structure and the production and phrasal and morphological structure. In contrast, phrasal and morphological structure is produced at the same level of processing and should be more closely related. These differing strengths of relationships should be seen in the strength of correlations between measures and in the extent to which individual people with aphasia show specific difficulties in one aspect of processing. Parameters at the same level of processing should be closely related e.g. mean percentage UTS, mean PAS complexity and mean argument omission but if sub-processes are involved in the production of each level of representation, then these may also have the potential to be selectively impaired.

3. Results

This section will present the results of the comparisons between the two groups of speakers as well as the patterns of performance seen in individual speakers with aphasia. Appendix B shows the mean normal score and the upper (two standard deviations above the normal mean) and lower (two standard deviations below the normal mean) limits which were considered within the normal range. On some parameters e.g. percentage UTS, there was a large amount of normal variation (as seen by the large standard deviations); this sometimes resulted in a lower limit less than zero making the individual comparisons inappropriate. These measures are labelled as not appropriate (NA) for comparison. Depending on the predicted performance of the people with aphasia (seen in section 2.4), the important figure (either the upper or lower limit) is highlighted in bold. The results for the individual speakers with aphasia can be

seen in table 2. At the end of the section, the results of the correlations between particular features of sentence production within the group of people with aphasia are considered.

Insert table 2

3.1. General Information

The two groups (normal speakers and people with aphasia) differed significantly from one another in their rate of speech ($t(40) = 8.606$, $p = <0.001$). On average, the people with aphasia produced fewer words per minute (mean = 54.76 wpm, range 17.9-136.63) than the normal speakers (mean = 137.02 wpm, range 82.6–195.63) although there was a lot of individual variation in both groups; some speakers with aphasia had rates of speech within the normal range. Individual people with aphasia were classified as non-fluent if their rate of speech was less than 71.3 wpm (>2 standard deviations lower than the normal mean). On this basis, JS, ML, NB, PW, RN & VC were considered fluent with the remaining sixteen people with aphasia considered non-fluent. The issues associated with determining fluency solely via the rate of speech will be considered in the discussion.

The narratives of the normal speakers contained a consistently high proportion of words which were subsequently included in the analysis (mean = 88.70%, range 74.9-98.0). The group of people with aphasia differed significantly from the normal group ($t(25.84) = 6.91$, $p = <0.001$) producing a large number of repairs, repetitions and unrelated responses that were subsequently excluded when extracting the narrative words. This resulted in a lower proportion of analysable narrative (mean = 62.19%, range 24.66-90.09). There was, however, a large amount of variability, with some

individual scores falling within two standard deviations of the normal mean (AL, AM, JM, MK & TF).

In contrast to the Saffran et al. (1989) procedure, direct speech utterances were not excluded from the narrative core. From an initial inspection of the normal samples, it was felt that the direct speech was not stereotypical and sometimes contained examples of varied verb tense that were limited in the remainder of the sample. However, direct speech accounted for a small percentage of the utterances in both groups of speakers (4.05% of the total sample for normal speakers, 2.78% for the group of people with aphasia). Fourteen of the speakers with aphasia produced no direct speech. For those speakers who did produce direct speech, these utterances did often contain complex verb phrases but in each case, the speakers also produced these phrases in other contexts.

3.2. Thematic Structure

Figure 1 shows the mean percentage distribution of different types of thematic structure for the two groups of speakers. Two argument structures were the most commonly used utterance in both groups. The group of people with aphasia produced more utterances with an undetermined thematic structure (UTS) ($t(21.47) = 5.03$, $p = <0.001$), fewer two argument structures ($t(28.28) = 2.56$, $p = 0.016$), fewer three argument structures ($t(35.48) = 4.46$, $p = <0.001$) and fewer utterances with thematic embedding (TE) ($t(20.82) = 4.85$, $p = <0.001$). They did not differ from the normal group in their production of one argument structures ($t(40) = 1.89$, $p = 0.067$). The production of thematic embedding was not considered an appropriate comparative measure for individual performance as normal speakers varied extensively in their use of embedding with three speakers producing no embedding at all.

Insert figure 1

In the initial analysis seen in figure 1, no distinction was made between phrases which were arguments of the verb and non-arguments (adjuncts). Figure 2 shows the breakdown of the two and three argument structures in terms of those containing only verb arguments and those containing non-arguments. It can be seen that the distribution for the two groups of speakers is very similar. In both the normal and aphasic speakers, two component structures were mainly two argument verbs with no additional information. In contrast, three component sentences consisted of both three argument verbs and two argument verbs with optional non-arguments.

Insert figure 2

The mean PAS complexity scores of the group of people with aphasia differed significantly from the normal group ($t(40) = 2.8$, $p = 0.08$). On average, the normal speakers produced more complex structures (mean = 2.08, range 1.80-2.27) than the people with aphasia (mean = 1.96, range 1.43-2.20). There was, however, extensive overlap with 16 of the people with aphasia falling within normal limits. The normal speakers rarely omitted verb arguments (mean = 0.15%, range 0-1). The group of people with aphasia omitted a significantly higher percentage of obligatory arguments (mean 9.53, range 0-66.7) ($t(40) = 2.7$, $p = 0.01$).

Extensive variability was seen in the performance of the individual speakers with aphasia on the measures related to thematic structure. None of the speakers with aphasia fell within the normal range on percentage UTS, mean PAS complexity and percentage argument omission. However, only three speakers AL, BG and BM differed on all of the parameters. Most of the speakers with aphasia fell outside normal limits on two of the measures associated with thematic structure. Two of the speakers GW and

ML just omitted more obligatory arguments and on this parameter although ML was very close to normal limits (1.35%). Five of the speakers (CG, RN, RS, TJ and VC) differed from the normal speakers only in their production of UTS. TJ and VC relied almost exclusively on single phrases producing over 90% UTS whereas the other speakers still produced a range of sentences alongside a slightly increased proportion of single phrases. Speaker RN was only just outside normal limits producing 9.38% of UTS utterances.

3.3. Phrasal Structure

Noun phrase complexity did not differ significantly between the two groups ($t(40) = 0.858$, $p = 0.380$). There was extensive overlap between individuals in the groups (normal mean = 1.83, range 1.52–2.12, mean of speakers with aphasia = 1.78, range 1.45-2.32). Figure 3 shows the mean percentage distribution of noun phrases for the two groups of speakers. The distribution for the two groups was very similar, with the production of a large proportion of single component noun phrases (single noun or pronoun). Only two individuals (IB & PW) produced noun phrases that were less complex than the normal speakers; this reflected an almost total reliance on single component phrases.

Insert figure 3

There was also no significant difference between the performance of the two groups in mean verb phrase complexity ($t(24.96) = 0.9$, $p = 0.848$). The normal and speakers with aphasia had a similar overall mean complexity (normal mean = 1.37, range 1.23-1.56, mean of speakers with aphasia = 1.39, range 1–2.04) and a similar distribution across verb phrase categories. Figure 4 shows the mean percentage distribution of verb phrases for the two groups of speakers and highlights the

dependence of both groups on single verbs. Even in the normal group, only a small percentage of verb phrases containing auxiliaries and compound verbs were produced due to a reliance on the simple past tense. Three of the speakers with aphasia (BM, DM, & TJ) had a mean verb complexity that was lower than normal speakers; these speakers produced only single verbs.

Insert figure 4

A significant difference was seen between the two groups in mean adjectival phrase complexity ($t(40) = 2.643$, $p = 0.01$). On average, the normal group produced more complex adjectival phrases (mean 2.07, range 1.25–3) than the group of people with aphasia (mean = 1.51, range 0–3.5), although there was extensive overlap. Figure 5 shows the mean percentage distribution of adjectival phrases for the two groups. The group of speakers with aphasia produced more phrases consisting of single adjectives and less complex phrases. There was, however, extensive variability in the performance of individual speakers in the production of adjectival phrases. DM, GW, IB, PW, RN and RS produced less complex phrases but CG and MK produced phrases that were more complex than normal speakers.

Insert Figure 5

When considering prepositional phrases, it must be remembered that if prepositions were omitted, phrases were coded as noun phrases and the error on the preposition was noted. The complexity of prepositional phrases did not differ significantly between the groups ($t(40) = 0.770$, $p = 0.45$) (normal mean = 2.95, range 2.60–3.38, mean of speakers with aphasia = 2.85, range 1–3.5). The mean percentage distribution can be seen in figure 6. Three component prepositional phrases (preposition plus determiner plus noun) were the most common type of phrase. In the production of

prepositional phrases, four individuals (CG, DM, IB & TJ) produced less complex phrases than normal speakers. This reduction in complexity reflected an increased number of prepositions produced in isolation and preposition plus noun constructions.

Insert figure 6

A combined mean phrasal complexity score was calculated for each of the normal speakers and people with aphasia. No significant difference was found between the two groups of speakers ($t(40) = 1.81$, $p = 0.077$). Only three of the individual speakers with aphasia (DM, IB & TJ) produced less complex phrases than normal speakers.

The normal speakers produced a very low percentage (always less than one percent) of phrasal errors (errors involving the use of free morphemes). In addition, there was around another one percent of utterances in which a repair of an incorrect function word had occurred. Table 3 shows the mean percentage of errors in the group of people with aphasia. Errors were produced in the production of all the free morphemes, with a combination of omission and substitution errors. Not all individuals with aphasia produced errors and the morphemes which resulted in errors differed across speakers. AM, TJ and VC made no errors when producing the free morphemes. JS and NB had consistent difficulties, making errors on all four categories. Most of the people with aphasia produced errors on two or three categories of morpheme with only three speakers having specific difficulties (BM in the production of prepositions, IB in the production of determiners and KD in the production of auxiliaries). There was no simple relationship between phrasal complexity and the presence of these phrasal errors. AL, MK and TF produced phrases of comparable complexity to normal speakers but made some phrasal errors. In contrast, TJ appeared to use function words appropriately

when they were used, but often his phrases were single content words, resulting in reduced phrasal complexity scores.

Insert Table 3

3.4. Morphological Structure

The analysis considered the production of bound grammatical morphemes and the production of irregular past tense and irregular plurals. Examples of each of the grammatical morphemes were not produced in each sample, and when used, the frequency of use varied across the morphemes. The mean frequency of use in the samples for the individual morphemes and the results of the comparisons between the two groups can be found in table 4. In both groups of speakers, the irregular past tense form was used most frequently. The possessive ‘s’, perfect ‘en’ morphemes and irregular plural forms were rarely used. The groups of normal speakers and speakers with aphasia differed in the frequency of production of all the bound morphemes except the progressive ‘ing’ and third person ‘s’.

Insert table 4

The normal speakers produced a very low percentage of morphological errors, less than one percent on each of the morphemes. The mean percentage of errors for the people with aphasia is shown in table 5. They only made errors on five of the eight categories; their lack of errors in the production of the other forms may reflect their low frequency of use in the sample. The majority of errors were omissions, although some substitutions were also present in both fluent and non-fluent speakers. As with the production of free morphemes, not all individual speakers produced errors and the forms which resulted in errors varied. Nine of the people with aphasia (AM, BG, BM, GW, HW, JM, RS, SS & TJ) made no errors when producing these bound morphemes

and irregular forms and nobody showed consistent difficulties across the range of forms. Eight of the speakers produced errors on a single form but for five (CG, DM, IB, TF & VC), this probably reflected the very restricted range of morphemes used. The remaining speakers generally produced errors on two forms.

Insert table 5

When looking at the relationship between phrasal and morphological errors, half of the speakers produced both types of error. TJ and AM made neither phrasal or morphological errors and AM also produced phrases of comparable complexity. BM, GW, HW, JM, RS, SS and NB made errors in their use of free morphemes but produced bound morphemes appropriately. VC made no errors when producing function words but produced a very restricted range of bound morphemes and made morphological errors.

3.5. Results of Correlations between Parameters of Sentence Production

The results of Pearson's correlations between the features of sentence production in the people with aphasia are presented in table 6. It can be seen that rate of speech was not significantly correlated with any of the other parameters of sentence production. No significant correlations were seen between the three measures associated with thematic structure (percentage UTS, mean PAS complexity and percentage argument omission). There was also no significant correlation between these measures and mean phrasal complexity or percentage phrasal errors. Many of the speakers with aphasia produced more single phrases and less complex argument structures than normal speakers but still produced phrases of comparable complexity. However, a significant negative correlation ($r = -0.542$, $p = 0.009$) was seen between mean PAS complexity and

percentage morphological errors. With reduced PAS complexity, there was an increase in the percentage of morphological errors.

Insert Table 6

Trends were seen between the measures associated with the production of phrasal and morphological structure. Figure 7 shows the relationship between mean phrasal complexity and the mean percentage of phrasal errors. A non-significant trend ($r = -0.412$, $p = 0.057$) was identified; with reduced phrasal complexity, there was a trend for an increase in the number of phrasal errors. This presumably reflects the fact that the omission of function words would lead to a reduction in phrasal complexity. Figures 8 and 9 show the relationship between mean phrasal complexity and the mean percentage of morphological errors and the mean percentage of phrasal and morphological errors. No correlation was seen between mean phrasal complexity and the production of morphological errors ($r = -0.232$, $p = 0.299$) but a trend was seen between the mean percentage of phrasal errors and the mean percentage of morphological errors ($r = 0.419$, $p = 0.052$). Speakers who produced more phrasal errors had a tendency to produce more morphological errors.

Insert figures 7, 8 & 9

3.6. Summary of Results

3.6.1. Group Comparisons

The performance of the group of people with aphasia was characterised by an increased proportion of repairs, repetitions and hesitations resulting in an overall reduction in speech rate and a low proportion of analysable narrative. On average, the speakers with aphasia produced an increased proportion of single phrases and had a lower mean PAS complexity due to a decreased proportion of two and three argument

structures. As a group, they also produced fewer utterances with thematic embedding and omitted some obligatory verb arguments. There was no difference between the normal and aphasic groups in terms of the complexity of noun, verb and prepositional phrases. However, the speakers with aphasia produced some errors involving the use of free morphemes, produced some bound morphemes less frequently than the normal speakers and produced errors when using morphology. These errors were a combination of omissions and substitutions.

3.6.2. Summary of Results: Correlations between Features of Sentence Production in Aphasia

None of the parameters showed a significant correlation with rate of speech, showing that the characteristics of sentence production were independent of fluency. No significant correlations were identified between the parameters associated with thematic structure but non-significant trends were seen between mean phrasal complexity and the mean percentage of phrasal errors and the mean percentage of phrasal errors and the mean percentage of morphological errors. When looking at the correlations between thematic, phrasal and morphological structure, the parameters were independent of each other with the exception of a strong negative correlation between mean PAS complexity and percentage morphological errors.

3.6.3. Summary of Results: Individual Speakers with Aphasia

A summary of the performance of the individual speakers with aphasia on parameters associated with the specification of the functional and positional levels of representation can be seen in table 7. It can be seen that non-fluent and fluent speakers did not have distinct patterns of impairment. JS and MK showed the same pattern of strengths and weaknesses despite marked differences in their rate of speech and there

was extensive variability seen in individual speakers with fluent or non-fluent speech. The majority of the people with aphasia presented with a combination of thematic, phrasal and morphological difficulties suggesting that both functional and positional level processing were affected. The exception was AM; AM had some thematic difficulties as she produced a high proportion of single phrases and omitted obligatory verb arguments but phrasal complexity was within normal limits and she produced neither phrasal or morphological errors. This suggests some difficulties creating the functional level representation but intact positional level processing. No speakers were within normal limits on all three parameters associated with thematic structure. However, RN was only just outside normal limits in his production of single phrases but his phrases were characterised by the production of both phrasal and morphological difficulties. Other speakers also varied in the severity of their difficulties across thematic, phrasal and morphological processing.

Insert table 7

Across all of the parameters of sentence production, extensive individual variability was seen. On each parameter, some of the speakers with aphasia fell within normal limits whilst others showed apparent difficulty. Different patterns of strengths and weaknesses were seen in the production of thematic structure; individual speakers varied in the extent to which their difficulties manifested in terms of an increase in single phrases, argument omission or the production of simpler argument structures. In the production of phrasal structure, the difficulties of most speakers resulted in phrasal (function word) errors. In contrast, TJ did not make phrasal errors but relied almost exclusively on single component phrases. Differences were also seen between individual speakers in terms of the production of phrasal and morphological errors.

4. Discussion

The aim of this study was to carry out a comprehensive investigation of sentence production deficits in aphasia during the production of narrative speech. The analysis investigated the production of thematic structure, as specified at the functional level of Garrett's model of sentence production, by analysing the production of the type and range of argument structures, the omission of obligatory arguments and whether speakers relied on single phrases instead of sentences. It also considered the production of phrasal structure and morphology, aspects of sentence production specified within the positional level representation. Within this section, the importance of obtaining comprehensive normal data will be considered, prior to discussing the sentence production difficulties of these speakers with aphasia and the possible contribution of this analysis to the assessment and treatment of sentence production difficulties.

4.1. Characteristics of Normal Performance

Some of the previous analyses of sentence production in aphasia have not obtained comprehensive information about normal performance, often relying on a limited number of normal subjects. The consideration of normal performance on a particular task is, however, vital when identifying the value of that task in eliciting particular types of linguistic structure and for characterising normal variability. Normal data highlights the features which should be present in the narrative sample, providing a basis for the identification of sentence production difficulties.

In the production of thematic structure within the Cinderella story, normal speakers produced thematically complete sentences, with a very low percentage of argument omission. Normal speakers rarely relied on single phrases, producing a range of one, two and three argument structures. There was, however, extensive variability in

their use of thematic embedding, with some normal speakers not producing any embedded sentences. In the production of phrasal structure, normal speakers showed that they were capable of producing some elaborated phrases but, with the exception of prepositional phrases, single component phrases still dominated. This was particularly true of verb phrases; the telling of the story relied predominantly on the simple past tense so normal speakers made limited use of auxiliaries and compound verbs. In the production of adjectival phrases, the normal speakers varied in the number and complexity of phrases produced. Normal speakers all produced some determiners, pronouns, auxiliaries and prepositions and made very few errors in their production of these free morphemes. The normal speakers also produced a range of bound morphemes but some forms e.g. possessive ‘s’ were not produced by all individuals. As with the free morphemes, very few errors were made.

The normal samples show the types and complexity of thematic and phrasal structures that are likely to be evident during the telling of the story of Cinderella. The samples also highlight that just because some complex structures are not present in the narratives of the people with aphasia, this may not be indicative of a problem. The Cinderella sample is a useful starting point but additional elicitation methods would be needed if it is these complex structures which are of interest. Normal speakers produce very few errors in the production of any level of structure and if errors are present in the samples, they are likely to reflect sentence production difficulties; this emphasises the importance of considering errors as well as frequency of use. The performance of the speakers with aphasia will now be considered.

4.2. Characteristics of Performance of People with Aphasia

It was predicted that the group of people with aphasia would differ from the normal group on all of the parameters of sentence production, producing less complex structures and more errors. As a group, the people with aphasia produced a higher proportion of repairs, repetitions and unrelated utterances whilst producing the story. They produced a high proportion of single phrases and a reduced number of complex two argument structures, three argument structures and embedded sentences. When sentences were produced, obligatory verb arguments were sometimes omitted. These findings are consistent with previous studies of agrammatic speech (Byng & Black, 1989; Goodglass, Gleason, Bernholtz, & Hyde, 1972; Thompson et al., 1995) and may reflect the high number of non-fluent speakers in this study.

In contrast to predictions, the group of people with aphasia did not differ from the normal group in the complexity of the noun, verb and prepositional phrases they produced. This may reflect the increased diversity of speakers included in this study. Alternatively, it may be a consequence of the high proportion of single component noun and verb phrases produced by the normal speakers. Phrasal production in the group of people with aphasia did contrast with normal performance in the number of errors produced. The speakers with aphasia produced errors involving both free and bound morphemes. These errors were a combination of omission and substitution errors and this mixture may again be a consequence of the variety of speakers involved in the study. However as in Miceli et al (1989), there were individual speakers who produced both types of error and the presence of omission and substitution errors was not consistently related to speech fluency.

It was predicted that extensive variability would be seen in the performance of individual speakers; this variability was seen and confirms the complex nature of sentence production difficulties in aphasia. On every parameter, there were some individual speakers who did not differ from the normal speakers, as well as individuals who were outside the normal range. It was predicted that this variability may reflect the inclusion of both fluent and non-fluent speakers, with consistent patterns of performance within each group. Alternatively, the parameters falling within/outside the normal range may depend on the relationship between the processes involved in those aspects of sentence production, with independent processes having the potential to be selectively impaired.

One of the main distinctions between agrammatism and paragrammatism is verbal fluency (the ease with which connected sequences of words are produced). Fluency is dependent on a number of characteristics, for example, melodic line, articulatory agility, the pattern and distribution of pauses and utterance length. It can be rated in terms of the longest, occasional uninterrupted strings of words (with non-fluent speech characterised by word-runs of less than four words) (Goodglass, Kaplan, & Barresi, 2001) or by measuring rate of speech. Rate of speech was used in this study as it was an objective measure which reflected the range of severity rather than a simple dichotomy and which considered the variability seen in normal speakers. It was also felt that utterance length confounded thematic and phrasal complexity. There was, however, a significant correlation between rate of speech and mean length of utterance ($r = 0.453$, $p = 0.036$).

There is no evidence that the extensive variability seen in this group is a consequence of the inclusion of both fluent and non-fluent speakers. Within the study,

some speakers can be identified who show the classic features associated with agrammatism and paragrammatism. IB and DM showed features consistent with agrammatism; they had non-fluent speech, produced a high proportion of single phrases, produced very simple phrases and produced a high percentage of phrasal and morphological errors (mainly omissions). ML showed a pattern of features consistent with the predictions for paragrammatism; she produced a normal proportion of UTS, was within the normal range for PAS and phrasal complexity but omitted obligatory arguments and made substitution errors when producing free and bound morphemes. However, individual fluent and non-fluent speakers showed widely varying patterns of performance and there isn't the consistency in features to support a functional syndrome account of agrammatism and paragrammatism (Caplan, 1985).

In line with previous investigations (e.g. Bird & Franklin, 1996), there was also overlap between the features of sentence production seen in non-fluent and fluent individuals. There was no significant correlation between rate of speech and the other parameters of sentence production and no distinct patterns of sentence production impairments were associated with fluent and non-fluent speech. JS and MK showed the same pattern of strengths and weaknesses despite marked differences in their rate. Similarly, when the groups of fluent and non-fluent speakers were compared, no significant differences were seen in percentage UTS ($t(20) = -0.53$ $p = 0.602$), mean PAS complexity ($t(20) = 1.96$ $p = 0.064$) and mean phrasal complexity ($t(20) = 0.581$ $p=0.568$). Only in percentage argument omission was a significant difference identified ($t(17.23) = 1.90$, $p < 0.001$), with fluent speakers omitting a greater percentage of obligatory arguments. The fluency of an individual's speech is thus not a useful

diagnostic measure as it provides very limited insight into their sentence production difficulties.

The normal data can be used to identify aspects of production which are equivalent to normal speakers and those which are particular weaknesses; these parameters can then be related to a level of processing involved in sentence production as conceptualised in Garrett's model. The model specifies independent levels of processing involved in the production of thematic and phrasal/morphological structure. It was predicted that there would be some independence between sentence parameters associated with thematic structure (produced at the functional level) and those associated with phrasal and morphological structure (produced at the positional level). As predicted, no significant correlation was seen in the people with aphasia between the measures related to the processing of thematic structure at the functional level representation (mean percentage UTS, mean thematic complexity and mean percentage argument omission) and phrasal processing at the positional level representation (mean phrasal complexity and mean percentage phrasal errors). Similarly, there was not a significant correlation between mean PAS complexity and mean phrasal complexity in the normal speakers ($r = -0.322$, $p = 0.1658$).

A significant negative correlation was, however, seen between mean PAS complexity and percentage morphological errors; with an increase in PAS complexity, there was a reduction in morphological errors. This pattern would be consistent with the traditional descriptions of agrammatism but it is then interesting that the same correlation was not seen with phrasal errors and overall phrasal complexity. Alternatively, this may reflect the fact that many of the speakers did not produce

morphological errors and thus the distribution of errors across the speakers is less of a continuum than other parameters.

Most of the speakers with aphasia performed outside the normal range on parameters associated with thematic, phrasal and morphological structure; this is consistent with difficulties at both the functional and positional levels of representation. However, the severity of those difficulties often varied across speakers and it is a benefit of the analysis that it can identify these relative strengths and weaknesses. Speaker AM was within the normal range on parameters associated with phrasal and morphological structure but produced a high proportion of single phrases and omitted obligatory arguments (measures of thematic structure). Speaker RN showed only minimal difficulties with thematic structure but produced both phrasal and morphological errors. The differences seen between these speakers provide additional support that the processes involved in the creation of thematic and phrasal structure are distinct and can be impaired independently in aphasia.

The study also considered the relationship between parameters assumed to be at the same level of processing within Garrett's model; this was done to investigate whether sub-processes are involved in the creation of each level of representation. In the production of thematic structure at the functional level of representation, there were no significant correlations between mean percentage UTS, mean PAS complexity and mean percentage argument omission. Overall the speakers with aphasia relied on more single phrases but this was not consistently related to the production of simpler sentences or the omission of arguments. Some speakers only differed from the normal range on one of the parameters associated with the production of thematic structure. Performance across these parameters is therefore relatively independent and the reasons

for this remain unclear. It could be that these different outward symptoms reflect impairment to different sub-processes involved in the production of the functional level representation. The reliance on single phrases that was characteristic of most speakers is most likely to result from failure to produce the verb (Berndt et al., 1997). The omission of obligatory arguments could arise from a variety of impairments, for example, failure to retrieve the semantic representation of the noun, poor knowledge of the arguments associated with the verb or impaired thematic role assignment (Webster, Franklin, & Howard, 2004). These possibilities cannot be evaluated on the basis of spontaneous speech alone; further investigations of performance on more constrained tasks would be needed (as described in Webster et al., 2004). It may also be that the differences in outward symptoms reflect severity differences. For example, TJ and VC produced a large proportion of single phrases, resulting in a low number of structures in which obligatory arguments could be omitted. Speakers who, due to less severe problems, produced a greater range of thematic structures increased their opportunities to omit arguments. Alternatively, it may be that some of these difficulties are actually arising from a level of processing other than the production of thematic structure at the functional level representation. For example, omission errors may also arise from an inability to retrieve the phonological form of the lexical items at the positional level. Again it is difficult to investigate this possibility on the basis of spontaneous speech alone but it should be considered that there was no strong association between percentage argument omission and other measures related to positional level processing.

Performance on the parameters related to phrasal and morphological structure was more strongly associated and this provides some evidence that they may be produced at the same level of processing. Trends were identified in the correlations

between mean phrasal complexity and the mean percentage of phrasal errors and between the mean percentage of phrasal and morphological errors. The trend for a reduction in phrasal complexity with increased phrasal errors is likely to reflect the production of omission errors. This could be a consequence of a failure to create phrasal frames or an inability to retrieve the function words needed within those frames. Within the group, there was also a trend that with an increase in phrasal errors, there was also an increase in morphological errors. This could reflect the more widespread difficulties that some of the people with aphasia have in producing phrasal planning frames at the positional level of representation.

The nature of the relationship between the processes involved in the production of phrasal and morphological structures becomes more complex when the performance of individual speakers relative to normal performance is considered. Some individuals with aphasia e.g. TF produced phrases of comparable complexity to normal speakers but made errors in the realisation of free and bound morphemes. These individuals made substitution errors which maintained the complexity of the phrase. It is these speakers with aphasia who would be difficult to identify using the QPA (Saffran et al., 1989). TJ's performance showed the reverse pattern and may be explained by the severity of his impairment. TJ relied so strongly on the production of single component phrases that there were minimal opportunities for him to produce free morphemes correctly or incorrectly. Further investigations would be necessary to see if, in contexts where free morphemes had to be produced, his error rate increased. In line with previous research (Miceli et al., 1989; Rochon et al., 2000) and with the model suggested by Lapointe and Dell (1989), differences were seen between the production of free and bound morphemes. Speakers were identified (JM, NB & VC) who had

specific deficits with either free or bound morphemes and there was variability in the morphemes subject to error. The specificity of such deficits must, however, be treated with some caution due to the limited range of morphemes produced by some speakers. As with the other parameters, investigations of the production of these morphemes in more constrained tasks would provide clearer evidence of these differences.

The discussion above highlights that if we are to consider relating patterns of sentence production impairment to a model of normal sentence production, it may not be sufficient to consider the overall level of production that is affected. The specific sub-processes which are responsible for the production of each level of representation may also have the capacity to be selectively impaired resulting in very specific impairments in sentence production. An analysis of spontaneous speech may not, therefore, be detailed enough to identify these specific symptoms or to determine the underlying impairment.

4.3. Evaluation of the Analysis

This study has presented the results of an analysis of sentence production that describes and quantifies thematic, phrasal and morphological structure. This final part of the discussion will consider the possible contribution of the analysis to the assessment and treatment of sentence production difficulties in aphasia. Investigations of spontaneous speech are time consuming and yet they provide the clinician with a valid way of assessing a speaker's ability to convey information in a coherent and structured way. The features of sentence production in narrative speech are likely to be characteristic of that person's speech in conversation and mild deficits, not identified in traditional aphasia assessments, will be identified in this task (Yorkston & Beukelman, 1980). In addition, eliciting change in spontaneous speech should be the ultimate aim of

any speech and language therapy intervention and thus clinicians need ways of monitoring this change. The summary measures within this analysis would provide a good means of monitoring changes in sentence production due to recovery or as a consequence of treatment.

The telling of a story provides a middle ground between other spontaneous speech tasks, namely complex picture description and conversation. As Saffran et al. (1989) highlight, the narrative is a monologue; this makes the sample easier to segment than conversations which involve exchanges between speakers. The story also provides a context for interpreting the speaker's production as there is some predictability in the propositional and lexical content. This predictability is not present in conversational speech (Yorkston & Beukelman, 1980). The content of picture descriptions is generally more predictable than narrative speech but the presence of the picture may aid lexical retrieval or prompt the labelling of items. Within the narrative, the normal speakers produced thematically complete utterances and a low percentage of repairs, repetitions and unrelated responses, highlighting the value of this task in identifying omitted arguments and general problems producing the story. A range of thematic structures were produced but the story did not elicit complex phrasal structure.

In contrast to previous studies, the analysis describes the information at both the functional and positional levels of representation of Garrett's model. It also combines a consideration of the frequency with which particular structures are used and the errors produced. The extent to which the creation of those levels of representation is impaired can be determined by comparing the performance of individual speakers with aphasia and the normal speakers. The comprehensive normal data obtained in this study ensures that clinically significant deficits can be distinguished from normal variability.

However, more detailed assessment may still be necessary to investigate whether particular sub-processes are affected. It is thus a combination of the study of spontaneous speech and performance on controlled tasks that would enable clinicians to identify the precise origin of an individual's difficulties and to plan appropriate treatment.

Appendix A: Extracts of the narrative samples of some of the individual people with aphasia.

AL: ‘once upon a time there lived a .. Cinderella .. the sisters . er . fat the Cinderella working all the time . cleaning cooking and erm so the the sisters went to the ball ….. erm . Cinderella is crying but the magic genie he says you shall be the best erm .. ball’

DM: ‘yes erm .. er . [d d d] Cinderella er er erm Cinderella er make [meɪ meɪn] radio radio er er (unintelligible) radio er … the fairies no no no no …. erm er no no no no (unintelligible) the prince er come to er come to er Cinderella uh huh huh uh huh and er they marry no no’

IB: ‘Cinderella and um .. um .. lady Cinderella and house and dusting no well er .. dusting and sweeping sweeping Cinderella and um sister one two sister and ball .. Cinderella ball and Cinderella ball and Cinderella ball .. no ball.. and sister one two sister and um off .. off’

JM: ‘Cinderella was very small his her mam died and his dad wanted to married and this woman had two daughters … so he they married and Cinderella had to be a maid … the died his dad dad fell ill and she died he died so the girl stayed with the mam and the two step daughters’

JS: ‘ordinary routines as they was go back into a rat back into a pumpkin or whatever it is .. taken the palace .. so anyway ah no she had they got a pair of glass slipper and she used to dance with those in the ball and then anyway when it came to twelve o’clock one night and they had to run out home less the ball the dress and everything was just disappeared’

Appendix B: Upper and lower limits of normal performance (two standard deviations from the normal mean).

	Mean of Normal Group	**Normal Lower Limit (2 SD)**	**Normal Upper Limit (2 SD)**
Rate of Speech (words per minute)	137.02	**71.34**	202.71
THEMATIC STRUCTURE			
a) Percentage Undetermined Thematic Structure	2.54	NA	**8.45**
b) Percentage 1 Argument	12.83	2.91	**22.74**
c) Percentage 2 Argument	58.02	**41.37**	74.67
d) Percentage 3 Argument	20.28	**7.48**	33.08
e) Percentage Thematic Embedding	6.33	NA	16.00
Mean PAS Complexity	2.08	**1.87**	2.30
Percentage Argument Omission	0.15	NA	1.09
PHRASAL STRUCTURE			
Mean Phrasal Complexity	2.06	**1.78**	2.34
Noun Phrases			
Mean NP Complexity	1.83	**1.51**	2.15
a) Percentage 1 Component NP	57.19	44.56	**69.82**
b) Percentage 2 Component NP	19.61	**9.62**	29.60
c) Percentage 3 Component NP	7.45	**1.43**	13.46
d) Percentage Complex NP	15.67	**4.27**	27.07

Verb Phrases			
Mean VP Complexity	1.37	**1.19**	1.55
a) Percentage 1 Component VP	68.11	56.15	**80.06**
b) Percentage 2 Component VP	26.97	**15.35**	38.58
c) Percentage 3 Component VP	4.2	NA	11.66
d) Percentage Complex VP	0.73	NA	2.59
Adjectival Phrases			
Mean AP Complexity	2.07	1.15	**2.99**
a) Percentage 1 Component AP	43.39	4.33	**82.45**
b) Percentage 2 Component AP	21.96	NA	51.81
c) Percentage 3 Component AP	20.73	NA	65.91
d) Percentage Complex AP	13.92	NA	42.98
Prepositional Phrases			
Mean PP Complexity	2.95	**2.53**	3.37
a) Percentage 1 Component PP	2.22	NA	**8.95**
b) Percentage 2 Component PP	21.04	NA	44.45
c) Percentage 3 Component PP	54.27	**24.14**	84.41
d) Percentage Complex PP	22.47	NA	46.64

NA = Not Applicable (value less than zero)

Figures in bold represent key values for evaluating the performance of people with aphasia.

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Table 1

Examples of each of the types of thematic structure

Utterance Type	**Examples**
1. Undetermined thematic structure (UTS)	‘ugly sisters’ ‘Cinderella ball’ ‘to the ball’
2. One argument structure	‘Cinderella danced’ ‘prince cried’
3. Two argument structure	‘Cinderella went to palace’ ‘the fairy godmother waved the wand’
4. Three argument structure	‘fairy turned pumpkin into coach’ ‘she gave Cinderella a beautiful dress’
5. Thematic embedding (TE)	‘so she went to the ball to dance with the prince who was very handsome’

Table 2

Performance of individual speakers with aphasia on the main parameters of sentence production

	Rate of Speech (words per minute)	Percentage Narrative	Percentage UTS	Mean PAS Complexity	Percentage Argument Omission	Mean Phrasal Complexity	Mean NP Complexity	Mean VP Complexity	Mean AP Complexity	Mean PP Complexity	Percentage Phrasal Errors	Percentage Morpho-logical Errors
AL	44.60*	78.79	41.18*	1.85*	11.76*	1.88	1.54	1.30	1.67	3.00	11.88*	20.21*
AM	40.28*	80.00	18.18*	2.11	13.33*	1.99	1.65	1.32	2.00	3.00	0.00	0.00
BG	27.14*	59.87*	53.57*	1.85*	36.36*	1.85	1.58	1.20	2.00	2.60	16.35*	0.00
BM	35.37*	35.60*	50.00*	1.81*	22.22*	1.98	1.92	1.00*	1.50	3.50	16.67*	0.00
CG	19.39*	67.79*	30.00*	1.92	0.00	2.21	1.89	1.44	3.00*	2.50*	8.01*	6.67*
DM	37.06*	51.59*	63.16*	1.42*	0.00	1.58*	1.81	1.00*	1.00*	2.50*	29.17*	100*
GW	17.90*	57.30*	2.35	1.92	14.29*	1.82	1.93	1.25	1.00*	3.10	5.00*	0.00
HW	68.00*	59.41*	39.13*	1.93	8.33*	2.01	1.72	2.00	1.33	3.00	6.09*	0.00
IB	21.09*	47.71*	91.43*	2.00	66.67*	1.16*	1.45*	1.20	1.00*	1.00*	16.67*	18.18*
JM	56.56*	81.22	12.5*	1.78*	0.00	1.86	1.81	1.20	1.17	3.25	12.28*	0.00

JS	136.73	64.23*	13.7*	1.98	5.77*	2.20	1.75	1.74	2.22	3.09	14.45*	0.24*
KD	29.20*	70.73*	46.15*	1.86*	0.00	2.29	2.04	1.43	2.50	3.20	2.27*	5.11*
MK	23.13*	90.09	11.76*	2.07	7.14*	2.49	2.20	1.25	3.50*	3.00	11.25*	25.89*
ML	115.44	66.24*	0.00	2.16	1.35*	1.95	1.69	1.27	1.91	2.92	2.98*	0.42*
NB	71.75	74.82*	11.67*	2.01	4.76*	1.82	1.67	1.38	1.22	3.00	12.11*	1.33*
PW	88.97	47.84*	30.77*	2.05	7.14*	1.84	1.49*	2.04	1.00*	2.82	12.78*	51.67*
RN	74.38	52.66*	18.18*	2.16	0.00	1.79	1.80	1.41	1.00*	2.94	8.54*	6.84*
RS	50.48*	74.53*	9.38*	2.06	0.00	1.79	1.74	1.41	1.00*	3.00	26.39*	0.00
SS	60.98*	56.99*	9.76*	1.91	2.94*	2.06	1.66	1.54	1.88	3.14	7.01*	0.00
TF	52.00*	86.54	11.76*	2.20	7.69*	1.87	1.81	1.19	NA	2.60	27.38*	3.33*
TJ	20.46*	24.66*	91.3*	2.00	0.00	1.74*	2.32	1.00*	1.33	2.31*	0.00	0.00
VC	113.85	24.66*	91.67*	2.00	0.00	2.34	1.68	2.00	NA	3.33	0.00	16.67*

*** Significant difference from normal performance (> 2SD from normal mean)**

NA – not applicable as not present in sample

Table 3

Mean percentage of phrasal errors in the group of people with aphasia in the production of free morphemes

Class of Free Morpheme	Mean Percentage Error	SD	Min	Max
Determiners	14.04	15.38	0	50
Pronouns	4.54	8.10	0	25.37
Prepositions	10.68	16.02	0	50
Auxiliary Verbs	16.34	20.24	0	66.67

Table 4

Mean frequency of use for the bound morphemes and irregular past tense and plural forms and the results of the comparisons between the normal group and the group of people with aphasia.

Form	Mean Frequency of Use in Normal Group	Mean Frequency of Use in Aphasic Group	Comparison of Normal and Aphasic Groups
Regular Plural	10.60	5.05	t (40) = 40.16, p = 0.0003*
Irregular Plural	1.85	0.59	t (28.77) = 3.191, p = 0.0033*
Possessive 's'	0.95	0.09	t (22.84) = 2.868, p = 0.0087*
Regular Past	18.35	2.45	t (22.35) = 7.612, p = <0.0001*
Irregular Past	22.05	6.45	t (28.94) = 4.369, p = 0.0001*
Progressive 'ing'	4.70	3.68	t (35.28) = 0.7720, p = 0.4411
Perfect 'en'	0.75	0.05	t (20.37) = 2.893, p = 0.0089*
3rd Person 's'	1.15	3.45	t (40) = 1.360, p = 0.182

* = Significant differences between the two groups of speakers

Table 5

Mean percentage of errors in the group of people with aphasia in the production of bound morphemes and irregular past tense and plural forms.

Form	Mean Percentage Error	SD	Min	Max
Regular Plural	11.00	19.36	0	54.55
Irregular Plural	0	0	0	0
Possessive 's'	0	0	0	0
Regular Past	7.14	17.50	0	50.00
Irregular Past	4.89	10.07	0	33.33
Progressive 'ing'	2	8.94	0	40.00
Perfect 'en'	0	0	0	0
3rd Person 's'	23.02	41.83	0	100

Table 6

Results of correlations between parameters of sentence production in the group of people with aphasia -

	Rate of Speech	**Percentage UTS**	**Mean PAS Complexity**	**Percentage Argument Omission**	**Mean Phrasal Complexity**	**Percentage Phrasal Errors**	**Percentage Morphological Errors**
Rate of Speech		r = -0.215 p = 0.336	r = 0.305 p = 0.168	r = 0.338 p = 0.124	r = 0.175 p = 0.437	r = 0.129 p = 0.568	r = -0.011 p = 0.963
Percentage UTS			r = -0.337 p = 0.126	r = 0.385 p = 0.077	r = -0.274 p = 0.217	r = -0.082 p = 0.716	r = 0.029 p = 0.097
Mean PAS Complexity				r = -0.017 p = 0.940	r = 0.138 p = 0.541	r = -0.0278 p = 0.210	r = -0.542 p = 0.009
Percentage Argument Omission					r = -0.116 p = 0.608	r = 0.038 p = 0.866	r = 0.226 p = 0.312
Phrasal Complexity						r = -0.412 p = 0.057	r = -0.232 p = 0.299

Percentage Phrasal Errors							r = 0.419 p = 0.052

Table 7

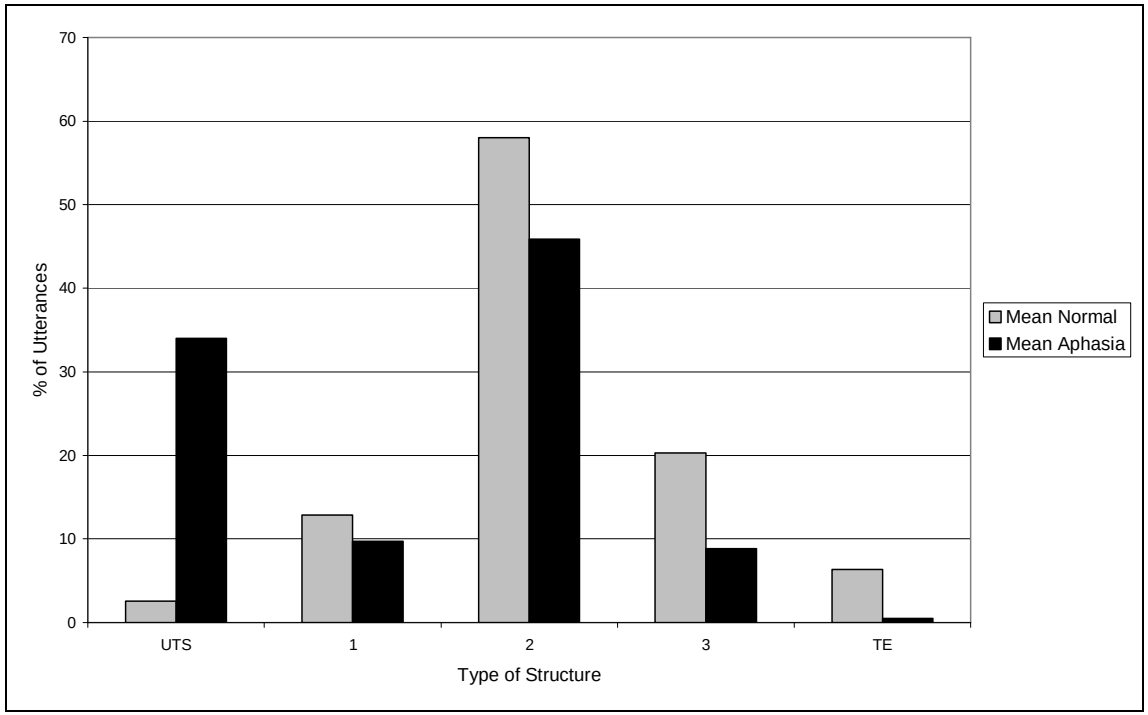
Summary of the performance of individual speakers with aphasia on parameters associated with the production of the functional and positional levels of representation.

		Functional Level Representation			**Positional Level Representation**		
	Fluency of Speech	**Percentage UTS**	**PAS Complexity**	**Omission Arguments**	**Phrasal Complexity**	**Phrasal Errors**	**Morphological Errors**
AL	Non-Fluent	-	-	-	√	-	-
AM	Non-Fluent	-	√	-	√	√	√
BG	Non-Fluent	-	-	-	√	-	√
BM	Non-Fluent	-	-	-	√	-	√
CG	Non-Fluent	-	√	√	√	-	-
DM	Non-Fluent	-	-	√	-	-	-
GW	Non-Fluent	√	√	-	√	-	√
HW	Non-Fluent	-	√	-	√	-	√
IB	Non-Fluent	-	√	-	-	-	-

JM	Non-Fluent	-	-	√	√	-	√
JS	Fluent	-	√	-	√	-	-
KD	Non-Fluent	-	-	√	√	-	-
MK	Non-Fluent	-	√	-	√	-	-
ML	Fluent	√	√	-	√	-	-
NB	Fluent	-	√	-	√	-	√
PW	Fluent	-	√	-	√	-	-
RN	Fluent	-	√	√	√	-	-
RS	Non-Fluent	-	√	√	√	-	√
SS	Non-Fluent	-	√	-	√	-	√
TF	Non-Fluent	-	√	-	√	-	-
TJ	Non-Fluent	-	√	√	-	√	√
VC	Fluent	-	√	√	√	√	-

Key: √ = retained (within normal limits) = impaired (outside 2 SD of normal mean)

Figure 1: Mean percentage distribution of thematic structure in normal group and group of people with aphasia



Key: UTS – Undetermined thematic structure

1 – 1 Argument structure

2 – 2 Argument structure

3 – 3 Argument structure

TE – Thematic embedding

Figure 2

Mean percentage of two and three argument structures containing non-arguments (NA) in normal group and group of people with aphasia

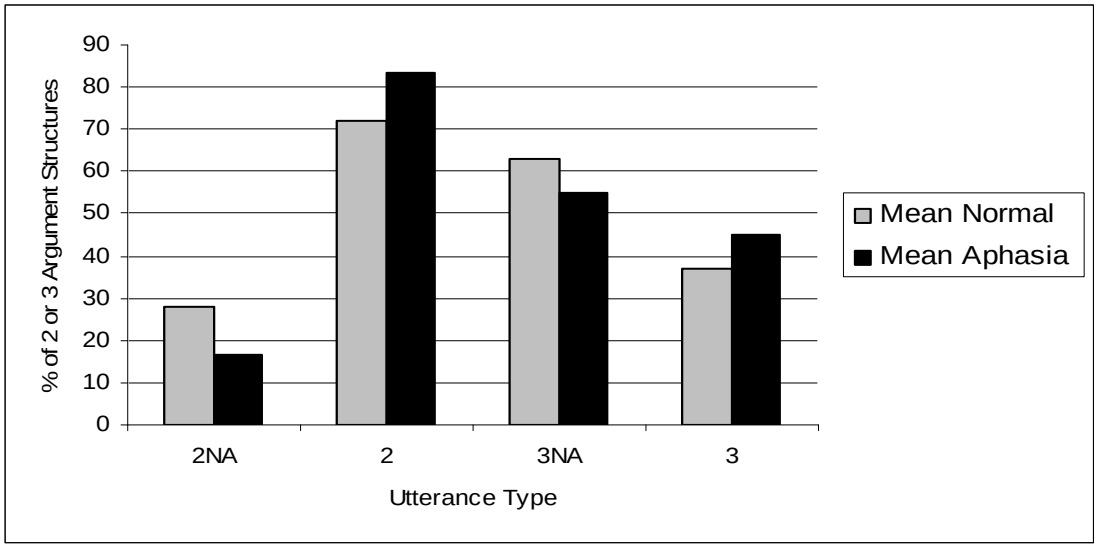
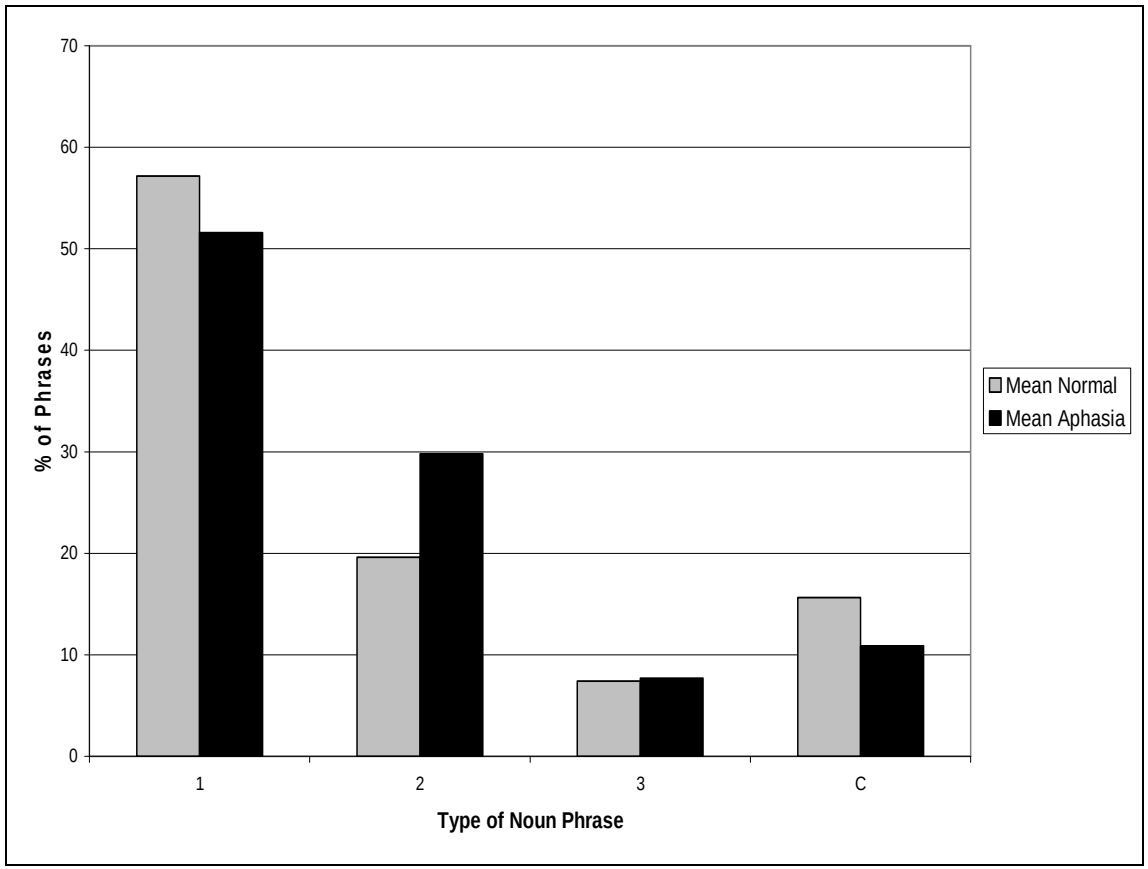


Figure 3

Mean percentage distribution of noun phrase complexity in normal group and group of people with aphasia



Key to figures 2 – 5

1	1 component phrase
2	2 component phrase
3	3 component phrase
C	Complex phrase

Figure 4

Mean percentage distribution of verb phrase complexity in normal group and group of people with aphasia

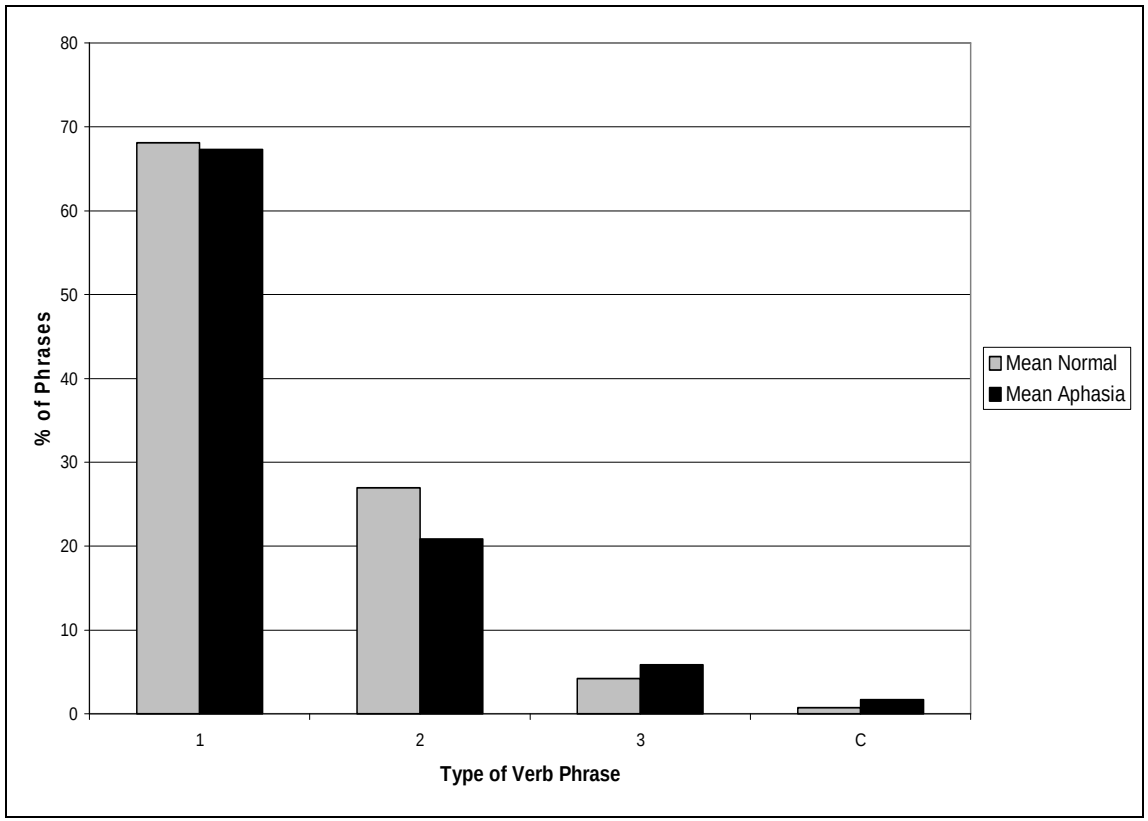


Figure 5

Mean percentage distribution of adjectival phrase complexity in normal group and group of people with aphasia

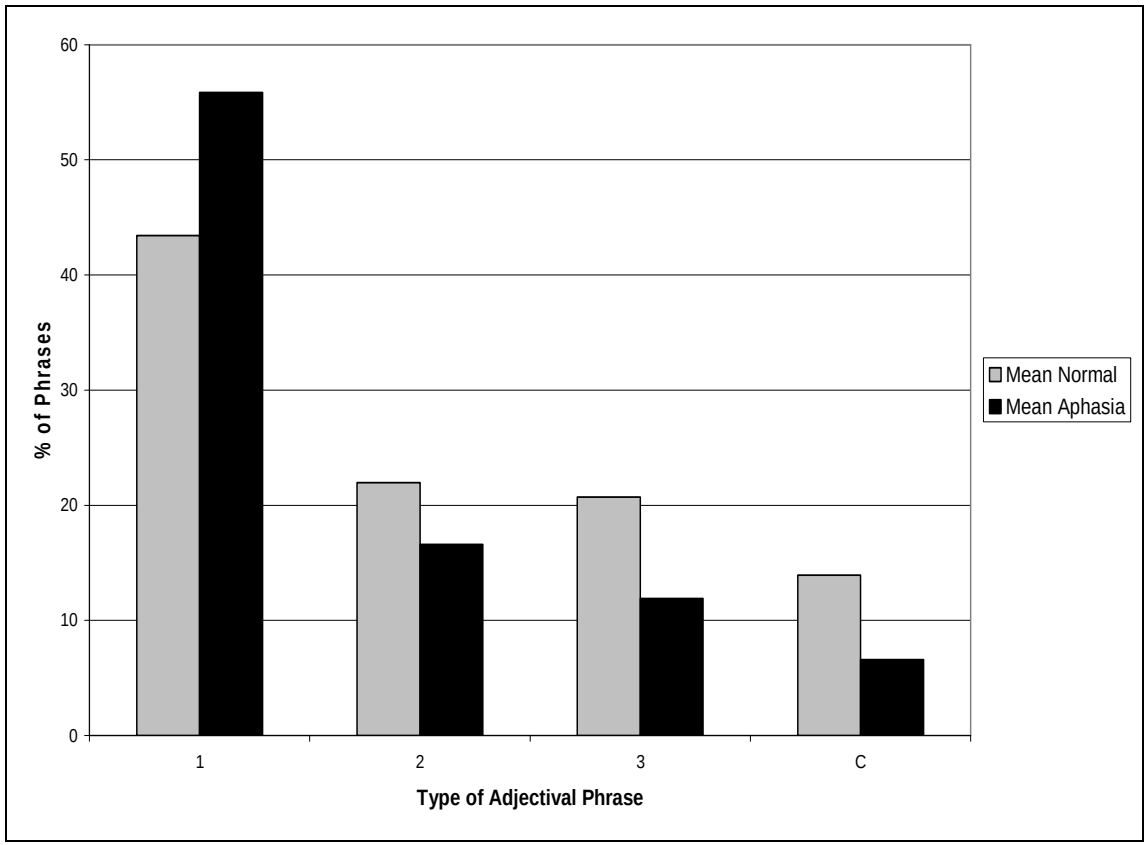


Figure 6

Mean percentage distribution of prepositional phrase complexity in normal group and group of people with aphasia

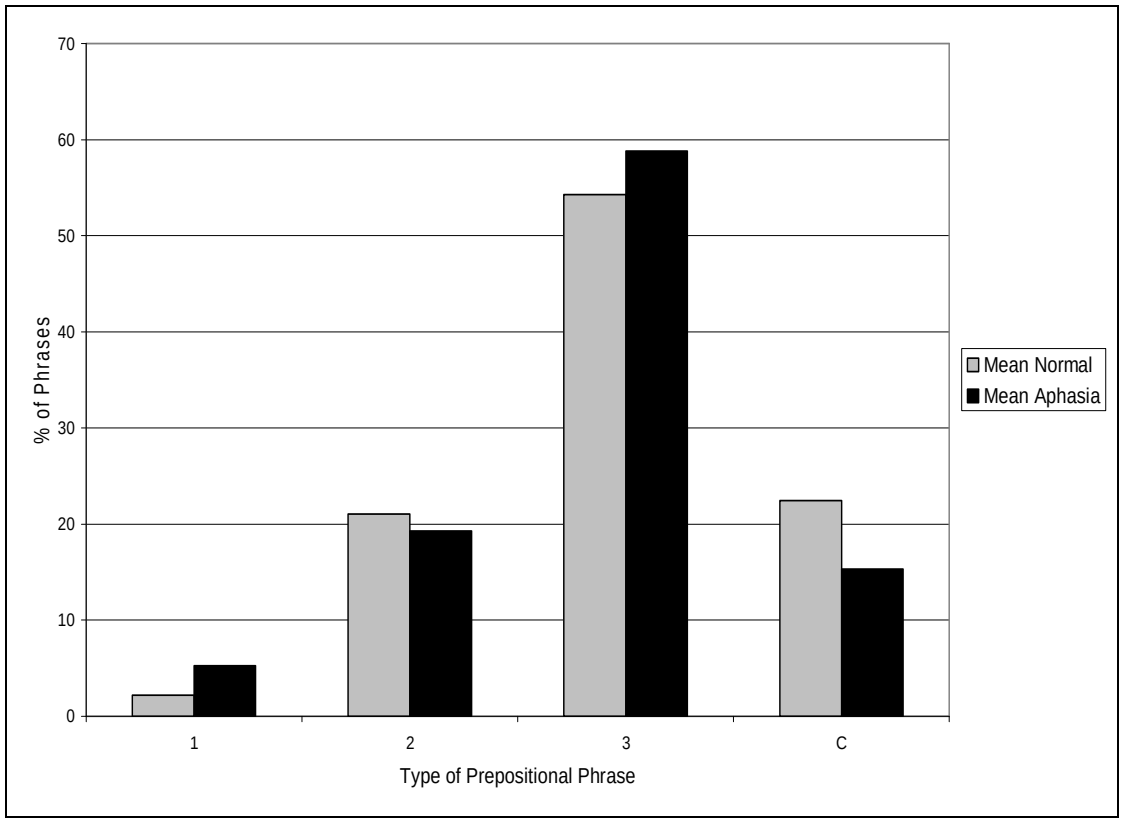


Figure 7

Relationship between mean phrasal complexity and mean percentage of phrasal errors in group of people with aphasia

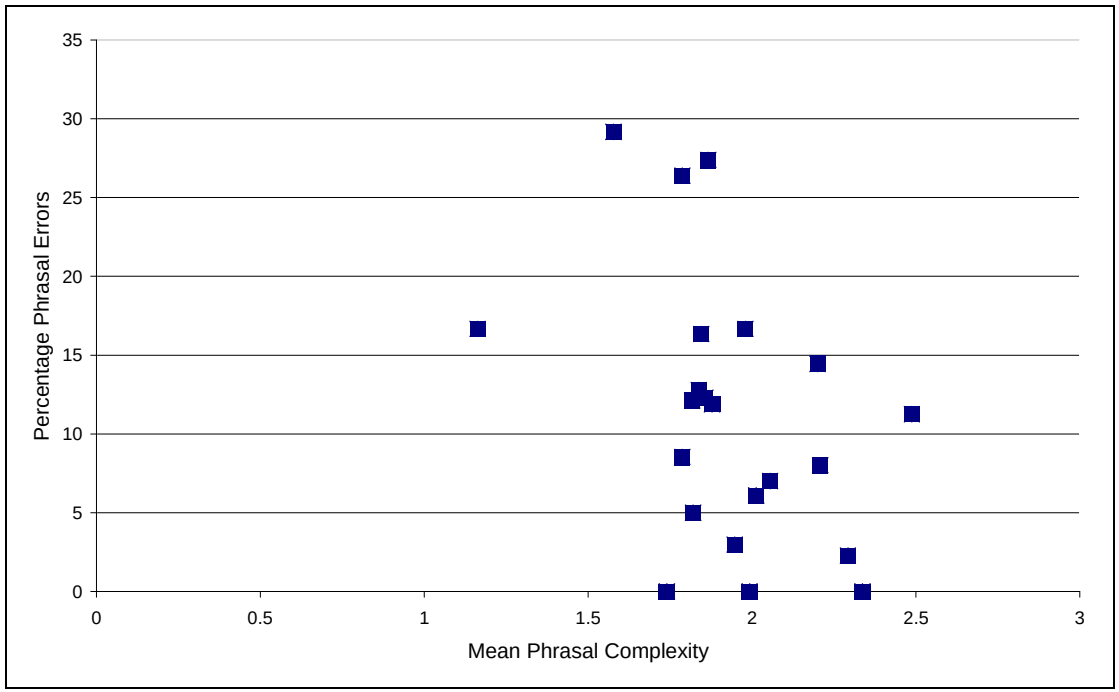


Figure 8

Relationship between mean phrasal complexity and mean percentage of morphological errors in group of people with aphasia

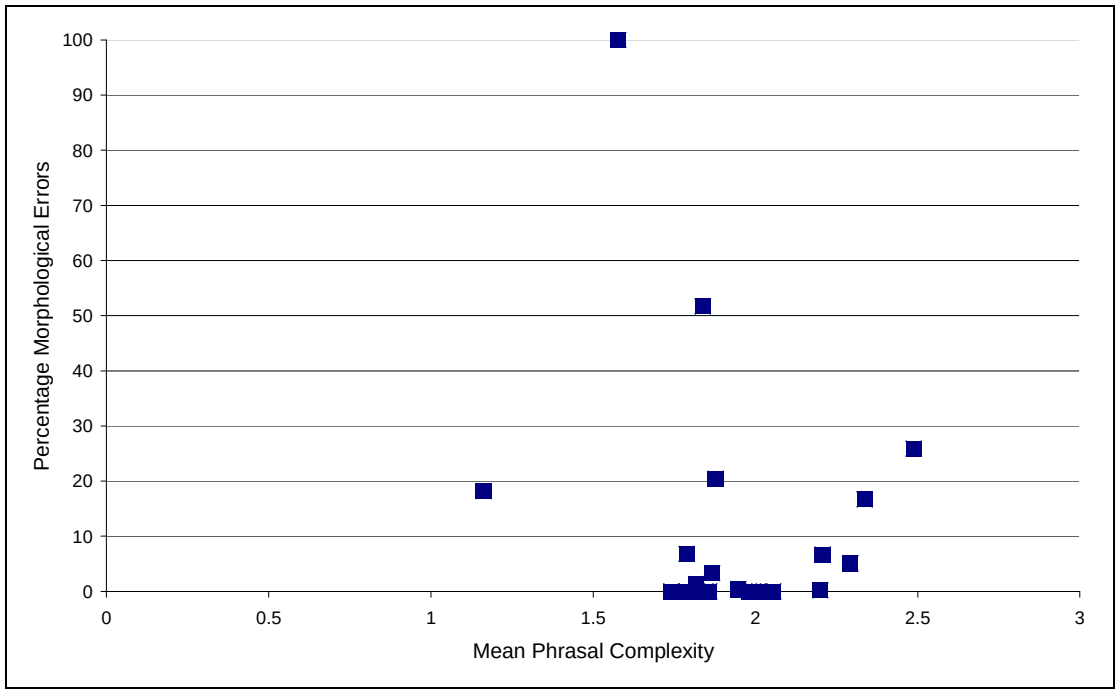
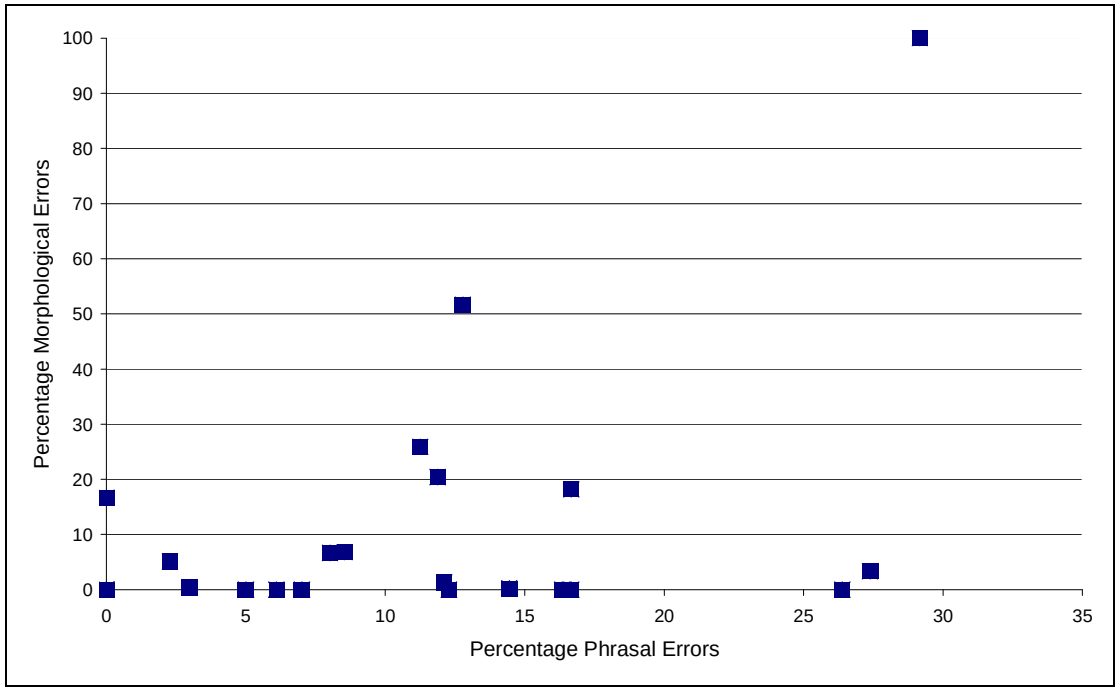


Figure 9

Relationship between mean percentage of phrasal errors and mean percentage of morphological errors in group of people with aphasia



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