# A Semantic and Syntactic Analysis of Aphasic Speech

**Janet Webster**



**Thesis submitted as fulfilment of the requirements of Doctor of Philosophy**

**December 1999**

**Department of Speech**

**University of Newcastle upon Tyne**

## Abstract

The aim of this study was to investigate sentence production deficits in subjects with aphasia, with a view to improving the description of the observed features of performance and determining the nature of the underlying impairment. An analysis of narrative speech was designed which described sentence production in terms of thematic, phrasal and morphological structure. The comprehensive analysis procedure allowed the sentence production of non-fluent aphasic subjects, fluent aphasic subjects and normal control subjects to be compared. The results of the narrative analysis questioned the validity of grouping subjects via the fluency of their speech; there was extensive variability within each group and the deficits seen in the non-fluent and fluent subjects were not differentiable. Garrett's (1980) model of normal sentence production provided a more beneficial framework for characterising sentence production deficits in aphasia. The majority of the subjects with aphasia presented with a combination of functional and positional level deficits. Selective deficits were, however, identified in the production of thematic structure, complex phrases, function words and inflectional morphology.

The independence of functional and positional level processing was confirmed by an additional study of narrative speech investigating how thematic structure influenced subsequent phrasal realisation. There was no trade-off between the complexity of the predicate argument structure (in terms of the number of phrasal components associated with the verb) and the complexity of the phrases used to realise those arguments. In addition, the argument status of the phrase was not found to influence its complexity. The number of phrasal components in an utterance and the complexity of those phrases was only influenced by the information to be conveyed.

The narrative analysis allowed the likely location of a subject's impairment to be identified. An investigation of four subjects with apparent difficulties in producing the functional level representation found that differential deficits were responsible for their production of thematic structure. These results provide support for the three sub-processes suggested by Schwartz (1987):- the retrieval of semantic information, the creation of the predicate argument structure and the assignment of thematic roles to lexical items.

## Acknowledgements

I wish to thank the many people who have supported and helped me in the course of the last three years. I wish to thank my supervisors Dr Sue Franklin and Professor David Howard for their advice and help and Helen Bird for her encouragement and support. Thanks must also go to the members of the adult research group for their helpful and thought-provoking discussions. I would also like to thank all of the local Speech and Language Therapists and the volunteers working in the local Speech after Stroke Clubs who helped me to find participants for this study.

A very special thank you to all of the patients with aphasia, and particularly AL, JM, GW, KD and TJ who gladly gave their time and welcomed me into their homes. It was a privilege to get to know you all. Thanks also to all the people who participated in the sessions to obtain the normal data and all those who filled in the many questionnaires.

Finally, to Pete, to Mum and Dad and to all my family and friends, thanks for your constant love, support and encouragement.

# Table of Contents

# LIST OF TABLES

# LIST OF FIGURES

# Chapter 1: Literature Review

Sentence production deficits have traditionally been described within the syndromes of agrammatism and paragrammatism. This chapter will review the features which characterise the two syndromes and the theories which have been proposed to account for the observed performance. The validity of these two syndromes has, however, been questioned due to the variability between subjects within groups and the overlap in the performance of the two groups. There has been a recent move in aphasia research towards a cognitive neuropsychological approach which analyses the performance of individual subjects in relation to models of normal processing. This approach is outlined, alongside a model of sentence production (Garrett 1980) which has been used to describe aphasic performance. The underlying processes which are thought to operate and the characteristic deficits resulting from their impairment are discussed. Finally, the aims of this study are introduced.

Sentence production deficits are a widespread feature of aphasic language. Kleist (1916) distinguished two distinct types of aphasic sentence production deficits, agrammatism and paragrammatism; it is this distinction which has continued to dominate the description of aphasic speech. Agrammatism describes the simplified syntactic structure and omission of morphology associated with Broca's aphasia. Paragrammatism is the disturbance of grammar, involving the substitution of morphemes associated with Wernicke's aphasia. Broca's and Wernicke's aphasia are considered to be aphasic syndromes, associated with damage to distinct areas of the brain. Broca's aphasia is characterised by good functional comprehension, effortful, dysprosodic and non-fluent speech containing phonemic paraphasias, articulatory disturbances and agrammatism (Goodglass and Kaplan 1983, Kean 1995). Wernicke's aphasia, in contrast, is characterised by a marked comprehension deficit, word retrieval difficulties resulting in the production of semantic and phonemic paraphasias and neologisms and the production of fluent, paragrammatic speech (Goodglass and Kaplan 1983). Paragrammatic speech is often semantically inappropriate. The majority of the research investigating sentence production difficulties in aphasia has focused on agrammatism; comparatively little research has been carried out into paragrammatism. The following sections will discuss the characteristics of agrammatic and paragrammatic speech.

## 1.1 Agrammatism

### 1.1.1 Features of Agrammatism

Agrammatism has been a widely investigated feature of aphasic performance. Saffran, Berndt and Schwartz (1989) described agrammatism as 'non-fluent and dysprosodic speech output, simple and poorly realised sentence structures, and frequent omission of bound and free grammatical morphemes' (p441). The omission of these morphemes, considered the defining feature of agrammatism, is generally evident in reading and repetition tasks, as well as spontaneous speech. These difficulties with function words result in the predominance of open class words, particularly concrete nouns (Saffran et al 1989) and poorly realised phrasal structure (Menn and Obler 1990).

Verb deficits have been identified alongside agrammatic speech. Miceli, Silveri, Villa and Caramazza (1984) studied noun and verb retrieval in agrammatic subjects and anomic subjects. The agrammatic subjects were shown to have a marked deficit in the retrieval of action names, compared to object names. This was in contrast to the anomic subjects who showed more difficulty with noun retrieval. Similar results were reported by Zingeser and Berndt (1990). Many single case studies of individual agrammatic subjects, for example, ROX, (McCarthy and Warrington 1985), ML, (Mitchum and Berndt 1989) BP, (Byng and Black 1989) and EA, (Mitchum, Haendiges and Berndt 1993) have also shown that agrammatic subjects have difficulty with verb retrieval in single word and sentence contexts. In sentence production, verb retrieval deficits result in the omission of verbs, an increased proportion of nouns (Gleason, Goodglass, Obler, Green Hyde and Weintraub 1980, Saffran et al 1989) and the use of 'light' verbs (McCarthy and Warrington 1985, Berndt, Haendiges, Mitchum and Sandson 1997). These light verbs, for example 'do', 'have', 'be' and 'make', are high frequency and semantically non-specific; they thus have a potentially wide usage. When lexical verbs are used by subjects, they typically occur in the progressive 'ing' form (Goodglass 1968, Saffran, Schwartz and Marin 1980). Goodglass (1968) attributed the predominance of 'ing' to a tendency to nominalise the verb.

Subjects with agrammatic speech produce a reduced range of syntactic structures, with a reliance on simple intransitive and transitive forms and the absence of conjoined and embedded clauses (Goodglass, Gleason, Bernholtz and Hyde 1972).

Agrammatic subjects may also have difficulty in the production of appropriate word order within sentences (Goodglass et al 1972, Saffran et al 1980a). Goodglass et al (1972) suggested that words were ordered according to their prominence in the sentence. Saffran et al (1980a) reported a study contrasting the production of reversible and non-reversible sentences, with noun phrases which differed in animacy; agrammatic subjects were unable to correctly order two animate noun phrases around a verb in reversible sentences. They suggested that in non-reversible sentences, the agrammatic subjects were able to rely on differences in animacy to produce appropriate sentences. In the absence of this non-linguistic information, subjects were unable to communicate meaning via word order.

Broca's aphasia was initially characterised as a disorder of expressive language. Broca's aphasics were believed to have good comprehension of single words and a good functional understanding of conversation. This apparently preserved comprehension led many researchers to conclude that despite their agrammatic production, Broca's patients retained their knowledge about syntactic and phrasal structure. Syntactic comprehension deficits were, however, described in early studies of subjects with agrammatism (for example, Isserlin 1922) and in the late 1970's and 1980's, there was a series of studies which challenged the apparent preservation of syntactic knowledge. Zurif, Caramazza and Myerson (1972) showed that in a relatedness judgement task, agrammatic subjects were unable to integrate function words into hierarchical structures. Other studies of comprehension showed that agrammatic subjects were not sensitive to the meaning conveyed by function words and inflections in sentences (Parisi and Pizzamiglio 1970, Goodenough, Zurif and Weintraub 1977). Shewan and Canter (1971) and Goodglass, Blumstein, Gleason, Hyde, Green and Statlender (1979) suggested that syntactic complexity influenced the comprehension performance of agrammatic subjects. Goodglass et al (1979) showed that more complex sentences, such as relative clauses, were understood less well than conjoined sentences with the same propositional content. With appropriate assessment, therefore, it appears that agrammatic subjects have deficits in the comprehension of function words, morphology and complex sentences which are similar to their agrammatic production.

Subjects with agrammatism are unable to comprehend sentences whose meaning cannot be derived from the lexical content alone, as in reversible sentences

(Caramazza and Zurif 1976). They proposed that two distinct processes contribute to sentence comprehension:- algorithmic linguistic knowledge and heuristic real world knowledge. Non-reversible sentences can be interpreted using real world knowledge as they describe only one plausible event. Reversible sentences, on the other hand, have more than one semantically plausible interpretation; they thus rely on syntactic processes to disambiguate these possibilities. According to Caramazza and Zurif (1976), agrammatic subjects have access to real world knowledge and thus retain the ability to understand non-reversible sentences; in contrast, they do not have access to the syntactic knowledge necessary to understand reversible sentences. The comprehension of subjects with agrammatism has, therefore, been described as asyntactic. Many subsequent studies have also highlighted these deficits in the comprehension of reversible sentences (for example, Schwartz, Saffran and Marin 1980, Jones 1984, Byng 1988, Schwartz, Saffran, Fink, Myers and Martin 1994). The deficit increases in reversible sentences with moved arguments (Caplan and Futter 1986, Kolk and Weijts 1996, Schwartz, Linebarger, Saffran and Pate 1987); this is hypothesised to be a consequence of the lack of transparency between surface syntactic structure and underlying meaning.

Howard (1985) discussed the many parallels between agrammatic performance in production and comprehension. These are summarised in table 1.1.

**Table 1.1: Similarities between the performance of agrammatic patients in production and comprehension (from Howard 1985).**

| PRODUCTION | COMPREHENSION |
|---|---|
| Omit function words | Unaware of the syntactic structure that function words convey |
| Omit inflectional affixes | Unaware of the meaning conveyed by inflectional affixes |
| Poor production of word order | Poor comprehension of word order |
| Verb retrieval difficulties | Poor comprehension of verbs |

These similarities between comprehension and production led to the notion of 'parallelism'. Parallelism suggests that the productive deficits in agrammatism are always accompanied by parallel deficits in comprehension and that the same impaired processing components are responsible for the deficits (Kolk, Van Grunsven and Keyser 1985). Parallelism has, however, been challenged by the presence of dissociations between comprehension and production (Howard 1985).

### 1.1.2 Agrammatism as a Unitary Syndrome

The characterisation of agrammatism as a syndrome suggests that the features co-occur with a frequency greater than chance (Caplan 1985). He 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 subjects should thus all show a similar pattern of impairment as features should not be dissociable from one another. In non-functional syndromes, symptoms co-occur due to neuroanatomical proximity and thus there is some potential for dissociations. This section will discuss the variability which has been identified initially in the features of agrammatic speech and then in relation to the verb and comprehension deficits associated with agrammatism. This variability has led to debates about which features are sufficient or necessary for a diagnosis of agrammatism and the validity of its characterisation as a functional syndrome.

The most prominent feature of agrammatic speech is the omission of function words and inflectional morphemes. Even restricting the characterisation of agrammatic speech to this feature, extensive variability has been identified within and between individual speakers. Kean (1995) described two distinct patterns of agrammatic speech. In some subjects with agrammatism, output is limited to single content words; other subjects are able to produce some evidence of sentence structure and some morphology, but other function words and inflections are omitted. These speech patterns vary in the extent to which function words and inflectional morphemes are produced. Extensive variability has also been identified in the morphemes which are omitted. Dissociations have been identified between the production of bound and free morphemes in spontaneous speech (Miceli, Silveri, Romani and Caramazza 1989) and in the production of inflectional and derivational morphology in spontaneous speech and repetition tasks (Miceli and Caramazza 1988).

Miceli et al (1989) also reported extreme variation in the rate of omission and the relative proportions of omission and substitution errors in the production of individual classes of function words. The characterisation of agrammatic speech as the loss of grammatical morphemes, therefore, is not as straightforward as it would seem; not all morphemes are lost, some are produced correctly and some are substituted. Investigations of individual subjects have also identified variability in the omission of morphemes in different tasks. Heeschen (1985) and Kolk and Heeschen (1992) showed that subjects who omitted morphemes in spontaneous speech, substituted morphemes in more constrained tasks of function word production. Saffran (1982) described a patient who was more agrammatic in spontaneous speech than in more structured and constrained tasks. Luria (1970) described a patient who was agrammatic in speech but who did not omit morphemes in repetition. These studies again question the precise characterisation of agrammatism.

Agrammatic speech is also considered to involve the production of simplified sentence structure. Dissociations have, however, been identified between the omission of morphemes and these structural abnormalities (Tissot, Mounin and Lhermitte 1973). These dissociations prompted Tissot et al (1973) to suggest that there were three sub-types of agrammatism:- syntactic, morphologic and an additional group with a combination of both syntactic and morphologic deficits. Miceli, Mazzuchi, Menn and Goodglass (1983) and Caramazza and Miceli (1991) identified dissociations between word order difficulties and morphologic deficits, suggesting that different impairments may be responsible for the two features of performance. These dissociations question the functional relationship between the two aspects of performance. It is, however, unclear to what extent different types of structural and morphologic deficits dissociate as the majority of studies have focused on the description of one of these aspects of production.

The validity of the functional relationship between agrammatic speech production, verb deficits and asyntactic comprehension has been questioned by the presence of dissociations between these aspects of performance. Agrammatic production has been identified in the absence of asyntactic comprehension and verb deficits. The patients JR (Schwartz, et al 1980), Mrs K. (Kolk et al 1985) and GG and TF (Miceli, Mazzuchi, Menn and Goodglass 1983) were all agrammatic speakers and yet retained the ability to understand reversible sentences. Berndt, Haendiges and Wozniak (1997)

described a patient who demonstrated no difficulties in the production or comprehension of verbs, but who had sentence production difficulties which resembled agrammatism. These dissociations suggest that the deficits are not the consequence of the same underlying impairment. Asyntactic comprehension and verb retrieval deficits have also been identified in non-agrammatic speakers. Patient MC (Caramazza, Berndt, Basili and Koller 1981) had asyntactic comprehension but produced grammatically intact speech. Other fluent patients with asyntactic comprehension have been identified by Caramazza and Zurif (1976) and Heeschen (1980). Williams and Canter (1987) and Berndt, Mitchum, Haendiges and Sandson (1997) have identified verb retrieval deficits in both non-fluent agrammatic and fluent patients. Patients have been identified who demonstrated difficulty with verb retrieval but who were able to produce appropriate morphology and sentence structure (Caramazza and Hillis 1991).

These studies demonstrate the heterogeneity of patients with apparently the same impairment. The consequences of these findings for the classification of agrammatism as a syndrome has been widely debated. For some, the variability in agrammatic speech production has challenged the very existence of the syndrome (Miceli et al 1989, Badecker and Caramazza 1986). In contrast, Caplan (1986, 1991) and Grodzinsky (1991) have defended the characterisation of agrammatic speech as a functional syndrome, arguing that within any syndrome there may be individual variation and variability. In these cases, theories of agrammatism must offer explanations for both the characteristics of agrammatic speech and the observed variation, for example, the selective loss and retention of morphemes and task differences. Some theories of agrammatism have tried to explain the co-occurrence of verb and asyntactic comprehension deficits with agrammatic speech production.

### 1.1.3 Theories of Agrammatism

Theories of agrammatism have searched for a unitary account of the observed features of the syndrome of agrammatism. In addition, theories have addressed the relationship between agrammatism and the other aspects of Broca's aphasia and the observed variability in agrammatic performance. Accounts of agrammatism fall into

four main groups:- prosodic and phonological accounts, syntactic accounts, processing and adaptation accounts and mapping accounts.

**a) Prosodic and Phonological Accounts of Agrammatism**

Prosodic and phonological accounts of agrammatism have focused on explaining the production difficulties characteristic of Broca's aphasia and the co-occurrence of phonological paraphasias (Blumstein 1973), dysprosodic speech and non-fluency. These features all seemed to be related to the processing of sound and prosody, and thus, prosodic and phonological accounts for the selective retention and omission of morphology were sought. Goodglass (1962) was the main proponent of prosodic theories of agrammatism. He proposed that there was an increased threshold for initiating and maintaining speech. The aphasics' ability to exceed threshold relied on the salience of the message, and thus, only informative, phonologically prominent items were produced. In a later study, Goodglass Fodor and Schulhoff (1967) found that in a repetition task, stressed function words were retained more frequently than unstressed, particularly in sentence initial position. Gleason, Goodglass, Green, Ackerman and Hyde (1975) demonstrated an increased omission of unstressed, sentence initial articles and pronouns. Goodglass et al (1967) suggested that the presence of stress increased salience allowing the initiation and maintenance of speech. Without the presence of stress, subjects are not able to initiate speech and thus unstressed components are omitted. This prosodic theory would, therefore, seem to offer some account of the selective loss and retention of morphemes. The theory does not, however, account for all of the features of agrammatic speech. In spontaneous speech most function words are unstressed, but some of these unstressed morphemes are still retained. In addition, prosodic accounts would suggest a similar loss of less salient inflectional morphemes. DeVilliers (1974), however, showed that more salient, syllabic morphemes were not retained with greater frequency than non-syllabic morphemes in speech.

Kean (1977) proposed that agrammatism results from an impairment to the phonological system which specifies the segmental shape of individual words and the stress and intonation of words within sentences. The selective omission of morphemes is governed by phonological principles, such as sonorance and stress. She predicts a greater omission of morphemes after decreased sonorant sounds than after more

sonorant sounds. This prediction is supported by the study into the production of morphemes by Goodglass and Berko (1960); they found an increased retention of post-vocalic inflectional morphemes compared to post-consonantal morphemes. In a similar way to Goodglass et al (1967), Kean (1977) proposed that stress affects the retention and omission of function words and morphology. Inflectional morphemes and function words which are not involved in the assignment of stress are omitted. Subjects with agrammatism, therefore, reduce sentences to strings of segments which can be lexically construed as a phonological words (defined as strings of segments which function in stress assignment). This inadequate phonological representation results in phonemic paraphasias in the specification of words and subsequent phonetic difficulties in the realisation of the sentences. The other aspects of performance are considered to reflect characteristics of intact normal processing. The observed variation in the omission of morphemes reflects a normal pattern related to the degree of separability between words and their morphemes. For example, derivational morphemes seem to be more closely bound than inflectional morphemes and are not stranded in normal speech errors. In a similar way, derivational morphemes are omitted less frequently than inflectional morphemes in agrammatic speech. Kean's phonological account of agrammatic speech does seem to offer an account for the selective retention of some morphemes. Data from some subjects with agrammatism, however, suggests that it is the grammatical function of morphemes and function words which affects retention rather than phonological form or the degree of separability (DeVilliers 1978).

The prosodic and phonological accounts of agrammatism proposed by Goodglass (1962, Goodglass et al 1967) and Kean (1977) offer a partial account of the speech production of subjects with agrammatism. They offer an explanation of the phonemic paraphasias, dysprosody and decreased rate characteristic of Broca's aphasia and suggest a possible account of the selective retention of some morphemes. The theories do not, however, offer a full explanation of the influence of grammatical function on the selective omission of inflectional morphemes. The omission of function words and morphology may account for the simplification of phrasal structure in agrammatism, but it fails to account for the reliance on simple syntactic structures and the observed difficulties in the production of linear word order. These theories do not offer any explanation of the co-occurring comprehension and verb deficits seen in many

subjects with agrammatism. Verbs, like other content words, are typically stressed and would thus be retained in agrammatic speech if sentence structure was reduced to phonological words as proposed by Kean (1977). As for the comprehension deficits seen in agrammatism, it may be proposed that a similar lack of stress and prominence may result in the poor recognition of function words and morphology in sentence comprehension. This may explain the poor performance of subjects with agrammatism on certain sentences, such as passives, whose interpretation depends on sensitivity to grammatical morphemes. This theory, however, offers no explanation for the poor comprehension of simple reversible sentences as identified by Schwartz et al (1980).

**b) Syntactic Accounts of Agrammatism**

Many of the features of agrammatism involve disruption to syntactic structure. The primary role of function words and inflectional morphology is the expression of syntax; their omission, therefore, seemed to warrant a syntactic explanation. The effect of syntactic complexity on the production and comprehension of sentences reinforced the notion that agrammatism required a syntactic explanation. Accounts were, therefore, proposed which posited that agrammatism resulted from damage to the component of the language system specialised for syntactic processing. There is no general consensus which syntactic processes are affected in agrammatism; various aspects have been proposed:- the knowledge of syntactic rules, the assembly and disassembly of phrasal structure and the processing of closed class vocabulary. Although the theories differ in the precise nature of the proposed impairment, all result in impaired syntactic parsing in comprehension and poor production of hierarchical phrase structure.

Berndt and Caramazza (1980), mindful that Broca's aphasics are unable to construct syntactic structures while able to produce individual content words, proposed that agrammatism represents an inability to construct the syntactic frames of utterances, with a failure to select items with a purely syntactic function. This inadequate selection results in the predominance of content words in speech and difficulty expressing relationships which rely on the use of grammatical morphology. In a later study, Caramazza et al (1981) investigated the performance of two Broca's patients on a number of tasks involving syntactic processing. The two subjects were

found to perform poorly on comprehension, production and anagram tasks involving syntactic processing and were, therefore, hypothesised to have a central syntactic impairment. Caramazza et al (1981) concluded that the syntactic deficit hypothesis could account for the omission of grammatical morphemes, the inappropriate development of syntactic frame and the extraction of only semantic information. The precise nature of this syntactic deficit was not, however, characterised. A very early syntactic account of agrammatism suggested that the syntactic deficit reflected a loss of syntactic rules and a loss of words with a purely grammatical function (Jakobson 1956). The deficits identified by Caramazza and his colleagues seem to support this view of a syntactic deficit.

With a reduced contribution of syntactic rules, subjects rely on semantic information (Caramazza and Zurif 1976, Caramazza et al 1981). There have been a number of studies that have demonstrated preferential processing of closed class words which encode semantic information. Zurif and Caramazza (1976) described the results of word grouping tasks, in which Broca's aphasics were more sensitive to function words which were critical for the expression of semantic relations, such as prepositions, than those with a less crucial semantic role, such as articles. Friederici (1982) demonstrated differential access to prepositions, depending on their grammatical role in sentences and their relative semantic content. Broca's patients had more difficulty accessing obligatory prepositions, which express syntactic information, than lexical prepositions which code semantic information.

Bradley, Garrett and Zurif (1980) proposed that agrammatism reflects a loss in the specialist retrieval mechanisms for closed class vocabulary, the 'closed class hypothesis'. Their hypothesis arose from the differential involvement of open and closed class vocabulary in normal speech errors. The results of an investigation of lexical decision seemed to confirm that different mechanisms were involved in the processing of open and closed class words, but their results have not been replicated. In agrammatic subjects, they demonstrated the retrieval of closed class words is influenced by the same factors as the retrieval of open class words in normal subjects. In the absence of specialist closed class retrieval mechanisms, it would seem that closed class words are retrieved by open class mechanisms. This suggests that those function words with some semantic content will be retrieved more successfully than those encoding purely syntactic information. Caplan (1985) presented a modified

version of the closed class hypothesis; closed class words may be accessed but are not fully interpreted. This failure of interpretation results in a failure to compute hierarchical phrase structure. In the absence of function word information, subjects establish word order using category membership information and the relative prominence of lexical items.

Grodzinsky (1984, 1986, 1990) proposed a partial loss of syntactic information in agrammatic comprehension in his 'trace deletion hypothesis' (TDH). The TDH is based on the syntactic theory of Government and Binding (Chomsky 1981) and relies on the distinction between deep and surface structure. Grodzinsky proposed that in agrammatism, traces are deleted from surface structure representations. This deletion of traces results in the impaired comprehension of sentences involving syntactic movement. As a consequence of this partial loss of syntactic information, a cognitive strategy augments performance by assigning thematic roles to noun phrases. In a similar way, Grodzinsky suggested that a loss of information in the surface structure representation could account for the differential impairment of prepositions in agrammatism. He proposed that governed prepositions were deleted from the surface structure representation resulting in impaired use of these prepositions whereas the representation of ungoverned prepositions (prepositions in sentential adjuncts) was not affected. With additional investigations of agrammatic comprehension (see summary in Grodzinsky 1995), Grodzinsky has found it necessary to restrict the TDH to particular kinds of traces and restrict the use of the cognitive strategy. He reformulated the TDH as 'only traces in theta positions are deleted and noun phrases lacking a theta role receive one strategically if they are referential' (Grodzinsky 1995, p28).

Within the syntactic accounts described above, there has been no explanation of the verb impairments evident in subjects with agrammatism. Syntactic accounts of verb retrieval deficits have, however, been proposed (Zingeser and Berndt 1990). These accounts highlight the importance of the syntactic information coded within verbs for sentence production and interpretation. It is assumed that this syntactic information has to be retrieved whenever the lexical form of the verb is retrieved (Zingeser and Berndt 1990). Widespread syntactic deficits may therefore affect access to verbs in single word and sentence production and comprehension tasks. Verb deficits may also be a consequence of the increased morphological complexity of

verbs, compared to nouns in English. In a similar way to above, if it is considered that morphological information is accessed whenever the verb is retrieved, then disruption to the morphological system will affect single word and sentence production and comprehension. This hypothesis is, however, unable to account for the presence of verb deficits in agrammatic subjects who speak un-inflected languages, such as Chinese (Bates, Chen, Tzeng, Li and Opie 1991).

The syntactic accounts although differing slightly in their characterisation of the syntactic impairment, all suggest a difficulty processing inflectional morphology, closed class vocabulary, particularly those function words with a purely syntactic function, and a difficulty computing hierarchical phrase structure. These difficulties result in difficulties creating phrasal structure and difficulties in the syntactic parsing of sentences. These syntactic deficit hypotheses, therefore, seem to explain the co-occurrence of agrammatic production and asyntactic comprehension. The selective loss and retention of function words and morphology is explained by their grammatical role in the sentence and the semantic information they convey. These syntactic accounts could also be elaborated to include an account of verb deficits, if it is assumed that syntactic information constitutes a necessary part of a verb's lexical entry. Various studies have, however, demonstrated an apparent sparing of syntactic knowledge in some agrammatic subjects and have thus questioned the validity of these syntactic accounts.

Goodglass et al (1972) initially suggested that subjects with agrammatism had an apparent preservation of grammatical knowledge due to their ability to self-correct. Self corrections often resulted in the production of a syntactically correct form; this fact was interpreted as an indicator of a preserved knowledge of syntactic correctness. Subsequent experimental studies confirmed this apparent preservation of syntactic knowledge and have demonstrated a sensitivity to function words. Linebarger, Schwartz and Saffran (1983) tested the ability to judge grammatical correctness in four subjects with agrammatic speech production and asyntactic comprehension. Despite their apparent syntactic deficits in production and comprehension, these four subjects were capable of detecting violations in syntactic structure related to poor realisation of phrasal structure, inappropriate treatment of gaps and violations in the use of morphology and function words. Only in the detection of violations involving tag questions and reflexives did the agrammatic subjects demonstrate difficulty.

Subsequent studies (for example Wulfeck 1988) have confirmed this apparent dissociation between grammaticality judgement and sentence comprehension tasks. Schwartz, Linebarger and Saffran (1985) argued that grammaticality judgements involve syntactic processing as well-formedness constraints are encoded in the syntactic component; agrammatic subjects have access to this syntactic information and thus the syntactic accounts of agrammatism were rejected. Berndt (1991), however, highlighted methodological concerns about the use of grammaticality judgement tasks to assess access to syntactic information. Grammaticality judgement involves off-line processing, which is different to the on-line processing involved in sentence comprehension and production. Subjects may use any clues, for example prosody, to judge the sentence as ungrammatical; in none of the reported studies were subjects asked to identify what was ungrammatical about the sentence.

Dissociations between asyntactic comprehension and agrammatic production have also challenged the notion of a loss of central syntactic knowledge. As previously highlighted, agrammatism is not always associated with asyntactic comprehension (Kolk et al 1985, Miceli et al 1983). In addition, asyntactic comprehension is not restricted to agrammatic speakers; similar patterns of comprehension deficit have been identified in some fluent patients (Caramazza and Zurif 1976, Heeschen 1980). These dissociations undermine the very motivating force behind syntactic accounts and the search for a single underlying impairment which accounts for production and comprehension performance. In a similar way, dissociations between the ability to produce verbs and agrammatism (Williams and Canter 1987, Caramazza and Hillis 1991, Berndt et al 1997c) have undermined the validity of a unitary syntactic account of verb deficits and agrammatism.

### c) Processing and Adaptation Accounts of Agrammatism

Kolk and Van Grunsven (1985) rejected the syntactic hypotheses as they proposed they could not explain the variability present within individual patients across sentence types, and between patients on the same sentences. Kolk and colleagues (Kolk and van Grunsven 1985, Heeschen and Kolk 1988, Kolk and Heeschen 1990) have proposed that agrammatism results from a general processing deficit, either a slowing down of on-line processing, noise within the processing system or an exacerbated decay rate. The result is a decrease in the temporal window for the

processing of sentences. The observed agrammatic speech is considered to be not a direct consequence of the impairment but an attempt to adapt to these processing difficulties (Heeschen and Kolk 1988, Kolk and Heeschen 1990). This view is consistent with some early characterisations of agrammatism (Pick 1913, Isserlin 1922).

Agrammatic speech is considered to be an attempt to minimise the demands that sentence production places on computational resources, by reducing speech output to informative words. The omission of inflectional morphemes and the reduced variety of grammatical form both reflect ways of reducing complexity whilst maintaining communication. Agrammatic speech has been shown to display many of the characteristics associated with normal 'telegraphic speech' (Kolk and Heeschen 1990) and is, therefore, considered to be a consequence of normal processing. If agrammatism is considered to be an adaptation to processing difficulties, then it is considered to be an optional strategy which may not be used at all times. Heeschen and Kolk (1988) and Kolk and Heeschen (1990) have demonstrated the optional nature of agrammatic speech; they found that agrammatic speech was not used in cloze tasks and in more formal interactions. The use of agrammatic speech in these situations was considered to be pragmatically or communicatively inappropriate. Even within single interactions, agrammatic subjects have demonstrated the ability to switch between agrammatic and non-agrammatic speech (Bastiaanse 1995). The characterisation of agrammatism as an adaptation to processing difficulties, therefore, can account for performance variability between patients, between tasks and between different sentence types.

Kolk and Heeschen (1990) outline how the processing and adaptation account of agrammatism can account for the dysprosody, reduced rate and restricted use of syntactic forms which characterise the output of subjects with Broca's aphasia. Processing accounts have also been used to account for the performance of this group of aphasics on comprehension tasks. Linebarger et al (1983) suggested the allocation of limited processing resources could account for the dissociation between performance on grammaticality judgement and comprehension tasks. In grammaticality judgement tasks, only parsing is required and thus the aphasics' were able to perform the task. In comparison, the parsing and semantic processes involved in sentence comprehension exceeded the available resources, and therefore,

performance was impaired. When processing requirements exceed the available resources, subjects may rely on non-linguistic information, for example, animacy (Kolk and Weijts 1996).

The processing and adaptation accounts of agrammatic speech production can explain many of the symptoms of Broca's aphasia. The presence of and the nature of the processing impairment has not, however, been explicitly investigated in this group of subjects. In addition, it remains unclear why producing agrammatic speech requires less processing resources than producing non-agrammatic speech. If agrammatic speech is less resource-demanding, then there should be a direct relationship between the omission of morphology and reduced phrasal complexity and the complexity of the sentence in which those features occur. There is, however, no experimental evidence which suggests the omission of morphology and the simplification of phrasal and sentence structure is a direct consequence of exceeding available processing resources. No studies have been reported which explicitly contrast the omission of morphology in the production of simple and complex sentences.

**d) Mapping Accounts of Agrammatism**

Mapping accounts of agrammatism stemmed from the identification of difficulties in the production and comprehension of word order in reversible sentences (Saffran et al 1980a, Schwartz et al 1980). In these papers, Saffran, Schwartz and Marin proposed the performance of the agrammatic subjects reflects an inability to associate sentence form and sentence meaning. In comprehension, agrammatic subjects were able to use syntactic procedures to adequately parse the sentence, but were then unable to use rules or procedures to associate the parsed syntactic constituents with the semantic representations of the lexical items (Schwartz et al 1980). This deficit in the association of sentence form and meaning has also been used to account for the difficulties agrammatic subjects demonstrate in their understanding of co-indexation in tag questions and reflexives (Schwartz et al 1985). Schwartz et al (1987) demonstrated that the effects of the mapping deficit increase when there is a non-transparent relationship between sentence form and meaning, for example, in the comprehension of sentences with moved arguments. In production, it has been suggested that agrammatic subjects present with a similar difficulty using word order to encode relational meaning. As a consequence of this difficulty computing word

order, noun phrases are ordered on the basis of non-linguistic information, for example, animacy or saliency (Saffran et al 1980a, Saffran 1982). The mapping hypothesis has also been used to explain the omission of verbs, the production of sentences with fewer arguments and the production of sentences with omitted arguments (Schwartz, Fink and Saffran 1995). The mapping hypothesis can explain the difficulties with word order that have been considered to be part of the syndrome of agrammatism. It, however, fails to explain the omission of morphology which is the defining feature of the syndrome. It has, therefore, been concluded that mapping deficits can account for some of the deficits seen in the syndrome of agrammatism, but are not the sole cause of the observed features of agrammatic speech (Saffran 1982). Mapping and mapping deficits will be discussed in relation to models of sentence processing in section 1.7.4.

### 1.1.4 Conclusions

It can be seen from the discussions above that agrammatic speech is a variable phenomena which occurs to a varying extent with verb deficits and asyntactic comprehension. The observed variation in agrammatic speech between and within patients has undermined the search for a unitary linguistic explanation of the deficits. Performance variability can be explained within a processing and adaptation account of agrammatism. The presence of a processing deficit in agrammatism and its effect on sentence processing has not, however, been demonstrated experimentally. The observed features of agrammatic speech may result from distinct damage to multiple aspects of processing. Schwartz et al (1995) suggested that agrammatism is a multi-faceted condition, with different aspects affected in different patients. The analysis of this hypothesis requires an in-depth and comprehensive investigation of multiple aspects of sentence production. Studies of sentence production in agrammatism have typically focused on a particular level of linguistic structure, and thus, the validity of this characterisation within individual subjects has not been investigated. With regard to the co-occurrence of verb and asyntactic comprehension deficits, the dissociations evident have undermined the notion of a functional relationship between these aspects of performance. The co-occurrence of these features may reflect a non-functional relationship, due to neuroanatomical proximity.

## 1.2 Paragrammatism

### 1.2.1 Features of Paragrammatism

In contrast to the extensive research into agrammatism, paragrammatism has not been widely investigated as a feature of aphasic performance. Saffran et al (1989) described paragrammatism as "fluent speech, better realised but still non-normal sentence structure with misuse of grammatical markers" (p441). Paragrammatic speech is generally verbose and fluent, but often irrelevant and unrelated to topic Paragrammatism is associated with Wernicke's aphasia, and thus, co-occurs with difficulties in comprehension and in the retrieval of content words. These deficits are thought to result from a central semantic deficit (Caramazza and Berndt 1978). The word retrieval deficits in Wernicke's aphasia result in the production of paraphasias (unrelated, phonemic and semantic) and neologisms (Goodglass and Kaplan 1983, Ellis, Miller and Sin 1983, Schwartz 1987) and an increased production of pronouns, generally without antecedents (Gleason, Goodglass, Obler, Green, Hyde and Weintraub 1980). Ellis et al (1983) proposed that the apparent sparing of function words in Wernicke's aphasia is a consequence of their length and high frequency; no differences were identified in the reading of content and function words, matched for frequency and length.

Kleist (1916) proposed that paragrammatism was characterised by the production of substitution errors in the realisation of grammatical morphemes. Wernicke's aphasics confuse rather than omit the grammatical aspects of speech; they retain the ability to access the appropriate class of function word but do not have sufficient access to semantic information to distinguish between items within that category (Friederici 1981). In a subsequent study, Friederici (1982) demonstrated that subjects with Wernicke's aphasia were more impaired in their retrieval of lexical prepositions than syntactic obligatory prepositions. The results of these studies is consistent with a central semantic deficit. Subsequent investigations of the errors in paragrammatic speech have, however, also observed omission errors (Berndt 1991, Butterworth and Howard 1987).

Goodglass and Kaplan (1983) suggested that fluent subjects were not impaired in the constructional aspects of sentence production, with clausal and phrasal complexity preserved. Butterworth and Howard's (1987) paragrammatic speakers produced an extensive range of complex syntactic structures. Many studies have, however, challenged this apparent preservation of complex sentence structure. Analyses of spontaneous speech samples from some fluent aphasics have shown the use of less complex constructions than normal subjects, with fewer embedded and relative clauses (Gleason et al 1980, Edwards 1995, Bastiaanse, Edwards and Kiss 1996, Edwards and Bastiaanse 1998), a decreased range of grammatical structures (Gleason et al 1980) and difficulty using grammatical devices to link clausal and phrasal structure (Edwards 1995). Bastiaanse et al (1996) and Edwards and Bastiaanse (1998), in their cross-linguistic studies of spontaneous speech production, identified similar patterns of grammatical deficit in English, Hungarian and Dutch fluent aphasics. Martin and Blossom-Stach (1986) in their examination of the spontaneous speech and writing of a mild, Wernicke's aphasic, WS, also demonstrated discrete syntactic deficits. WS produced few embedded clauses, despite an adequate range of sentence structure. In addition, WS displayed difficulty in associating meaning and surface form, resulting in the mis-ordering of words and the exchange of sentence constituents. These difficulties resembled those of agrammatic subjects in the production of reversible sentences.

Paragrammatism is, therefore, considered to be a characteristic speech pattern associated with Wernicke's aphasia. Paragrammatic speech is characterised by the substitution (and occasional omission) of grammatical morphemes. In some patients, there is also a restricted use of complex clauses and phrases. It is not clear to what extent these syntactic deficits are characteristic of all paragrammatic speakers. As with the syndrome of agrammatism, individual subjects may vary in the extent to which morphological and syntactic deficits co-occur and their occurrence with other features of Wernicke's aphasia. Some fluent aphasic subjects display features of performance more frequently associated with non-fluent, agrammatic speech.

### 1.2.2 Theories of Paragrammatism

The lack of studies which have systematically investigated speech production in fluent aphasic subjects has led to a scarcity of theories explaining the observed deficits and their relationship to other aspects of Wernicke's aphasia. Butterworth and Howard (1987) suggested that theories of paragrammatism fall into four categories:- lexical accounts, syntactic accounts, monitoring accounts and control processing accounts.

#### a) Lexical Accounts of Paragrammatism

The lexical accounts of fluent sentence production propose that the sentential features are a consequence of lexical difficulties (Bates et al 1991, Bird and Franklin 1996). Paragrammatism, in Wernicke's aphasia, is therefore considered to be an additional consequence of the semantic impairment which dominates in subjects with Wernicke's aphasia. Word retrieval deficits may result in the omission of obligatory sentence components, extended repair sequences within sentences and poor realisation of sentences with increasing numbers of components (see Berndt and Caramazza 1981 for discussion of the relationship between word retrieval and sentence construction). Friederici (1981, 1982) suggested that semantic deficits can account for the deficits seen in Wernicke's aphasics in the production of prepositions. Semantic deficits were reported to result in poor access to and comprehension of lexical prepositions. Martin and Blossom-Stach (1986) acknowledged that semantic deficits may account for the errors relating to the production of some function words, for example, pronouns and prepositions which encode some semantic information.

The validity of lexical accounts of paragrammatism has, however, been questioned by the presence of deficits in paragrammatic speech which cannot be accounted for by lexical semantic difficulties and the independence of lexical and constructional deficits. It is unclear how a semantic deficit could account for errors in the production of those function words fulfilling a purely structural role (Martin and Blossom-Stach 1986). Lexical deficits also fail to explain the presence of the word order errors and constituent exchanges in the speech of WS (Martin and Blossom-Stach 1986). Butterworth and Howard (1987) suggested that if lexical deficits are responsible for the production of paragrammatisms, the incidence of paragrammatisms should be associated with the incidence of lexical selection deficits, as shown by the presence of

neologisms. This correlation between the rate of neologisms and paragrammatisms was not evident in the spontaneous speech of the four paragrammatic subjects described in their study. Edwards and Bastiaanse (1998) reported an apparent dissociation between lexical abilities, as measured by the type token ratio for nouns and verbs, and the ability to produce appropriate sentence structure. Subjects were identified who had good lexical skills, in terms of the number of nouns and verbs produced, but who showed discrete syntactic impairments in their production of complex phrases and clauses. Lexical difficulties may account for some of the features of paragrammatic speech, but some subjects appear to have additional difficulties which cannot be explained by lexical semantic deficits.

**b) Syntactic Accounts of Paragrammatism**

The syntactic accounts of paragrammatism suggest that the sentential features are a consequence of syntactic impairments. Initial characterisations of paragrammatism (Kleist 1916, Pick 1931) were syntactic accounts; these accounts proposed that paragrammatic speech resulted from difficulties activating or inhibiting appropriate sentence frames. Butterworth and Howard (1987) suggested that these syntactic deficits could be conceived as the loss of rules used in the generation of phrasal and clausal structure. Recent evidence of the reduced use of complex, embedded clauses (Gleason et al 1980, Bastiaanse et al 1996, Edwards and Bastiaanse 1998) provides some support for this syntactic account of paragrammatism. Grodzinsky and Finkel (1996) have provided additional evidence that some fluent patients exhibit syntactic deficits. In their study, it was demonstrated that in a grammaticality judgement task, Wernicke's subjects were impaired in their identification of syntactic anomalies. It is, however, unclear to what extent these results are a consequence of the lexical semantic comprehension deficit. Syntactic deficits may occur alongside lexical deficits.

The validity of syntactic theories of paragrammatism has been questioned by the apparent preservation of some syntactic abilities and the presence of content word errors. Experiments by Zurif, Swinney, Prather, Solomon and Bushell (1993) and Shapiro, Gordon, Hack and Killackey (1993) investigating the comprehension of Wernicke's aphasics proposed that despite poor access to the semantic and thematic properties of verbs, subjects were sensitive to syntactic properties of sentences, for

example, syntactic traces. Butterworth and Howard (1987) suggested that the syntactic account predicts that the processing of function words would be more impaired than the processing of content words and the resulting paragrammatisms would differ in character to normal errors. These predictions were not confirmed by their analysis of the errors produced by the four fluent aphasic subjects studied. The paragrammatisms seen in the fluent patients affected the production of both content and function words and resembled those of the normal speakers. Butterworth and Howard (1987) therefore, concluded that there is little evidence to support the loss of grammatical knowledge in paragrammatism.

**c) Monitoring Accounts of Paragrammatism**

The monitoring accounts propose that paragrammatism results from a failure to monitor speech output. This failure to monitor speech results in the production of errors, which would edited out by normal speakers. It is suggested by some current models of language processing (Ellis et al 1983, Levelt 1989) that the same processes are involved in the monitoring of our own speech as in the comprehension of the speech of others. These accounts, therefore, see paragrammatic output as an additional consequence of the semantic impairment evident in sentence comprehension. Butterworth and Howard (1987) pointed out that this hypothesis suggests that all subjects with paragrammatism should also have a comprehension deficit. Their analysis of four fluent patients, however, found no significant correlation between the degree of comprehension impairment and the frequency of paragrammatisms in speech. It was thus concluded that monitoring accounts could not explain the speech production errors seen in their fluent aphasics.

**d) Control Processing Accounts of Paragrammatism**

The control processing accounts state that paragrammatism results not from lexical or syntactic deficiencies but from a more general cognitive impairment (Butterworth and Howard 1987, Butterworth, Panzeri, Semenza and Ferreri 1990). The control processing accounts arose from the observations that paragrammatic speech is qualitatively (if not quantitatively) similar to that of normal speakers. The morphological deficits seen in fluent paragrammatic patients were similar in nature to normal slips of the tongue, but occurred with increased frequency. Grammatically

complex sentence structures are present in paragrammatic speech, showing that subjects are able to produce these forms, but not in the same frequency as normal speakers (Gleason et al 1980, Edwards and Bastiaanse 1998). Edwards and Bastiaanse (1998) suggest that a reduction in processing resources could account for this limited capacity to use complex forms, although they prefer syntactic accounts. In a similar way, Zurif et al (1993) and Shapiro et al (1993) proposed that reduced processing abilities could explain Wernicke's aphasic comprehension performance. It was proposed that the increased processing resources needed to access certain verbs resulted in impairment, whilst performance on less complex verbs was maintained. Butterworth and Howard (1987) suggested that paragrammatisms result from transient malfunctions of the control processes which regulate the components of the normal language processing system. These control processes are thought to initiate and terminate operations within a module and co-ordinate activity between modules. Defective control processes result in an increased number of normal speech errors.

### 1.2.3 Conclusion

Paragrammatism reflects a pattern of speech which varies in its characteristics and the extent to which it can be accounted for by the semantic deficit which is prominent in Wernicke's aphasia. Further characterisations of the speech of fluent speakers are needed to investigate the extent to which paragrammatic speech resembles that of normal and agrammatic speakers. Evidence that paragrammatic speech has features not associated with normal speakers would question the validity of the control processing accounts and may support the presence of syntactic deficits in some subjects. It is likely that paragrammatism, like agrammatism, is a heterogeneous disorder with some variability in the deficits evident in individual subjects.

## 1.3 Agrammatism and Paragrammatism

The characterisation of sentence production difficulties in aphasia within the syndromes of agrammatism and paragrammatism has been challenged by the variability within the syndromes and the apparent overlap of symptoms across the two syndromes. The speech of agrammatic and paragrammatic speakers differs in terms of

fluency, but there is a lot of overlap in the morphological errors made. In the production of function words and inflections, the two groups do not differ in the number and type of errors made (Goodglass and Mayer 1958, Goodglass 1968). Agrammatic speakers have been found to make substitution errors (Kolk and Heeschen 1992) and some paragrammatic speakers omit rather than substitute grammatical morphemes (Berndt 1991, Butterworth and Howard 1987). Goodglass, Christiansen and Gallagher (1993) found no difference in the performance of agrammatic and paragrammatic aphasics in their comprehension of morphology. As previously outlined, deficits in verb retrieval (Berndt et al 1997a) and syntactic comprehension (Caramazza and Zurif 1976) have also been identified in both fluent and non-fluent speakers. Heeschen and Kolk (1988) proposed that the sentence production deficits in Broca's and Wernicke's aphasics are the consequence of the same underlying impairment. They suggested that in both cases the impairment symptoms are substitution errors; the omission errors in agrammatism resulting as a consequence of adaptation. It was suggested the lack of adaptation in Wernicke's aphasics may reflect a lack of awareness or unconcern about their aberrant speech. Alternatively, sentence production deficits in aphasia may be considered the result of damage to distinct aspects of processing, which occurs with varying frequency alongside damage to other processes. This concurrent damage results in the characteristic patterns of performance associated with agrammatic and paragrammatic speech. Deficits can, however, occur independently and alongside other difficulties. A detailed study of the sentence production deficits evident in fluent and non-fluent patients, compared to normal performance, would help to determine the degree of similarity and dissimilarity between speakers (Martin and Blossom-Stach 1986).

## 1.4 Studies of Sentence Production in Subjects with Aphasia

Many of the original studies into the syndromes of agrammatism and paragrammatism were group studies, focusing on the similarities between subjects within the groups. Group studies attempt to capture the systematic regularities which are evident in performance. This facilitates the search for general theories and unitary explanations of performance (Grodzinsky 1991). The use of mean scores, however, masks individual variability in performance and differentiable patterns of disorder are

difficult to identify from group studies (Howard 1985). Individual case studies have highlighted the variability in individual performance and the dissociations between different aspects of performance. In-depth investigations of single subjects with aphasia can also provide information about the nature of the normal language system (Saffran 1982). Saffran suggested the study of a damaged system provides insight into processes which are often difficult to observe in a normal system. Data obtained from the analysis of sentence production deficits is thus a rich source of input to psycholinguistic models of production, helping to define and re-define models of normal processing (Schwartz 1987, Maher, Chatterjee, Rothi, Gonzalez and Heilman 1995). The identification of dissociations between aspects of performance (and in particular double dissociations) has been used as evidence of separate processing components. Multiple symptoms result from damage to more than one component within the language system (Marshall, Pring and Chiat 1993).

Both group and individual case studies can contribute to the understanding of sentence production deficits in aphasia. Group studies identify trends in performance which provide information about the nature of normal processing. In-depth analyses of individual subjects allow the identification of dissociations between aspects of performance, giving insight into the distinct processing mechanisms which contribute to performance. This study will combine group studies and the detailed analysis of individual subjects. Group studies of spontaneous speech will be used to capture regular patterns of performance and test specific hypotheses relating to the production of thematic and phrasal structure. Individual case studies will be used to investigate the nature of processes which contribute to sentence production in normal speakers and their impairment in aphasia. Individual case studies will also be used to determine whether similar patterns of performance are a consequence of different underlying impairments.

## 1.5 A Cognitive Neuropsychological Approach to Sentence Production

Models of sentence processing provide a framework for the analysis of aphasic disorders. There has been a recent move in the assessment and treatment of language disorders towards a cognitive neuropsychological approach. The aim of this approach is to discover the underlying cause of the linguistic difficulties by analysing the

disordered language in relation to models of normal language production. Normal sentence processing models provide a framework for interpreting the outward symptoms in terms of damage to underlying processes (Mitchum and Berndt 1994). The identification of the underlying impairment allows predictions to be made about the likely co-occurring deficits in production and comprehension. The identification of the underlying deficit also allows treatment to be targeted more effectively and the likely effects of that treatment to be determined. Saffran (1982) highlights that in using models of normal production to describe aphasic speech, there is an assumption that aphasia reflects a loss of processing components present in the normal system. Performance may, however, also reflect any adaptation to that disruption (Caplan 1986, Kolk and Heeschen 1990). The performance observed in aphasic speech production is thus a combined result of the damaged system (both in terms of aspects damaged and aspects spared) and the subjects' adaptation to the damage. It is possible that in some cases, adaptation may mask the true nature of the underlying impairment (Kolk and Heeschen 1990). It is, therefore, important to consider the possible effects of such strategies on observed performance.

### 1.5.1 A Model of Normal Speech Production

Garrett (1980, 1982) developed a model of normal sentence production based upon an analysis of a corpus of normal speech errors. This model conceived sentence production as a series of independent processing levels, each corresponding to a level of linguistic representation. The message level representation corresponds to a non-linguistic conceptual level which specifies the features of the event. The functional level representation corresponds to the thematic structure of the sentence; this specifies the verb and its arguments. The positional level representation specifies the syntactic and phonological structure of the sentence. The phonetic level representation specifies the phonetic information used in the articulation of the sentence. Garrett's model proposes that these independent levels of processing can be selectively impaired. At the broadest level of distinction, impairment may result in message, functional, positional or phonetic level deficits. These distinctions are descriptive labels which correspond to deficits in the specification of the event, the production of thematic structure, the specification of phrasal structure and the realisation of phonetic

form respectively. Multiple deficits are the consequence of impaired processing at more than one level. In the assessment and treatment of aphasic sentence production deficits, it is important to identify the underlying impairment. It is, therefore, necessary to specify the processes involved in the production of each level of representation, as it is likely that these processes can be damaged selectively, with different implications for performance (Caramazza and Hillis 1989).

Garrett restricted his characterisation of sentence production to what could be inferred from the speech error data; the processes involved in the production of these levels of representation were, therefore, left unspecified (Caramazza and Hillis 1989). Schwartz (1987) elaborated Garrett's model, by suggesting the processes which operate to form each level of structure. This model can be seen in figure 1.1 and is described below. Schwartz (1987) proposed that the following processes were involved in sentence production. The non-linguistic message level specifies the information to be conveyed about an event, its participants and timing and the speaker's perspective on that event. The conceptual information derived from encoding the event triggers a series of steps entitled the logical and syntactic processes. These processes are detailed in figure 1.2. A initial lexical search based on the semantic form and the grammatical category of the word is performed. A predicate-argument structure (PAS) is then specified; this is a conceptual representation which determines the number and type of arguments associated with a verb. The predicate refers to the concept which specifies the action or relation; the arguments refer to the concepts identifying the participants in the event (Byng and Black 1989). The semantic role played by each of the arguments is described as its thematic role. Definitions of the common thematic roles can be found in appendix 1. Lexical items are assigned to each of the thematic roles. The resulting representation at the functional level thus specifies the major lexical content and the meaning relations between items. The PAS can be translated into several different syntactic structures. Syntactic and phonological processes are then initiated; these are detailed in figure 1.3. A second lexical search retrieves the phonological form of the lexical items. A syntactic frame for the sentences is then created; this frame specifies the grammatical morphemes and contains slots in which the lexical items are inserted. The positional level of representation is, therefore, produced which includes phonologically specified items inserted in a syntactic frame with both the lexical and

grammatical content present. The regular phonological processes and the motor coding processes which follow are involved in the specification of phonetic form and the subsequent articulation of the sentence.

The sub-processes suggested by Schwartz (1987) provide some insight into what processes may be involved in the production of each level of linguistic structure but these are not supported by the speech error data and have not been tested experimentally. The comprehensive assessment of subjects with aphasia provides a means of investigating the presence of these sub-processes. The study of aphasic sentence disorders may also provide information about the extent to which processing at each level interacts. Schwartz' elaborated model predicts that certain patterns of deficit may be evident in sentence production. Dissociations may exist between the retrieval of content words and the retrieval of function words as these occur at different locations in the processing system (Caramazza and Hillis 1989). There is a two stage retrieval of content words, based on the retrieval of semantic information at the functional level and phonological information at the positional level. Word retrieval deficits may, therefore, be a consequence of a breakdown at either the functional or positional level or at both levels (Ellis et al 1983). In contrast, function words are only retrieved as part of the syntactic frame, in the creation of the positional level of representation. Although, function words encode some semantic information, they are not retrieved in the production of the functional level representation. Inflections are also retrieved as part of the syntactic planning frame. No distinction is made between the production of noun, verb, adjectival or prepositional phrases in the production of the positional level representation.

**Figure 1.1: A model of normal sentence production (Schwartz 1987)**

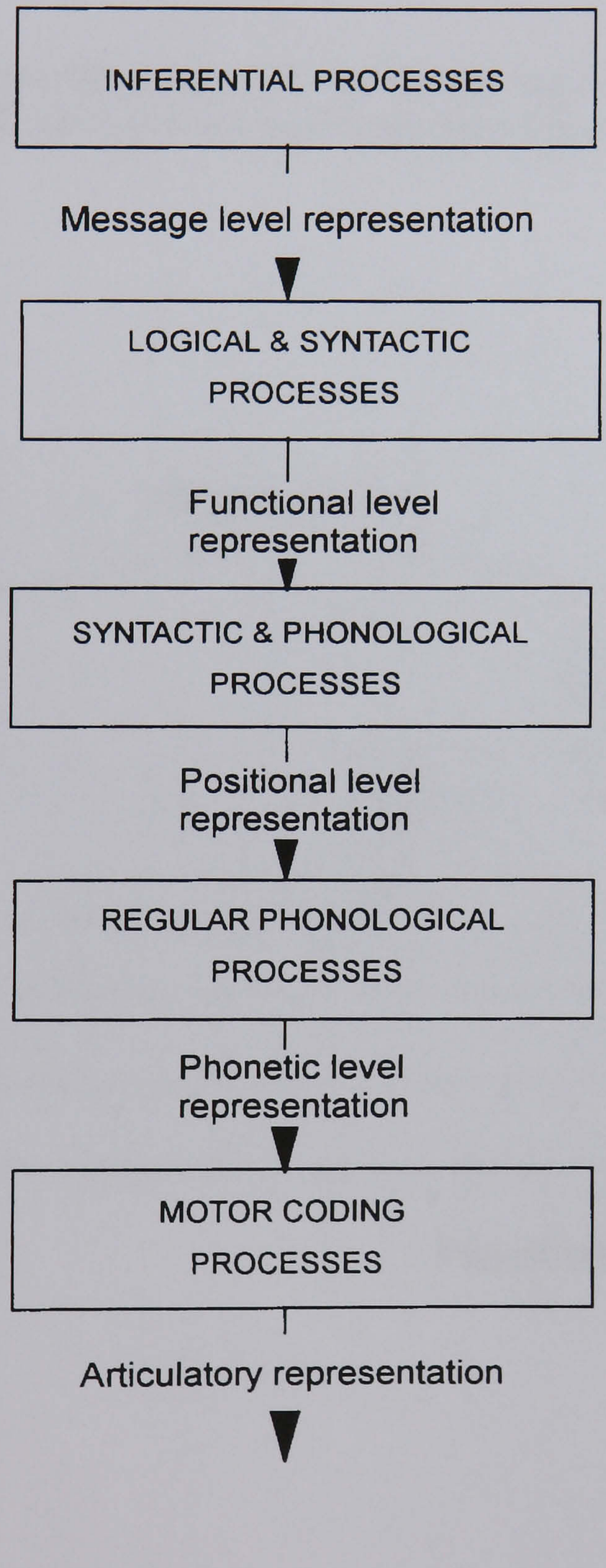


**Figure 1.2: Diagram illustrating the processes involved in the production of the functional level representation (Schwartz 1987)**

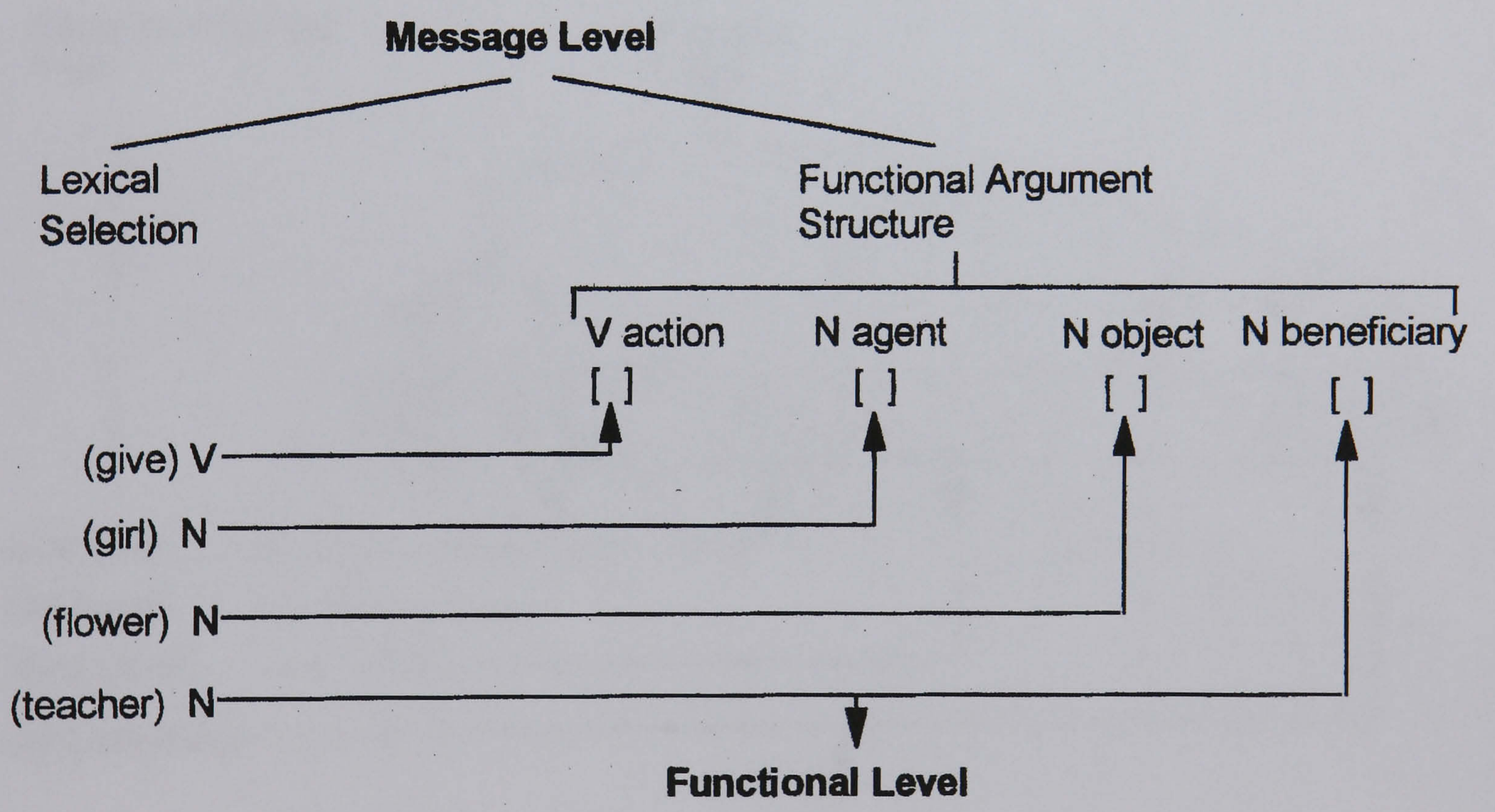
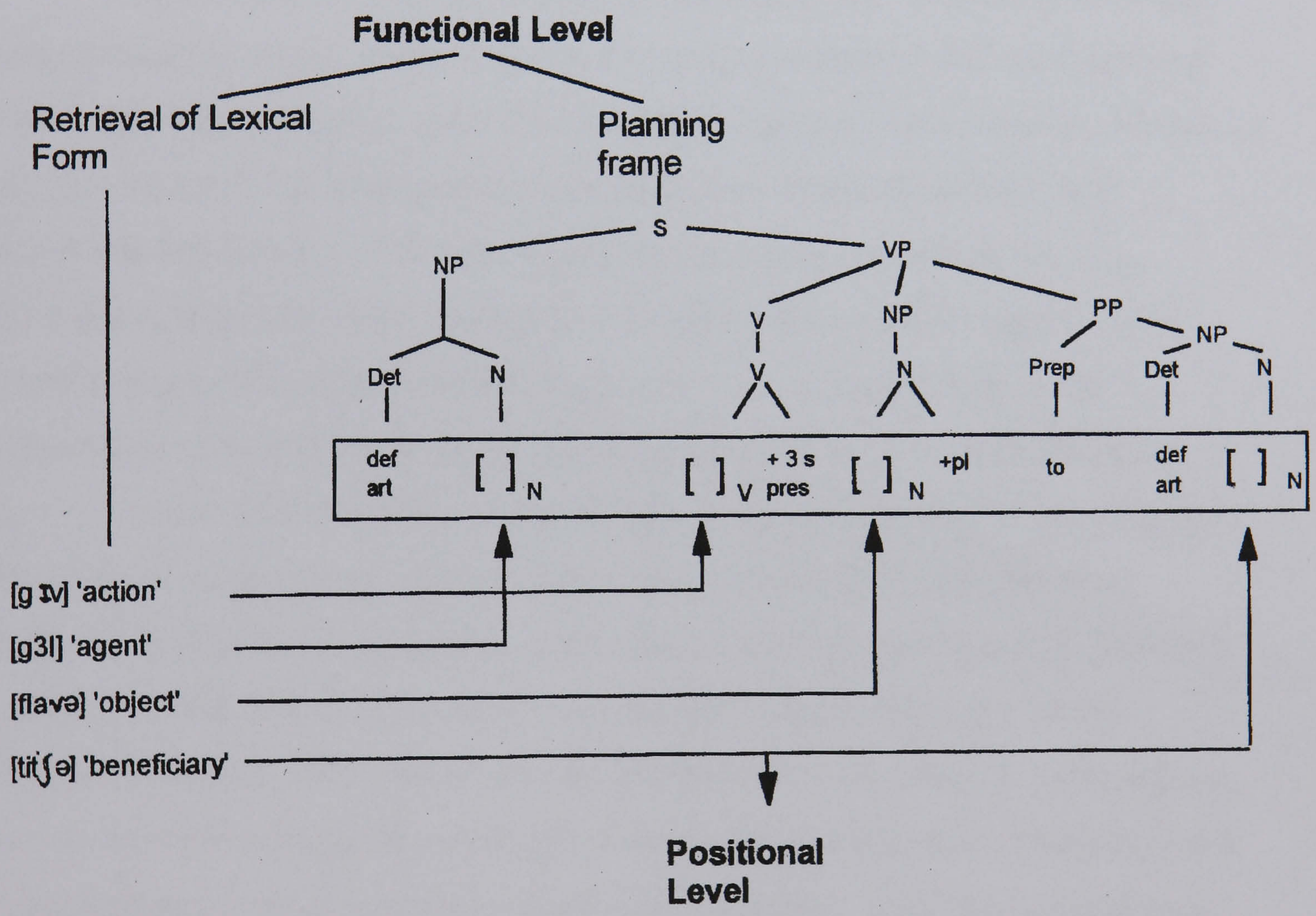


**Figure 1.3: Diagram illustrating the processes involved in the production of the positional level representation (Schwartz 1987)**



### 1.5.2 Sentence Production Deficits in Subjects with Aphasia

Garrett's model has been used as framework to describe the deficits seen in some individual aphasic subjects. Poor specification of the message level representation affects a person's ability to encode those events linguistically. Nickels, Byng and Black (1991) and Marshall et al (1993) have suggested that some aphasic sentence production difficulties are a consequence of event perception abilities. It is argued that an inability to extract the relevant features of an event may result in impaired verb selection and thematic role difficulties. The observed effects of these impairments mirror the effects of thematic role assignment and mapping difficulties (see section 1.7.4).

Of particular interest in the description of the deficits seen in agrammatism and paragrammatism are the processes involved in the production of the functional and positional levels of representation. The proposed difference in the retrieval of function and content words has been used as a general account for the difficulties with grammatical morphemes seen in both agrammatic and paragrammatic speakers (Caramazza and Hillis 1989, Goodglass et al 1993). These authors suggested that inadequate activation of the syntactic frame results in poor production of the grammatical content of the sentence. The lexical deficits seen in paragrammatism have been associated with additional difficulties in the dual retrieval of semantic and phonological information (Ellis et al 1983). These lexical difficulties result in problems associating the functional and positional levels of representation, and thus, may result in difficulties with sentence construction (Menn, Powelson, Miceli, Williams and Zurif 1982; cited in Martin and Blossom-Stach 1986). In agrammatism, poor verb retrieval, impaired mapping between thematic and syntactic roles and word order problems in some subjects have led some researchers, such as Caramazza and Miceli (1991), Jones (1986) and Maher et al (1995), to conclude that functional level deficits predominate. In other agrammatic subjects, poor phrasal elaboration and the omission of grammatical morphemes have resulted in the level of deficit been located at the positional level (Berndt and Caramazza 1980, Caramazza and Hillis 1989). Other researchers, for example Saffran et al (1980b), have proposed that the functional and positional level representations are adequately specified by some agrammatic and paragrammatic speakers, but that deficits in subsequent phonetic

processing result in poor realisation of morphemes. The precise processes which are thought to be impaired are not precisely specified in the descriptions of these patients.

## 1.6 Verb Retrieval And Sentence Production

Garrett's model suggests that the verb has a central contribution to sentence production. Lexical entries of verbs contain information which determines the semantic and syntactic character of the sentence in which the verb is embedded. This information is thought to include a word's syntactic category, argument structure, thematic information and syntactic sub-categorisation information (Shapiro, Brookins, Gordon and Nagel 1991). The nature of the relationship between verb retrieval deficits and sentence production difficulties has been explored in relation to this lexically specified information. Lexical accounts of sentence production deficits suggest that lexical deficits for verbs result in impaired sentence production. The presence of dissociations between verb retrieval and sentence production difficulties has, however, questioned the validity of these lexical accounts. Patients have been identified who have difficulty with verbs but who do not have sentence production difficulties (Caramazza and Hillis 1991) and Berndt et al (1997c) described a patient who had no verb retrieval deficit, but had severe sentence production difficulties. A revised account of the relationship between verb and sentence deficits has been proposed by Marshall, Pring and Chiat (1998). The 'refined lexical hypothesis' suggests that sentence production difficulties are a consequence of verb retrieval deficits, but proposes that there is differential access to lexical information; the precise nature of the sentence production difficulties depends on the information which cannot be accessed. It could be argued that the presence of dissociations between verb retrieval and sentence production also argues against this hypothesis. In contrast to the lexical hypothesis, however, this hypothesis does not suggest a complete loss of information. It may be that in the presence of impaired access to certain lexical information, other aspects may partially compensate for what is lost. In this way, sentences may be generated even with the loss of some lexically specified information.

Lexically specified information may be used alongside general processes in the production of different levels of representation (Byng, Nickels and Black 1994).

Schwartz's (1987) model suggests PAS and thematic information is accessed alongside semantic information in the production of the functional level of representation. In contrast, syntactic sub-categorisation information is used alongside phonological information in the assembly of the syntactic frame at the positional level of representation. The following sections will review the apparent role of lexically specified information and the processes involved in the production of the functional and the positional levels of representation. The patterns of deficit resulting from impaired access to lexical information and impaired processing at each level will be discussed.

## 1.7 The Production of the Functional Level Representation

The production of the functional level representation is thought to involve three distinct processes:- the retrieval of semantic representations, the retrieval of the predicate-argument structure and the assignment of thematic roles to the lexical items (Schwartz 1987). The functional level representation is considered to be a conceptual representation, based around the verb and its arguments; it precedes the specification of surface form. The production of the functional level representation relies on access to semantic and PAS information. The following sections will outline the processes involved and the deficits seen in aphasic patients, relating to each of these aspects of performance.

### 1.7.1 The Retrieval of Semantic Information

Garrett's model suggests that at the functional level representation, semantic representations are retrieved for the major lexical items within the sentence. Semantic representations consist of a set of conceptual conditions; representations are retrieved if the requirements of the message match these conditions (Levelt 1992). In relation to verbs, this semantic specification has been described as the core meaning of the verb (Marshall, Chiat and Pring 1997); it details the type of the event the verb encodes and the features of that event. For example, the core meaning of the verb 'eat' specifies 'to take into the mouth and swallow food'. A person's perspective on an event at the message level influences verb selection as verbs do not give equal prominence to

participants in the event. The core meaning of the verb imposes certain restrictions on the selection of accompanying arguments, for example, with the verb 'eat' one of the arguments must be edible. These constraints are called semantic selection restrictions (Marshall et al 1997).

Semantic information is considered to be central to production and comprehension; semantic impairments, therefore, result in parallel impairments to both aspects of processing. The semantic system is thought to be organised on the basis of syntactic category, and thus, selective deficits of nouns and verbs may be identified (Zingeser and Berndt 1990). Semantic deficits affect both single word and sentence processing. If a particular noun cannot be retrieved within a sentence, obligatory verb arguments may be omitted. Verb retrieval deficits at a semantic level have been reported to result in the production of semantic paraphasias and the production of light verbs (Berndt et al 1997b, Breedin and Martin 1996). Berndt et al (1997b) proposed that light verb use reflected a preserved sensitivity to the need for a verb, with a reliance on high frequency and low semantic verbs. In the absence of a specified verb, the phonological representations of light verbs (which resemble auxiliaries) may be activated as part of the syntactic frame. Breedin, Saffran and Schwartz (1998) investigated the effect of semantic complexity on verb retrieval, by contrasting the retrieval of general versus specific verbs and semantically heavy and light verbs. They found that semantically rich verbs were retrieved more accurately than light, general verbs. It was proposed this reflected the increased number of perceptual features possessed by specific verbs, resulting in more complex semantic representations. They suggested that the observed increase in light verb production in some patients reflected the use of an adaptive strategy; a reliance on a small set of accessible verbs. Their study was restricted to the analysis of non-fluent subjects; the performance of fluent aphasic subjects was not investigated. It has been proposed that verb retrieval deficits at this level may also have detrimental effects on the production of sentence structure (Berndt et al 1997a). It is, however, unclear to what extent these deficits may be a consequence of poor access to PAS information. Semantic verb deficits have been identified in the presence of preserved access to phonological information, thematic role assignment and access to syntactic sub-categorisation information.

### 1.7.2 The Predicate Argument Structure

The predicate argument structure specifies the number of arguments required alongside a verb and the thematic roles that these arguments fulfil. The PAS, therefore, specifies the semantic structure of a sentence (Shapiro, Zurif and Grimshaw 1987). The extent to which PAS information is a component of a verb's overall semantic representation has not been investigated. The PAS may be coded alongside the verb's core meaning and semantic selection restrictions. No studies have demonstrated differential access to semantic and PAS information.

The PAS for the verb 'eat' specifies that it requires two arguments, one to be the agent who does the eating, one to be the patient, the item which is eaten. Some verbs have an obligatory (fixed) predicate-argument structure, i.e. they can only be used in a particular argument structure. For example, the verb 'fetch' can only be used in a two argument structure, with an agent and a patient, 'the woman fetched the shopping'. Other verbs have optional (variable) predicate-argument structures, i.e. they can be used in more than one argument structure arrangement. For example, the verb 'bake' can be used as both a one argument structure with only an agent, 'the woman is baking', or as a two argument structure with both an agent and a patient, 'the children baked a cake'. It is of interest whether verbs with different PAS arrangements constitute the same lexical item or whether they should be considered as separate lexical entries. In the above example, 'bake' seems to have a very similar core meaning, whether it is used in its one or two argument form. In other cases, however, the different argument structures seem to portray different events, for example, 'he is going mad' 'he is going to the shop'. In the first example, the verb specifies the event 'becoming', in the second, it specifies the event of 'moving'.

As previously highlighted, semantic selection restrictions govern the lexical items which can fulfil arguments within the PAS. A verb's semantics and its effect on the PAS may contribute to the complexity of verb processing (Jones 1984, Breedin et al 1998). Jones (1984) suggested that the ability of aphasic subjects to understand reversible sentences was related to the verbs they contained. The degree of difficulty seemed to be a consequence of the predicate structure of the verbs. Aphasic subjects were shown to have increased difficulty with directional motion verbs, in comparison with non directional motion verbs and non-motion verbs. Jones (1984) suggested that non-motion verbs and non-directional verbs are inherent verbs which encode actions

which are properties of the agent alone; their meaning is independent of the other entities in the sentence. Directional motion verbs, on the other hand, are relational verbs which code the relationships between entities. Comprehension of sentences including these verbs thus requires the decoding of both the noun phrases and the relationship between them. In addition, relational verbs code prepositional information which must be accessed, thus adding to the complexity of the predicate. A second experiment showed that the addition of the preposition resulted in near-normal comprehension performance. Jones, therefore, suggested that the difficulties with directional motion verbs resulted from accessing the prepositional information at a lexical semantic level.

Predicate argument structure complexity may also be influenced by the number of arguments associated with the verb and/or the number of different PAS arrangements. Shapiro and colleagues in series of experiments with normal subjects (Shapiro et al 1987, Shapiro, Zurif and Grimshaw 1989) showed that the processing complexity of a verb during sentence comprehension (as indicated by reaction time in a dual task paradigm) was dependent on the number of different PAS arrangements. They suggested that this resulted from the momentary activation of all possible PAS arrangements. In contrast, the number of arguments and the number of syntactic sub-categorisation frames associated with a verb were not found to influence reaction times. Shapiro and Levine (1990) showed that Broca's aphasics showed the same sensitivity to PAS structure as the normal subjects. Other researchers, for example Schmauder (1991) and Ahrens and Swinney (1995) have failed to replicate the effect of the number of PAS arrangements in comprehension. Ahrens and Swinney (1995) suggested that it is the number of thematic roles associated with the central sense of the verb which governs its processing complexity; the greater the number of thematic roles the more complex the verb. They proposed that during comprehension of a verb, the person has access to the central sense of the verb and the thematic properties associated with that central meaning.

Normal subjects are able to produce appropriate PAS for verbs with an increased number of arguments and an increased number of PAS arrangements (Thompson, Lange, Schneider and Shapiro 1997). It is, however, unclear to what extent for verbs with variable argument structures, the various PAS arrangements are activated. Momentary activation of the multiple PAS arrangements in production may be less

likely than in comprehension; the choice of PAS in production is to a large extent governed by the number of participants in the event. Thompson et al (1997) investigated the production of argument structures by agrammatic subjects. They concluded that the aphasics preferentially produced verbs with simple argument structures both in terms of fewer PAS arrangements and fewer arguments. It was suggested that when a verb has a single PAS arrangement, retrieval is uncomplicated; when a verb has more than one PAS arrangement, a choice between alternatives has to be made, increasing processing complexity. In contrast, Edwards and Bastiaanse (1998) suggested that verbs sub-categorised for few rather than several argument structures were more difficult for fluent aphasic subjects. There is, however, little evidence for this preference in the data reported in their study. Aphasic subjects have been reported to have difficulty producing sentences with an increasing number of arguments (Thompson et al 1997, Schwartz et al 1995, Whitworth 1995b). These difficulties may, however, be a consequence of the increased number of lexical items, difficulty accessing the PAS or difficulty assigning thematic roles.

Investigations into the retrieval of PAS information and its use in sentence production in subjects with aphasia have been limited. In spontaneous speech, Thompson et al (1997) suggested that the reliance on simple one and two argument structures may reflect difficulties in accessing PAS information. Thompson et al (1997) found that aphasic subjects were unable to produce all the argument structure arrangements associated with the verb, particularly those requiring sentential complements. Difficulties accessing PAS information may also result in the production of sentences with an inappropriate number of arguments or the production of arguments fulfilling inappropriate thematic roles. Systematic investigations of the production of different PAS arrangements in more constrained tasks have not been reported in the literature. Investigations into the production of appropriate syntactic structures have , however, been carried out (for example, Breedin and Martin 1996, Marshall et al 1997). The production of appropriate sentences in these tasks also relies on the retrieval of PAS information. Assuming PAS information is central to comprehension and production, parallel deficits should be observed in sentence production and comprehension. The comprehension of and ability to detect PAS anomalies in sentences with differing PAS arrangements has not been investigated. Some studies have, however, investigated the ability of subjects to detect structural

violations in grammaticality tasks (Marshall et al 1997, Marshall et al 1998, Breedin and Martin 1996). As in sentence production, it is proposed that these tasks may reflect access to PAS information alongside access to syntactic information.

### 1.7.3 The Production of Non-arguments

In addition to the production of the PAS, sentences often involve the production of non-arguments. Non-arguments are defined 'not arguments of predicates; they place restrictions or qualifications on the predicate and its arguments, or give additional information about the participants in the situation and the speaker's perspective on it' (Byng and Black 1989, p244). Non-arguments typically give additional information about time, manner or place; by definition, they never specify obligatory information. Byng and Black (1989) outlined two linguistic-based differences between arguments and non-arguments. Firstly the syntactic realisation of non-arguments is not determined by the verb, and secondly, the principles which govern word order do not apply equally to arguments and non-arguments; non-arguments have much more freedom in their position in the sentence. These differences may suggest that different mechanisms are used in the production and comprehension of arguments and non-arguments.

Garrett's model of sentence production gives no account of the production of non-arguments; the production of the functional level representation revolves around the PAS. Non-arguments contain major lexical items, whose semantic representations must be retrieved; it is thus difficult to conceive that non-arguments are not represented within the functional level representation. The production of non-arguments, relative to the production of verb arguments, by normal subjects has not been investigated. There has been some evidence from the study of aphasic performance which suggests that functional level processing is sensitive to the argument status of sentence components. In some subjects with aphasia, differential production of verb arguments and non-arguments has been identified. In spoken production, Shapiro and Levine (1990) found that more verb arguments were produced correctly than adjuncts. Shapiro, McNamara, Zurif, Lanzoni and Cermak (1992) found that the sentence repetition performance of subjects with amnesia was sensitive to the argument status of the phrases. Subjects differentially benefited from

the presence of argument and adjunct prepositional phrases; sentences containing verb arguments were repeated with greater accuracy than those containing non-arguments. Byng and Black (1989) suggested that non-arguments were easier to produce than verb arguments by some subjects with aphasia. They analysed the realisation of the PAS of sentences in a narrative task. In some cases, non-arguments were produced despite the omission of verb arguments. Martin and Blossom-Stach (1986) investigated the production of verb arguments and non-arguments in the spoken and written output of a single fluent aphasic subject, WS. Their data revealed that adjuncts (non-arguments) moved to fill unrealised verb arguments. They suggested that this reflected a preferential processing of verb arguments and the necessity of all verb argument slots being filled if the sentence is to be produced. It is, however, suggested that this may merely reflect the increased ease of non-argument production. The differential production of arguments and non-arguments in subjects with aphasia needs more extensive study in relation to the performance of normal subjects.

### 1.7.4 Thematic Role Assignment and Mapping

Schwartz (1987) suggested that the final process in the production of the functional level representation is the assignment of thematic roles to lexical items. The thematic roles associated with a particular verb are specified as part of the PAS information. Individual lexical items are assigned to the thematic role of agent, patient etc. according to the part they are playing in the event. This places the items in the form of 'who is doing what to whom or what' (Whitworth 1994). In some cases, semantic selection restrictions and real world knowledge govern the roles which the lexical items can fulfil. For example, in the non-reversible sentence 'the man drives the car', the thematic roles which 'man' and 'car' are likely to fulfil are governed by the facts that people drive things and cars are driven. In the production of reversible sentences, such pragmatic information is not available to aid thematic role assignment. Garrett's model suggests that thematic role assignment precedes the specification of surface form; it is a mapping of lexical items with the thematic roles specified in the PAS. The same functional level representation can be translated into sentences with different surface forms. It is, however, difficult to assess thematic role

assignment in sentence production without considering the subsequent realisation of those thematic relationships in the surface form of the sentence.

The association of sentence meaning and surface form has been described as mapping (Saffran et al. 1980a, Schwartz et al 1980). Mapping lies at the interface of semantics and syntax (Whitworth 1994). Byng et al (1994) described mapping as the association of the PAS with the syntactic form of the sentence. In terms of Garrett's model, this describes the association of the functional level representation and the syntactic frame specified at the positional level. Garrett's model, however, does not offer any explanation of the processes involved in the association of meaning and form. It has been proposed that mapping may involve a combination of lexically specified information and general rules and procedures (Byng et al 1994).

Jones (1984) highlighted that there is no simple correspondence between semantic (PAS) structure and syntactic sub-categorisation frames (see section 1.7.2); the relationship is governed by the verb. A verb's lexical entry must specify, therefore, how thematic roles are assigned to syntax. Although there is no simple relationship between thematic role assignment and structural position, there are some systematic regularities across different verbs. As a consequence of these similarities, it has been proposed that alongside lexically specified information, there may also be general rules or procedures involved in mapping (Byng et al 1994). These general rules may operate to link thematic roles, PAS and syntactic sub-categorisation information (Williams 1981, Pinker 1989, Breedin and Martin 1996). These authors propose that lexical redundancy rules operate to link these levels of representation. Breedin and Martin (1996) suggest three possible rules of linkage (p53):-

1. Link the agent to the syntactic position of subject
2. Link the theme to the syntactic position of subjects if it is empty, otherwise link it to the syntactic position of object
3. Link the goal to the syntactic position of indirect object.

There may be additional grammatical rules and procedures which determine how thematic roles are assigned to syntax in sentences with non-canonical word order (Schwartz et al 1987, Breedin and Martin 1996). These procedures are not lexically determined. Non-canonical sentences, for example, passives, contain moved arguments, and there is, therefore, a non-transparent (indirect) relationship between thematic role assignment and surface structure. Non-canonical sentences are

presumably produced as a consequence of information coded at the message level (in terms of the precise nature of the event or the lexical items which are to be given prominence). In some way, the production of non-canonical word order must be indicated at the functional level representation in Garrett's model so that the rules which produce a particular sentence type can be initiated (Martin and Blossom-Stach 1986).

It has been proposed that mapping is a central process involved in sentence comprehension and production. This centrality is thought to account for the parallel deficits seen in subjects with aphasia (Schwartz et al 1980, Saffran et al 1980a, Jones 1986, Byng 1988). In comprehension, mapping is thought to involve the association of the parsed phrasal constituents with the thematic roles specified in the PAS. In the comprehension of non-canonical sentences, subjects must acknowledge the structural cues that indicate there is not a transparent relationship between surface form and thematic role assignment. The comprehension of sentences with non-transparent mapping is thought to require more processing resources than sentences with canonical word order (Schwartz et al 1987).

Bock and Levelt (1994) in their model of sentence production characterise the contribution of thematic role information and the nature of functional level processing in a very different way to that described above. In their characterisation, thematic roles are not involved in functional level processing. If thematic roles contribute at all to sentence production, their effect is considered to be in the specification of the event in the message. At the functional level, Bock and Levelt suggest that it is not thematic role assignment that occurs but the assignment of syntactic or grammatical functions, for example, subject-nominative, object-dative. In this way, it is proposed that 'within grammatical encoding, there is no level of processing at which the element that serves as the subject of the sentence plays a role that can be realised as a different grammatical relation' (p962). In contrast to Garrett's proposal, therefore, active and passive sentences may be represented in the same way within the message, but do not have the same representation at subsequent levels of representation. There is a one to one correspondence between the underlying roles specified at the functional level and the surface roles found within the positional level representation. Bock and Levelt suggest that there is no evidence that function assignments undergo change during grammatical encoding.

Impaired mapping was proposed to be one of the features of agrammatism (see section 1.1.3). Poor association between sentence form and sentence meaning has also been identified in fluent aphasic subjects (Whitworth 1994). It is, however, unclear to what extent these deficits result from poor thematic role assignment within the PAS, poor access to lexical mapping information or impaired access to general rules and procedures. Mapping deficits were originally divided into two types:- lexical mapping deficits and procedural mapping deficits (Saffran and Schwartz 1989); these correspond to impaired access to lexical information or impaired general mapping procedures respectively. Subjects with aphasia have been described with these different variants of mapping deficit.

Jones (1986) and Byng (1988) described patients who appeared to have difficulty accessing lexical mapping information. These deficits resulted in difficulties in the comprehension and production of reversible, canonical and non-canonical sentences. Performance on non-reversible sentences remained intact due to reliance on real-world pragmatic information. Byng (1988) suggested that mapping difficulties also result in verb comprehension difficulties for verbs which require an appreciation of thematic properties. Reverse role verbs, for example, 'buy and sell', 'give and receive' represent similar actions but differ in the way they assign thematic roles. Byng (1988) found that an aphasic subject BRB, performed significantly worse on reverse role verbs than reverse action e.g. 'throw' and 'catch' and reverse direction verbs e.g. 'rise' and 'fall' which differ only in semantic features. In production, lexical mapping deficits have also been thought to account for the omission of verbs and verb arguments (Schwartz et al 1995).The omission of verb arguments, as a consequence of thematic role assignment difficulties, is thought to increase in sentences with an increasing number of arguments (Whitworth 1994, Schwartz et al 1995). Procedural mapping deficits have been described only in relation to the rules and procedures involved in the production of sentences with non-canonical word order and moved verb arguments. Impaired access to the general rules and procedures governing canonical word order in non-exceptional verbs has not been investigated. With procedural mapping deficits, comprehension and production performance is maintained for reversible sentences with canonical word order, but deteriorates for sentences with moved arguments. It is not clear to what extent these deficits reflect

the loss of mapping rules or the increased processing complexity associated with these non-canonical sentences (Schwartz et al 1987, Kolk and Weijts 1996).

Mapping has been shown to be a process which can be remediated. A number of effective treatment studies have been carried out. Individual studies have, however, differed in their characterisation of mapping therapy, the outcome of therapy and in the patterns of generalisation (a table summarising these mapping therapy studies can be found in appendix 2). It is not clear in these studies whether it is thematic role assignment or the subsequent association between meaning and form which is being targeted. Three main variants of mapping therapy have been used. Jones (1986) described a therapy involving the explicit identification of thematic roles in written sentences using 'wh' question cues. This method has formed the basis of the majority of subsequent mapping studies, for example, LeDorze, Jacob and Coderre (1991) and Whitworth (1994). A similar therapy involving the use of meaning cards to explain the relationship between components and thus allowing the identification of thematic roles was used by Byng (1988). These first two types of mapping therapy involve the explicit identification of thematic roles. In contrast, Mitchum and colleagues (Mitchum, Haendiges and Berndt 1993, Mitchum, Haendiges and Berndt 1995) described a mapping therapy in which subjects had to implicitly derive thematic role information. Subjects were presented with a reversible active or passive sentence alongside a picture; the subjects had to decide whether the sentence was appropriate for the picture. Feedback was restricted to the correctness or incorrectness of their answer. The subject thus had to derive information about the consequences of word order and the structural cues in active and passive sentences for thematic role assignment.

The outcome of mapping therapy on treated and untreated aspects of processing has provided some insight into the nature of the normal mapping process. Evidence which supports the central nature of mapping has been obtained from the observed generalisation from comprehension to production. Jones (1986) and Byng (1988) both treated thematic role assignment in sentence comprehension; sentence production was not targeted in therapy. Parallel gains were, however, observed in production and comprehension. Similar patterns of generalisation have been observed in other mapping therapy studies, for example, LeDorze et al (1991) and Whitworth (1994). It

is unclear whether this is a consequence of a shared central source of information or shared mapping procedures in comprehension and production.

Generalisation to production was not observed in Mitchum et al's (1995) study. They concluded that knowledge of the mapping mechanism in comprehension was not sufficient to support mapping between meaning and form in production. Mitchum et al (1995) suggested that although there may be a central store of lexically specified mapping information, the procedures which use that information in production and comprehension may differ. It could be, therefore, that in the above therapy studies, it is the central store of information which has been targeted. In contrast, the procedure used by Mitchum and colleagues may target the process used in comprehension. The differences could also reflect the contrast between thematic role assignment and the mapping of form and meaning. Alternatively, it could be that the different method used by Mitchum et al (1995) is not treating thematic role assignment or mapping at all, but is treating a parsing deficit. This therapy concentrated on increasing a person's awareness of the structural cues which signal word order; the explicit identification of thematic roles was not an aspect of therapy.

The patterns of generalisation observed in treatment studies have also suggested that a common mechanism is involved in mapping in spoken and written comprehension. Byng (1988) and Jones (1986) both treated written comprehension and parallel gains in auditory comprehension were observed. Conversely, Mitchum et al (1995) and Haendiges, Berndt and Mitchum (1996) treated auditory comprehension and found some generalisation to reading. The centrality of the mapping mechanism to different thematic roles and different sentences types has, however, been brought into question by the results of therapy studies. There have been some studies which have reported generalisation across different sentence types, for example, reversible sentences and reversible locatives (Byng 1988). Other studies have, however, failed to replicate this finding (Whitworth 1994). In addition, Marshall (1994; cited in Marshall 1995) found no generalisation from the treatment of reversible three argument sentences to two argument sentences. The general failure to observe generalisation across verb type caused Marshall et al (1997) to suggest that thematic information for different verb types may be encoded in different semantic regions. This pattern could also be observed if different general procedures are involved in the assignment of thematic roles within different sentence types and therapy is targeting those

procedures rather than lexically specified information. Nickels et al (1991) suggested that overall mapping procedures may be differentiated in terms of the thematic roles which are involved in the sentence.

It is important to view the results of these therapy studies with some caution. Studies have varied extensively in the amount of assessment, and thus, the accuracy with which the nature of the underlying impairment and the effects of therapy could be determined. The effects of individual therapy have been very varied; few replications have been carried out and thus it is difficult to determine the reasons for the discrepancies in treatment effects. The effectiveness of therapy in some patients may be dependent on the presence of additional lexical, phonological or comprehension difficulties (Schwartz et al 1994). It is also unclear to what extent mapping therapies target a normal process or are involved in the development of a conscious strategy to overcome impairment to the normal process. If therapy is involved in the development of a strategy then it is unclear to what extent inferences about the normal mapping process can be derived (Marshall 1995).

## 1.8 The Production of the Positional Level Representation

The production of the positional level representation is thought to involve three distinct processes:- the retrieval of phonological representations, the creation of a syntactic frame and the subsequent insertion of lexical items into that syntactic frame (Schwartz 1987). The positional level representation is a linguistic representation which specifies word order and the grammatical content of a sentence. The production of the positional level representation relies on the retrieval of function words and morphology and access to phonological and syntactic sub-categorisation information. Research investigating the production of the positional level representation in aphasia has focused predominantly on the description of the surface symptoms. The processes which are involved in the creation of the syntactic planning frame have not been investigated.

### 1.8.1 The Retrieval of Phonological Information

Garrett's model suggests that in the production of the positional level representation, the phonological representations of the lexical items are accessed; these specify the syllabic structure of the word, the component phonemes and the lexical stress. There have been extensive debates about whether a central phonological representation subserves both comprehension and production or whether there are separate phonological lexicons for production and comprehension (see Monsell 1985 for a review). Allport and Funnell (1981) suggested that a single lexicon could account for the observed pattern of phonological deficits. Howard and Franklin (1987), in contrast, argued that the presence of semantic errors in repetition was more coherently explained within a model of normal production, with separate phonological lexicons.

Verb retrieval deficits at a phonological level may result in the production of semantic or phonemic paraphasias in single word and sentence production (Berndt et al 1997a, Marshall et al 1998). Berndt and colleagues (Berndt et al 1997a, Berndt et al 1997b) proposed that phonological verb information was less important for sentence construction than semantic information. It was, therefore, suggested that in subjects with a phonological verb deficit, sentence structure may be preserved even if the verb is omitted. Alternatively, as with semantic deficits, the verb position may be filled with a high frequency, light verb, neologism or gesture. In all cases, it is predicted that the subject will show some ability to realise sentence structure. A study of the speech of JS (Berndt et al 1997b) confirmed some of these predictions. JS was a fluent aphasic subject, who produced phonological errors in single word and sentence tasks and often failed to lexicalise the verb. Despite these difficulties, JS produced good phrasal and sentence structure; this sentence structure did not change when JS was given the verb. Berndt et al (1997b) concluded that access to semantic information facilitated access to predicate argument information, allowing the sentence to be constructed.

A study by Marshall et al (1998) has, however, questioned the minimal impact of phonological verb impairments on sentence production. Subject EM had a selective deficit in the retrieval of phonological information. Despite retained access to semantic information, EM's speech was agrammatic, consisting of predominantly single nouns. Her spontaneous speech contained no verbs and no verb related

structure. EM's sentence production improved with the provision of the verb in cued tasks and following phonologically based verb retrieval therapy. Marshall et al (1998) thus suggest that phonological information is necessary for the production of syntactic structure, and is used alongside semantic and PAS information. They proposed phonological representations of verbs may contain prosodically specified verb phrases which encode information about the prosodic structure of the sentence in which the verb occurs. Alternatively, this prosodic information could also form part of the syntactic sub-categorisation frame of the verb, but it is not clear to what extent verb retrieval therapy would facilitate access to this information. The extent to which phonological and syntactic sub-categorisation information can be differentially accessed needs further investigation.

### 1.8.2 The Creation of the Syntactic Planning Frame

The assembly of phrasal constituents, the ordering of those constituents and the specification of the relationships between the phrases is a grossly under-specified process. The type of phrases produced is determined by the syntactic sub-categorisation frame associated with the verb. A verb's syntactic sub-categorisation frame characterises the syntactic form of the phrases and/or clauses which can occur alongside the verb (Grimshaw 1979). Like other aspects of the lexical information encoded within a verb, syntactic sub-categorisation information is idiosyncratic; synonymous verbs do not always have the same sub-categorisation frames (Thompson, Shapiro, Li and Schendel 1995, Thompson et al 1997).

Some verbs have the potential to occur in varied syntactic environments and thus have more than one syntactic sub-categorisation frame whilst other verbs have a fixed syntactic frame. For example, the syntactic sub-categorisation frame for the verb 'donate' specifies:-

donate [ - NP PP]

Donate is considered to be a non-alternating dative verb; it cannot occur in the syntactic environment of [- NP NP] (Shapiro et al 1987). In contrast, the verb 'send' is associated with the following syntactic sub-categorisation frames:-

send [ - NP]

[ - NP PP]

[ - NP NP]

Send is referred to as an alternating dative verb, as its three argument structure can be syntactically realised in two ways (Shapiro et al 1987). Send can be used in a double noun phrase construction, 'the man sent the girl a letter' or with a noun phrase followed by a prepositional phrase, 'the man sent a letter to the girl'. In either case, the arguments fulfilling the thematic roles of agent, patient and benefactive (man, letter and girl respectively) remain unchanged. This highlights the independence of PAS information and the syntactic sub-categorisation frame. Unlike the number of PAS arrangements associated with a verb, the number of syntactic sub-categorisation frames associated with a verb has not been found to influence its processing complexity (Shapiro et al 1987).

Breedin and Martin (1996) assessed access to syntactic sub-categorisation information in four aphasic subjects. Impaired access to syntactic sub-categorisation information resulted in the production of sentences with an inappropriate syntactic structure, in terms of the number and types of phrases produced. These deficits were sometimes, although not always, associated with difficulties identifying syntactic anomalies in a grammaticality judgement task. It was, however, unclear to what extent the tasks investigated access to syntactic sub-categorisation information. In the grammaticality judgement task, ungrammatical sentences were produced by the addition and omission of phrasal components. The addition or omission of phrasal components, increases or decreases the number of arguments in the PAS. This grammaticality judgement test, therefore, could be testing either access to PAS or syntactic sub-categorisation information. The ability of aphasic subjects to produce sentences correctly and identify anomalies in sentences with alternating syntactic sub-categorisation frames has not been investigated.

The production of individual phrases, the retrieval of the function words and inflections which constitute those phrases and the ordering of the phrases are grossly under-specified processes in Garrett's model. It was proposed in section 1.7.4 that word order and the choice of a syntactic frame is governed by lexical mapping information and general mapping rules which determine how thematic role information is mapped onto surface form. Depending on the requirements of the message, sentences of certain types, for example active or passive, will be produced. In a similar way, the grammatical devices produced at this level realise aspects of the

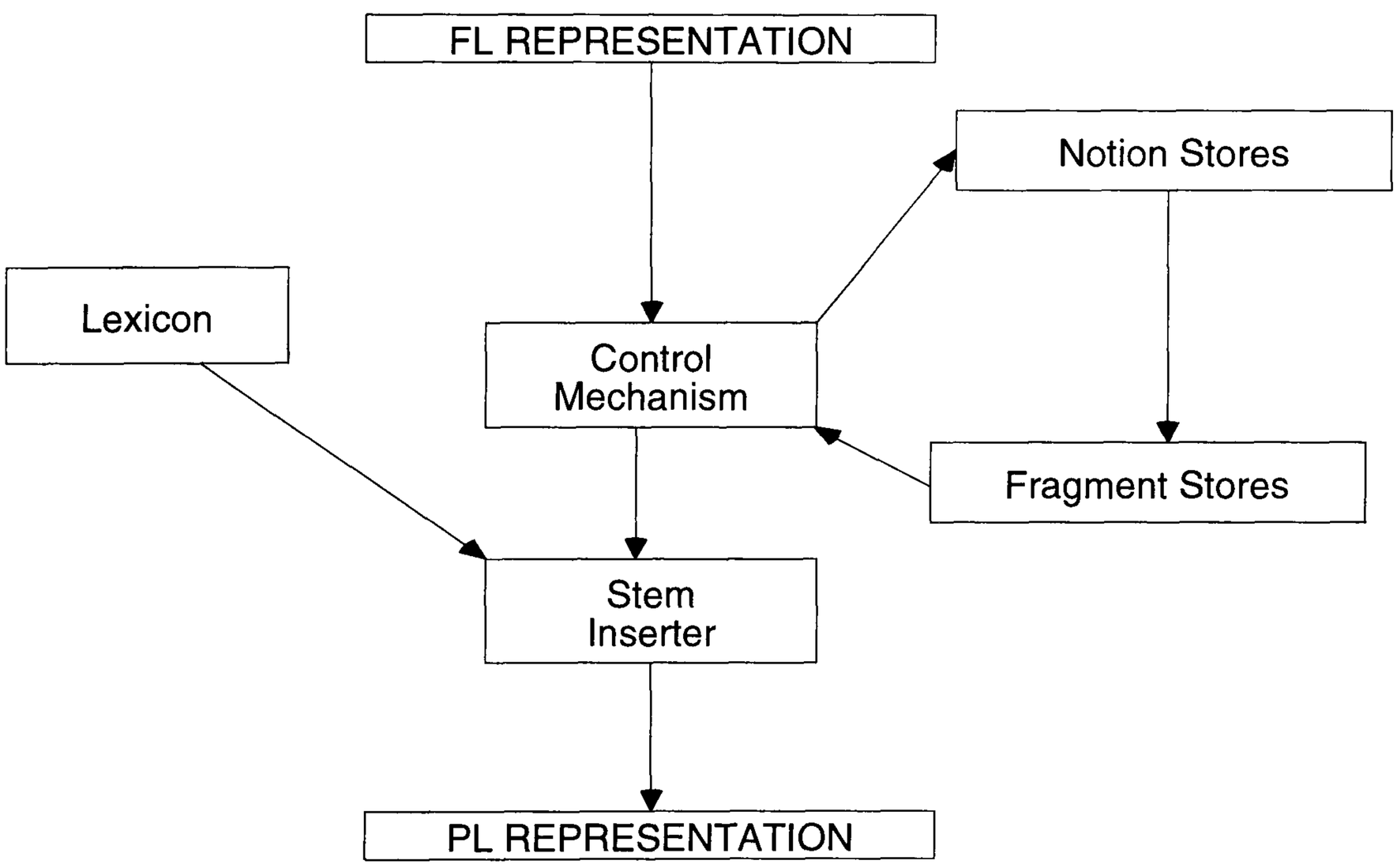
message level representation, related to the timing of the event, a person's perspective on the event and its relation to other aspects of the current discourse. The syntactic processes involved in the production of the phrasal constituents may include the production of inflections to mark person, tense, number etc., pronominalisation and coding for case, number and gender, the retrieval of other function words and the use of relative clauses (Goodglass and Menn 1985). In this way, the production of the syntactic frame is influenced by the information specified at other levels of representation. It is not clear from Garrett's model how this information is mediated from the message, via the functional level representation.

Schwartz's elaboration of Garrett's model does not specify to what extent the same or different procedures are involved in the production of different phrasal types and in the retrieval of function words and inflectional morphology. There have been no reported studies which have contrasted the production of noun, verb, adjectival and prepositional phrases, in terms of their phrasal structure and the errors made. The production of function words and inflections by subjects with aphasia has, however, been described. The dissociations reported in the production of function words and inflections (Lapointe 1985, Miceli et al 1989) suggest that these are either stored in separate components of a morphological system or are retrieved via different mechanisms. Lapointe (1985) showed differential retrieval of auxiliaries and verb affixes in agrammatic subjects. He suggested that a structural frame is created which includes the verb affix and slots for the main verb and auxiliary; the auxiliary is then retrieved from a store of function words before the phonological representation of the main verb is inserted. Lapointe and Dell (1989) extended this characterisation to other structural frames in their elaboration of the processes operating to form the positional level representation. These processes are depicted in figure 1.4. This model proposes that during syntactic processing, information is computed via two separate but interacting stores, a notion store and a fragment store. Processing within these stores is monitored by a control mechanism. The notion store mediates between the functional level representation and the fragment store; it contains the semantic notions, for example, time, gender etc. that are expressed using function words and inflections. The notion stores are thought to be organised according to phrasal category and within each category according to semantic markedness. Following retrieval in the notion stores, fragments are automatically retrieved from the fragment

store. The fragment store is divided into phrase fragments and function word fragments; phrase fragments consist of inflections, stem markers and function word markers. Following the retrieval of these fragments, the control mechanism oversees the assembly of the fragments and the insertion of the phonological stems within the phrase.

Miceli et al (1989) identified extreme variation in the realisation of prepositions, definite articles, indefinite articles, clitics and auxiliaries. Errors were not distributed evenly across the groups and word classes were differentially omitted and substituted. There was no consistent hierarchy of difficulty between subjects. Differences in function word retrieval may be a consequence of the different procedures used in the assembly of different phrasal types. Alternatively differences may reflect the relative meaningfulness and semantic content of the words (Zurif and Caramazza 1976, Friederici 1985). Many of the function words encode some semantic information, for example, number, gender, etc. It is, however, unclear to what extent function words are represented at the functional level representation. Kempen and Hoenkamp (1987), acknowledging the semantic content of function words, proposed that they are inserted at the functional level. Their incremental procedural grammar (IPG) also suggests that word order is determined at the functional level. The IPG describes syntactic procedures responsible for the assembly of syntactic constituents; these procedures are grouped into four non-overlapping families:- clauses, noun phrases, adjectival and adverbial phrases and prepositional phrases. Within these families are two groups of procedures. Categorial procedures build the syntactic shape of individual phrases and retrieve the lexical items at the head of the phrase. Functional procedures build the syntactic relations between the phrases. Within these procedures, functorization rules govern the retrieval of function words. In this characterisation of sentence production, inflections are inserted at the subsequent morpho-phonological stage.

**Figure 1.4: Syntactic processes involved in the production of the positional level representation (Lapointe and Dell 1989)**



In the production of inflectional morphemes, studies have identified consistent hierarchies of difficulty. DeVilliers (1974) analysed the spontaneous speech of 14 non-fluent aphasics. She identified that progressive 'ing' was the easiest morpheme to produce, followed by plural 's', regular past tense and irregular past tense. The third person 's' morpheme was the most difficult to produce. Goodglass and Berko (1960) found a similar hierarchy of difficulty in the performance of 21 aphasic subjects on a sentence completion task. Plural 's' was found to be the easiest morpheme, followed by regular past, third person 's' and possessive 's'. Stemberger (1985) found that plural 's' was the easiest followed by third person 's' and possessive 's'.

DeVilliers (1974) investigated the extent to which normal language acquisition, grammatical agreement, transformational complexity, semantic complexity, redundancy and frequency, could account for the difficulties seen in aphasic subjects. None of the factors were found to account for the observed hierarchy, but a combination of factors may be involved. This highlights the need for a systematic investigation of the production of morphology. Of particular interest would be the contrastive production of morphology associated with particular phrasal types.

It is hypothesised that multiple processes are involved in the production of function words and inflectional morphemes. It is thought that these differences may in part reflect differences in the processes responsible for the production of different phrasal types. Systematic investigations of these aspects would clarify their role in the production of the syntactic frame. Comprehensive investigations are also needed into the relationship between comprehension and production of grammatical morphemes.

## 1.9 Selective Deficits in the Retrieval of Verbs

Recent studies of aphasic subjects, for example, Breedin and Martin (1996), Marshall et al (1997) and Marshall et al (1998) have provided some evidence that subjects may have differential access to aspects of verb information. Table 1.2 shows the patterns of deficit seen in the single word and sentence production of the six subjects tested. These dissociations suggest that there are separable components of verb processing related to these aspects of information (Breedin and Martin 1996). Marshall et al (1997) suggest that these dissociations may be a consequence of differential storage of information in different semantic domains. The consequence of

each of these difficulties for performance on particular task has been described in the previous sections. No studies have, however, specifically investigated the retrieval of PAS information, although the performance of some tasks has relied on access to this information. In particular, the relationship between PAS and semantic information has not been explored.

**Table 1.2 Differential access to aspects of lexical information encoded within a verb.**

| | **Breedin and Martin (1996)** | | | | **Marshall et al (1997)** | **Marshall et al (1998)** |
|---|---|---|---|---|---|---|
| | LK | PW | JS | VP | PB | EM |
| **Semantic Information** | + | + | - | - | + | + |
| **Phonological Information** | + | + | - | + | + | - |
| **Thematic Role Information** | - | - | + | + | - | + |
| **Syntactic Sub-categorisation** | + | - | - | + | + | - |

Key: + = preserved access, - = impaired access

The 'refined lexical hypothesis' suggested that in the absence of some information, other aspects of information may partially compensate for that loss. It has certainly been suggested that the use of non-linguistic real world information may mask the effects of a mapping deficit in aphasic subjects (Saffran et al 1980a, Schwartz et al 1980). Marshall et al (1997) suggested that in the absence of thematic information, syntactic sub-categorisation and prosodic information may be used to generate an appropriate sentence. Subject PB was unable to access verb semantics and thematic role information, but was able to generate appropriate syntactic structure. It was proposed that PB exploited phonological information in order to construct phrasal structure. This study suggests that despite an inability to access semantic information,

subject PB was still capable of accessing phonological information. This would suggest that these aspects are retrieved in parallel; this is in contrast to the serial nature of processing proposed by Garrett.

It is, however, unclear to what extent the performance of PB and EM (Marshall et al 1997, Marshall et al 1998) reflects differences in accessing PAS and syntactic sub-categorisation information, rather than semantic and phonological information. Marshall and colleagues apparently assume that PAS information is part of a verb's semantics and that prosodic information is encoded within the phonological representation of the verb. PAS information may, however, be represented separately from semantic information. Breedin and Martin (1996) demonstrated that access to thematic role information and semantic information could be differentially impaired. Predicate argument structure information may also be represented separately. Syntactic sub-categorisation frames, in a similar way, may be represented separately from lexical phonological information. Subject PW (Breedin and Martin 1996) showed differential access to these aspects of information suggesting discrete representations. The performance of subjects EM and PB may, therefore, reflect difficulties accessing PAS and syntactic sub-categorisation information, rather than semantic and phonological information.

## 1.10 Limitations of Garrett's Model of Sentence Production

Garrett's model of normal sentence production has provided a useful means of characterising aphasic sentence production, in terms of the likely location of the deficit. Schwartz in her elaboration of Garrett's model highlights some of the processes thought to be involved in the production of each level of representation. In this way, there is the possibility of identifying the impaired processes which are contributing to the observed performance. The model is, however, still grossly under-specified and cannot account for all the observed patterns of performance. Other models of sentence production have addressed some of these difficulties, but none can account for all aspects of normal and aphasic sentence production.

As previously highlighted, in the production of the functional level representation, Garrett's model as it stands has no account of the production of non-arguments. Speech production, however, obviously involves the production of non-arguments and

observed performance suggests a difference between argument and non-argument production (Shapiro and Levine 1990, Byng and Black 1989). In the production of the positional level representation, there is no account of the observed dissociations between the production of bound and free morphemes (Miceli et al 1989). These dissociations suggest that multiple processes are involved in the construction of the syntactic planning frame. The elaborated model of positional level processes proposed by Lapointe and Dell (1989), however, can account for the observed dissociation.

Garrett's model proposes that the same mechanisms are involved in all spoken tasks. There is, however, some evidence to suggest that sentence production differs between constrained and unconstrained tasks (Maher et al 1995); Garrett's model cannot explain these differences unless the contribution of adaptive strategies and non-linguistic processes is considered. Kolk and van Grunsven (1985) suggested that unconstrained tasks were more difficult for aphasic subjects and that variability between tasks may be a consequence of the allocation of limited processing resources. It is unclear from Garrett's model which processes require conscious processing and which proceed automatically; the extent to which processes compete for limited resources cannot therefore be determined. Bock (1987) in her model of sentence production incorporated a limited capacity working memory component. She suggested that processing resources are required for message level processing and phonetic encoding, whereas semantic, syntactic and phonological processes proceed automatically. Bock's model also suggests that there is some interaction between levels of processing, specifically feedback from phonological processing to lexical selection at the functional level. Bock (1987) demonstrated that the difficulty of phonological processing influenced lexical selection and phrasal production. Garrett's model consists of serial stages; there is apparently no feedback between levels of representation. It is also not clear to what extent the information coded at one level of representation, influences processing at subsequent levels of representation.

## 1.11 The Relationship between Sentence Production and Comprehension

Garrett's model is restricted to a description of the processes involved in sentence production; the processes involved in sentence comprehension and their relationship

with production is not considered. This is also true of the other models of sentence production considered in the previous sections. Black, Nickels and Byng (1991) suggested that the following processes are involved in the comprehension of sentences. Initially, acoustic and phonological processes segment the incoming wave form into phonological words and phrases. As each phonological word is accessed, the semantic representations of the lexical items are retrieved. A syntactic representation of the sentence is constructed, following the parsing of the grammatical content of the sentence. The syntactic representation codes the linear order of the sentence and the structural relationships between phrasal constituents. Those structural relationships are then mapped onto thematic role relations within the predicate argument structure of the verb. As in production, this may involve a combination of lexically specified information and general mapping procedures. The semantic content of individual lexical items is, therefore, integrated with the PAS to form a full semantic representation of the sentence; this specifies the relationship between the participants in the event. The semantic representation forms the basis for inferential processes. These inferential processes judge the semantic and pragmatic plausibility of the sentence. These inferential processes are similar to the heuristic processes described by Caramazza and Zurif (1976). These processes use real world knowledge to ascertain the most likely relationship between participants in the event. If there is a conflict between the interpretation reached as a consequence of the linguistic processes and this real world knowledge, sentence comprehension may be slower (Black et al 1991).

It can be seen that there are many similarities between the levels of processing involved in sentence comprehension and production. In each case, phonological, syntactic, thematic and inferential processes are involved. There is, therefore, a temptation to just reverse Garrett's model to produce a model of sentence comprehension. It is unlikely, however, that entirely the same processes are involved in comprehension and production. Production and comprehension differ in the nature of their input and output and the availability of context; the processes involved are likely to reflect these differences (Mitchum et al 1995). Mitchum et al (1995) suggested that in comprehension, a sentence is provided in which word order and grammatical content is specified. The sentence is interpreted from left to right and the underlying representation accessed. In contrast, in the production of a sentence, the

specification of word order and grammatical content is the ultimate target of the production process. Comprehension and production, however, both involve the retrieval of representational information, for example, semantic, PAS, mapping information; this information may be central to both modalities (Mitchum et al 1995). The relationship between comprehension and production may differ according to the level of processing.

The associations and dissociations which exist between the comprehension and production of thematic, phrasal and morphological structure have been highlighted in the descriptions of agrammatism and paragrammatism. There is, however, a need for a more comprehensive investigation of all aspects of sentence processing. Symptom co-occurrence in production and comprehension has been used as evidence of impairment to shared processes (Caramazza et al 1981). Associations may, however, also co-occur as a consequence of impaired access to shared representational information or multiple impairments to distinct processes (Berndt 1991). It is difficult to distinguish between these possibilities using only assessment. As highlighted in the discussion of mapping in section 1.7.4, monitoring the effects of treatment can help to ascertain the relationship between comprehension and production with reference to a particular aspect of performance. If comprehension and production impairments are the consequence of shared processes or shared representational information, treatment in one modality will result in parallel gains in the other modality. If the deficits result from parallel damage to distinct processes, no gains will be observed in the untreated modality. The use of this method has not been extended to the analysis of other processes.

## 1.12 Introduction to Study

The aim of this study was to investigate sentence production deficits in subjects with aphasia, with a view to improving the description of the observed features of performance and determining the nature of the underlying impairment. Specific hypotheses related to the three parts of the study are introduced at the beginning of chapters two, three and four. Previous analyses of sentence production have focused on a particular level of linguistic structure. A comprehensive analysis of narrative speech which characterised sentence production in terms of thematic, phrasal and morphological structure was thus developed, enabling a complete profile of

performance to be established. The performance of non-fluent and fluent aphasic subjects was compared to that of normal control subjects. The observed patterns of deficit were explored in relation to Garrett's model of sentence production. Specific hypotheses related to the location of the impairment, the nature of normal processing and interactions between levels of representation were investigated. In this way, it was hoped to clarify the processes responsible for normal sentence production. The characterisation of the observed deficits provided some insight into the nature of the processes involved in the production of each level of linguistic structure. It was, however, hypothesised that different underlying impairments may result in similar patterns of observable deficit. Four subjects with apparent difficulties in the production of thematic structure were tested on a battery of single word and sentence processing tasks. In this way, the sub-processes responsible for the production of thematic structure were investigated. Sentence production deficits are a widespread feature of aphasic language; they often interfere with functional recovery, remaining after single word deficits have improved. The clinical implications for the assessment and treatment of sentence production deficits in aphasia are discussed at the end of the study.

# Chapter 2: Analysis of Narrative Speech

The aim of this initial part of the study was to analyse sentence production in non-fluent and fluent speakers with aphasia. The performance of aphasic speakers on parameters of thematic, phrasal and morphological structure was compared to that of normal speakers. Three hypotheses were investigated:-

1. Agrammatism and paragrammatism are disorders of sentence production associated with non-fluent and fluent speakers respectively.
2. Agrammatism and paragrammatism are distinct disorders with differentiable patterns of deficits and distinct non-overlapping symptoms.
3. The sentence production deficits in aphasia represent a continuum, with the severity of impairment (as indicated by rate of speech) determining the features which are evident.

With the rejection of these hypotheses and the rejection of fluency as an adequate means of grouping subjects, sentence production deficits were considered in relation to models of normal sentence production.

## 2.1 Introduction

The features of agrammatism and paragrammatism were described in sections 1.1.1 and 1.2.1. Their characterisation as distinct syndromes has been questioned by the variability within each group and the overlap between the two groups (see sections 1.1.2 and 1.3). The description of the features of agrammatism and paragrammatism has, however, been limited by the restricted nature of previous analyses of sentence production. Agrammatism and paragrammatism affect more than one level of linguistic structure, and yet analyses have typically focused on a single aspect of performance. There is a need to compare and contrast the sentence production of these two groups of aphasic subjects using a more comprehensive analysis procedure.

Two techniques have traditionally been used to obtain samples of connected speech which can then be analysed:- narratives and free conversation. The methods which have then been used to analyse these samples have varied greatly, depending on the aspect of performance which is being investigated. Typically these analyses have

focused on one level of linguistic structure. In the investigation of thematic structure, Whitworth (1995a) analysed the realisation of thematic roles in the conversation of two fluent aphasic subjects. This analysis characterised the thematic roles used by the subjects, the relative frequency of thematic structures and the accuracy with which they were realised. This thematic analysis was based on Byng and Black's (1989) profile of the syntactic realisation of the predicate argument structure. This profile analysed the phrasal realisation of one, two and three argument structures, produced in a narrative task. Byng and Black again focused on the range of PAS present and the accuracy with which they were produced. Their analysis considered the syntactic realisation of the PAS in terms of the phrases used to realise verb arguments and non-arguments. The internal structure of those phrases was not analysed. Thompson, Shapiro and Schendel (1995) introduced a more detailed analysis of the production of PAS by subjects with aphasia. Their analysis focused on the range of verbs used by subjects during interaction, and the extent to which aphasic subjects were able to realise the same verbs in a variety of PAS arrangements and use a breadth of verbs with different PAS arrangements.

Syntactic analyses of aphasic sentence production have focused on the characterisation of clausal and phrasal structure. Penn and Behrmann (1986) used the LARSP procedure (Language Assessment, Remediation and Screening Procedure) (Crystal, Fletcher and Garman 1989) to analyse the clause, phrase and grammatical structure of language produced during interaction. Following this syntactic profile, they used hierarchical cluster analysis to group patients with similar profiles. The validity of the use of LARSP for this clinical population has been questioned, however, due to the difficulties segmenting and analysing the speech sample, as a consequence of word finding and sentence formulation problems (Saffran et al 1989, Edwards 1995). Subsequent syntactic analyses by these authors, therefore, tried to eliminate these difficulties. The Quantitative Production Analysis (QPA) of narrative speech designed by Saffran et al (1989) focused on quantifying aspects of production known to be difficult for aphasic speakers. The QPA characterised clausal structure in terms of sentences (minimally consisting of a noun and verb) and non-sentences (other sentence fragments divided into topic-comment structures and other phrases). The

internal structure of these sentences was then investigated in terms of the realisation of function words and morphology. Quantitative information was obtained about individual aphasic performance which could then be compared with the performance of normal subjects. Edwards (1995) investigated the realisation of syntactic structure in the conversation of fluent aphasic speakers. Her analysis focused on the analysis of text units, in terms of the complexity of the clauses and phrases used to realise components. An analysis of the morphological structure of sentences was performed by Goodglass et al (1993). This analysis focused on the production of noun and verb morphology in both structured tasks and free narratives. These methods have been used successfully to describe particular aspects of sentence production, and have thus contributed to the description of deficits seen in subjects with aphasia. None of these analyses has, however, allowed a complete profile of a subject's ability to be established. This has placed restrictions on the qualitative and quantitative comparisons which have been made of the performance of non-fluent and fluent aphasic speakers.

The description of sentence production has also been limited by the lack of data available for normal subjects with which to compare aphasic performance. The above analyses have varied in the extent to which they have obtained normal data on the parameters investigated. In some cases, analyses of normal performance have been restricted to single matched subjects (Whitworth 1995a, Byng and Black 1989). In other studies, analyses of a group of normal subjects have been carried out (Saffran et al 1989, Thompson et al 1995), but these group studies were still limited to a small number of subjects. In the characterisation of aphasic performance, it is essential to have a knowledge of the normal range of performance on the parameters to be investigated. Adequate normal data is not currently available for all of the parameters considered to be important in the characterisation of agrammatism and paragrammatism.

The aim of the current analysis was to provide a comprehensive description of the thematic, phrasal and morphological aspects of sentence production in non-fluent and fluent aphasic subjects. Normal data was obtained on all of the parameters tested to enable the comparison of normal and aphasic performance. The performance of non-fluent and fluent subjects was compared in order to evaluate the three hypotheses

stated above. This analysis of sentence production combined aspects of some of the analyses described above in order to provide a comprehensive description of sentence production. The analysis procedure was based on the levels of representation specified in Garrett's model (see section 1.5.1), particularly the characterisation of the linguistic structures specified at the functional level and positional level representations.

It was decided to use narrative speech in this study for the following reasons (based on a discussion in Edwards 1995). Firstly, narratives obtained by the telling of particular stories, have a highly predictable propositional and lexical content; this ensures that the researcher has some control over the sample collected. Secondly, narratives are predominantly monologues; the sample is, therefore, easier to segment than conversational speech and utterances are typically thematically complete (not incomplete due to deixis). In conversation, there is a high number of comment clauses, minimal turns and stereotypical phrases; it is hoped that using a narrative sample will increase the amount of analysable thematic content and decrease the amount of non-propositional speech.

## 2.2 Method

### 2.2.1 Subjects

A group of 20 normal control subjects was compared to a group of 22 aphasic subjects. The normal group consisted of 4 male subjects and 16 female subjects, mean age = 54.85 years (range 18 to 90 years). The normal data was collected for a previous study (Bird and Franklin 1996). The aphasic group consisted of 10 male subjects and 12 female subjects, mean age = 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 subjects, one subject whose aphasia resulted from surgery and one subject who had had two previous strokes; he had, however, experienced no language difficulties following these previous episodes. The aphasic subjects were all at least 6 months post onset (mean 3½ years, range 7 months to 10 years). A summary of the individual details of the aphasic subjects can be found in appendix 3. Eight of the subjects were still receiving Speech and Language Therapy, predominantly in a group setting; the other subjects were recruited from local Speech after Stroke clubs. The aphasic

subjects were selected on the basis of having some difficulties with sentence production in spontaneous speech. All subjects were also tested using the Comprehensive Aphasia Test (Swinburn, Baker and Howard unpublished). The results for the language and cognitive sections of this test can be found in appendix 4.

### 2.2.2 Narrative Analysis

Samples for the analysis were obtained by asking subjects to tell the story of Cinderella. The procedure for obtaining the sample was as Saffran et al (1989). It was, however, decided to use the whole samples obtained and not just the first 150 words. Bird and Franklin (1996) used the complete samples and suggested that their analyses were more reliable as a consequence. It must be noted that in some cases, the narrative sample obtained was less than 150 words. In these cases, it was thought more important to maintain the likely content of the narrative (by keeping the story constant), than increasing the length of the sample by using other additional stories. The sample was transcribed and the narrative core was obtained in a similar way to Saffran et al (1989). The sample was then segmented into utterances and each utterance was analysed in terms of its thematic structure, phrasal structure and morphological structure. The full procedure for analysing the narrative can be found in appendix 5. A brief description of the major stages of the analysis follows.

The thematic structure of the utterances was analysed according to a framework based on the Thematic Role Analysis of Spontaneous Output (Whitworth 1995a). Utterances were broadly divided into those with an undetermined thematic structure, one, two and three argument structures and utterances containing thematic embedding. Utterances were coded at this level for their underlying linguistic representation (as in Thompson et al 1995), rather than their surface form. Utterances with an undetermined thematic structure included those which contained no verb, those containing a verb but which were semantically anomalous 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 argument structure complexity. The phrasal components

were all coded for the thematic role they were expressing. The utterances were also coded as optional, obligatory or non-argument depending on the status of the phrasal components and the fixed or variable nature of the PAS (see discussion in sections 1.7.2 and 1.7.3). The omission of arguments in two and three argument structures was recorded. The category of thematic embedding was defined by Whitworth (1995a) as containing "those utterances where thematic roles are embedded in more complex syntactic and thematic structures", for example, 'so he came here to be in charge of the company that was then making a loss' (p390). In addition, the use of complex co-ordinate and subordinate sentences and the use of post-modifying clauses was coded as an indicator of sentence complexity.

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. The categories for the components of each phrase were based on the LARSP Analysis (Crystal et al 1989). The number of constituents in the phrase was taken as a measure of the complexity of the phrase. The categories were, therefore, grouped into one, two, three and complex. Errors involving the omission or inappropriate use of nouns, verbs, prepositions, determiners, pronouns and auxiliaries were coded in the error section. The presence of noun and verb morphology was coded in the morphological analysis to allow their frequency of use to be determined. Errors involving the omission or inappropriate use of noun and verb morphology were coded in the error section.

## 2.3 Comparison of Normal and Aphasic Groups

The performance of aphasic speakers on parameters of thematic, phrasal and morphological structure was compared to that of normal speakers, allowing the initial two hypotheses to be investigated:-

1. Agrammatism and paragrammatism are disorders of sentence production associated with non-fluent and fluent speakers respectively.
2. Agrammatism and paragrammatism are distinct disorders with differentiable patterns of deficits and distinct non-overlapping symptoms.

The narrative analysis characterised the performance of the non-fluent and fluent aphasic groups and the consistency of individual performance within each group. This allowed the observed features in the fluent and non-fluent groups to be considered in relation to the descriptions of agrammatic and paragrammatic speech. Comparing the profiles of the two groups allowed the extent of the similarity or dissimilarity between the two groups to be determined. A lack of a distinct pattern of performance within each group and overlap between the groups would question the validity of the characterisation of agrammatism and paragrammatism as differentiable sentence production deficits.

### 2.3.1 Method

The narrative analyses were completed for the 20 normal and 22 aphasic subjects. The summary information obtained under the headings of general information, thematic, phrasal and morphological structure, formed the basis of the group comparisons. The aphasic subjects were divided into non-fluent and fluent groups, according to their rate of speech. The performance of the normal, non-fluent aphasic and fluent aphasic groups was then compared using two sample t tests. Repeated t tests were used as it was considered important to contrast the performance of all three groups. In order to reduce the risk of making a type I or type II error, a Bonferroni corrected significance value was used; p values between 0.017 and 0.050 were not considered to be significant. The group comparisons were followed by a consideration of the performance of the individual aphasic subjects in the fluent and non-fluent groups. The performance of each subject was compared to the performance of the normal group. The aphasic subjects were considered to differ from the normal group if they fell outside two standard deviations from the normal mean. Appendix 6 shows the mean and the upper and lower limits which were considered normal. On some parameters, due to the large amount of variation, the lower limit was less than zero. In these cases, the measure was not considered to be an appropriate comparison. The results for each of the subjects with aphasia is shown in appendix 7.

### 2.3.2 Predictions

From the definitions of agrammatism and paragrammatism and the findings of previous research, predictions were made for the performance of each group; these are listed in table 2.1.

**Table 2.1: Predictions for the performance of non-fluent and fluent aphasic groups.**

| | Non-Fluent Group | Fluent Group |
|---|---|---|
| **General Information** | | |
| Rate of Speech | Reduced rate | Normal rate |
| Percentage Narrative | Decreased narrative | Decreased narrative |
| Percentage Complex Sentences | Lack of complex sentences | Reduced use of complex sentences |
| Percentage Discourse Markers | Reduced use of discourse markers | Reduced use of discourse markers |
| **Thematic Structure** | | |
| Mean Thematic Complexity | Lower mean thematic complexity | Comparable to normal subjects |
| Omission of Arguments | Some omission of arguments | Some omission of arguments |
| **Phrasal Structure** | | |
| Mean Phrasal Complexity | Lower mean phrasal complexity | Comparable to normal subjects |
| Phrasal Errors | Omission errors | Substitution errors |
| **Morphological Structure** | | |
| Morphological Errors | Omission errors | Substitution errors |

## 2.4 Results of Comparisons of Normal and Aphasic Groups

### 2.4.1 General Information

#### a) Rate of Speech

The rate of speech (in words per minute) for the normal and aphasic subjects can be seen in figure 2.1 and table 2.2. The non-fluent and fluent groups were defined with reference to the normal mean. Subjects with rates of speech lower than 2 standard deviations from the normal mean (equivalent to a rate of less than 71.3 wpm) were regarded as non-fluent. Sixteen of the aphasic subjects were, therefore, considered to be non-fluent and six were labelled fluent. Although two standard deviations from the mean was considered to be the cut-off between fluent and non-fluent speech, rate was in fact a continuum. From the results of the CAT (in appendix four), it can be seen that the non-fluent subjects varied in the extent to which they would be described as having a classic Broca's aphasia. All of the subjects (with the exception of BM and DM) had good functional comprehension and produced some phonemic errors in naming, reading or repetition. BM and DM both presented with pre-semantic auditory comprehension difficulties. In the fluent group, two of the subjects (RN and NB) did not appear to have the marked semantic comprehension deficit, characteristic of Wernicke's aphasia.

**Figure 2.1: Comparison of normal and aphasic groups; Rate of speech**

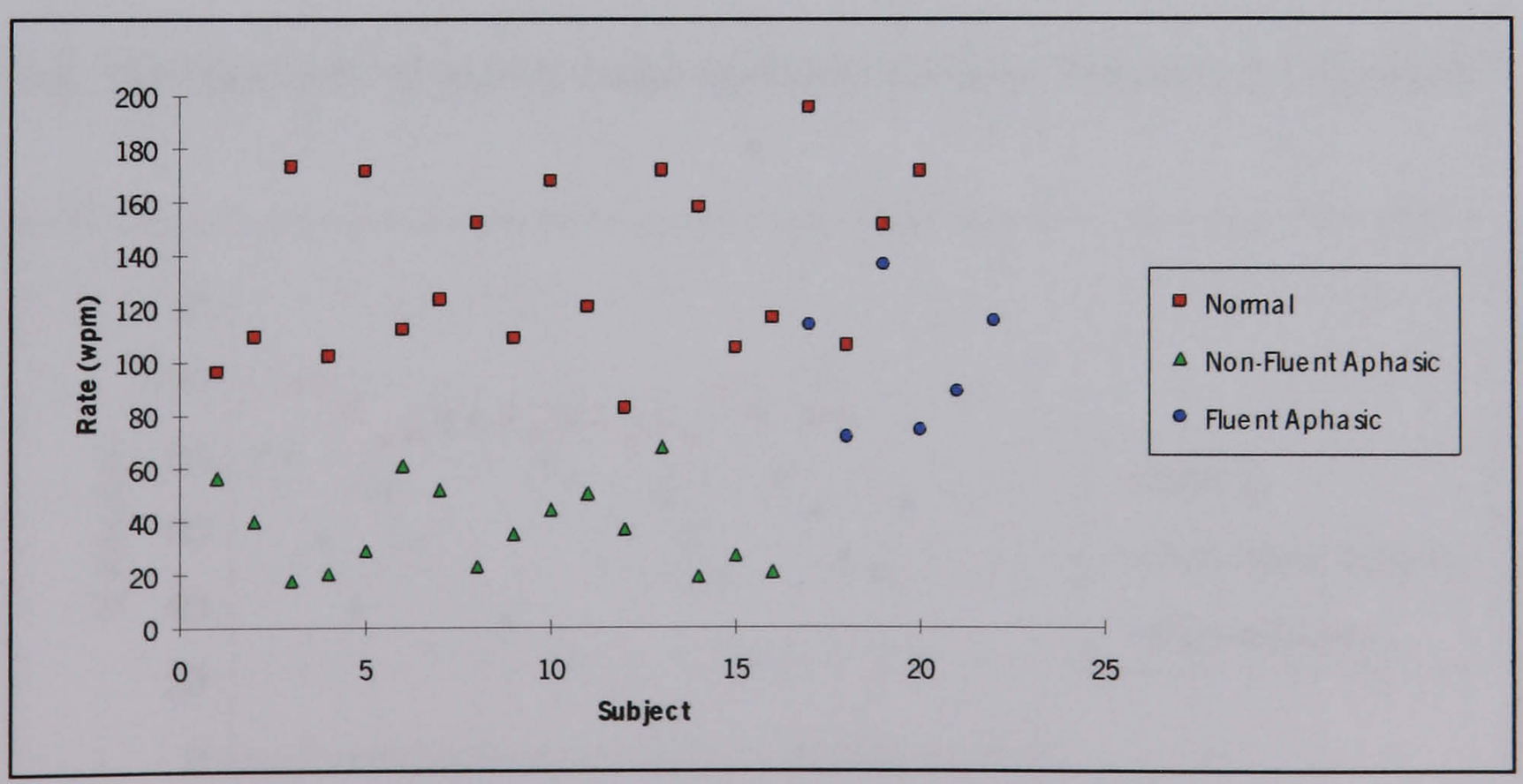


**Table 2.2: Summary of group performance; Rate of speech**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 135.0 | 31.9 | 82.6 | 195.6 |
| **Non-Fluent Aphasic** | 37.7 | 16.2 | 17.9 | 68.0 |
| **Fluent Aphasic** | 100.2 | 25.9 | 71.8 | 136.7 |

**b) Percentage Narrative**

Figure 2.2 and table 2.3 show the distribution of percentage narrative scores for the normal and aphasic subjects. The percentage narrative was an indication of how much of the material produced in the task was included in the subsequent analysis. The results of the group comparisons are recorded in table 2.4. The non-fluent and fluent aphasic subjects differed significantly from the normal group. There was, however, no significant difference between the non-fluent and fluent aphasics. The normal subjects produced a high percentage of analysed narrative; the material which was excluded was predominantly conjunctions between sentences and stereotypical starting phrases. All of the fluent subjects and the majority of the non-fluent subjects (11/16) produced a lower percentage of narrative than the normal group, due to the increased production of repairs, repetitions and comments on the task.

**Figure 2.2: Comparison of normal and aphasic groups; Percentage narrative**

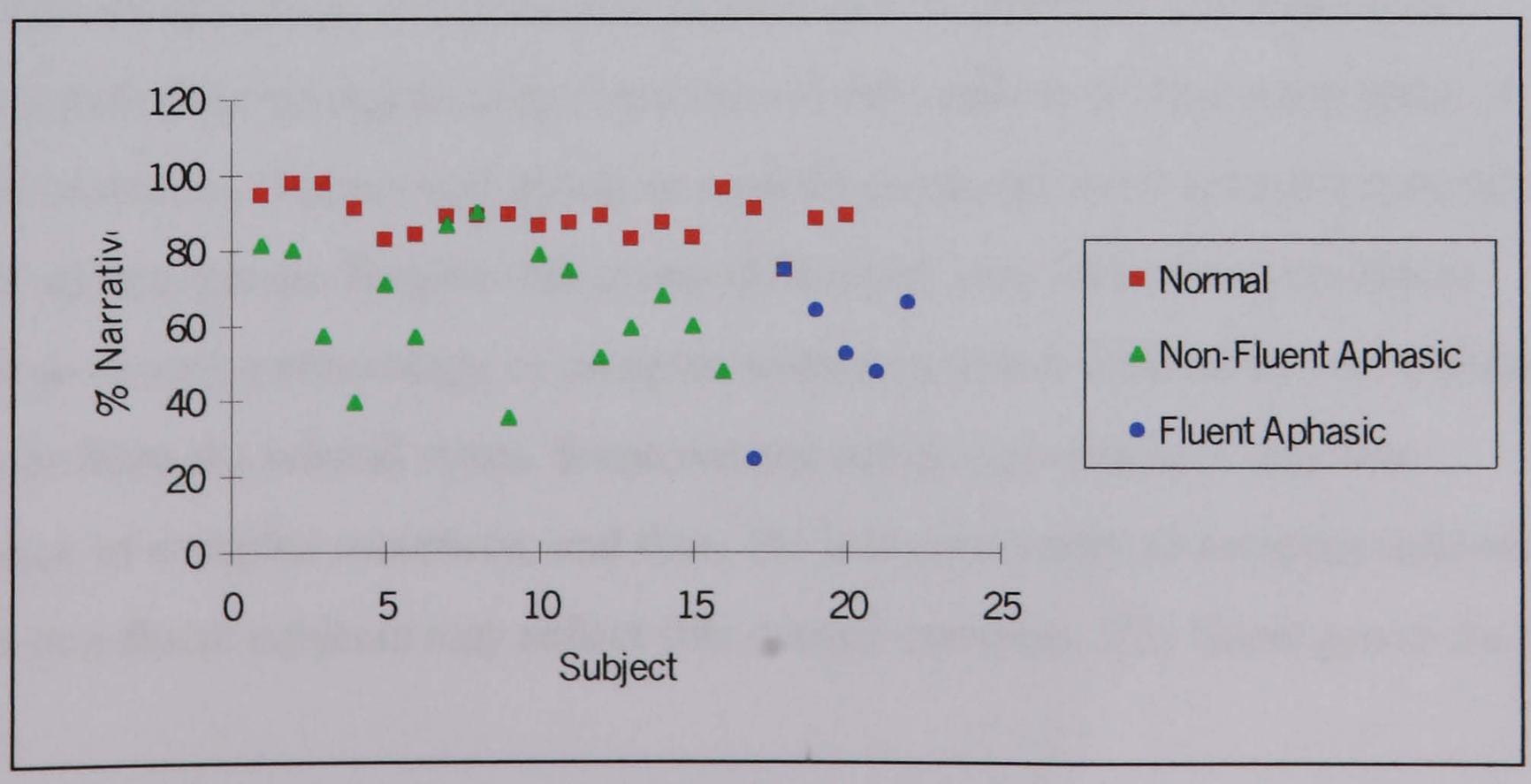


**Table 2.3: Summary of group performance; Percentage narrative**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 88.7 | 5.6 | 74.9 | 98.0 |
| **Non-Fluent Aphasic** | 64.9 | 16.5 | 35.6 | 90.1 |
| **Fluent Aphasic** | 55.1 | 17.8 | 24.7 | 74.8 |

**Table 2.4: T test results of group comparisons; Percentage narrative**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | unequal | 5.54 | 17.74 | 0.000* |
| **Comparison Normal and Fluent Aphasic** | unequal | 4.56 | 5.30 | 0.006* |
| **Comparison Non-Fluent and Fluent Aphasic** | equal | 1.241 | 20 | 0.104 |

**c) Percentage Complex Sentences**

Figure 2.3 and table 2.5 show the percentage of utterances involving the production of complex sentences in the normal and aphasic groups. The production of complex sentences was a measure of the proportion of utterances which included co-ordinate and subordinate sentences and sentences containing post-modifying clauses. The results for the group comparisons can be found in table 2.6. The non-fluent aphasic group differed significantly from the normal subjects in their production of complex sentences. The normal group as a whole produced more complex sentences than the aphasic group. Despite this group difference, only five of the non-fluent subjects produced a percentage of complex sentences which differed by two standard deviations from the normal mean. Some normal subjects produced a very low percentage of complex sentences, and thus, the low percentage of complex sentences in some non-fluent subjects may reflect this normal variation. The fluent group did not

differ significantly from the normal group and the two groups of aphasic subjects did not differ significantly from each other.

**Figure 2.3: Comparison of normal and aphasic groups; Percentage complex sentences**

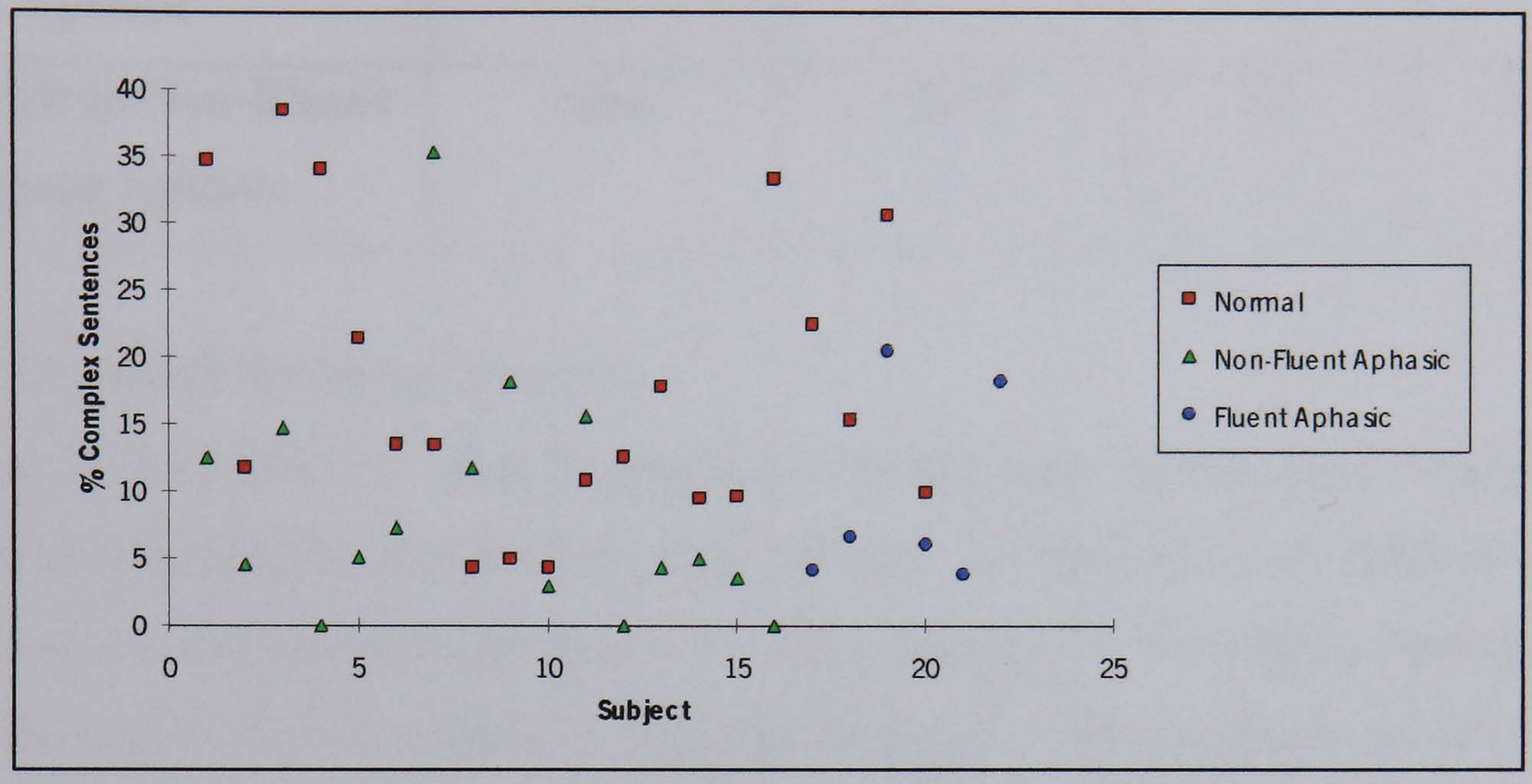



**Table 2.5: Summary of group performance; Percentage complex sentences**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 17.7 | 11.0 | 4.4 | 38.5 |
| **Non-Fluent Aphasic** | 8.8 | 9.2 | 0 | 35.3 |
| **Fluent Aphasic** | 9.9 | 7.5 | 3.9 | 20.5 |

**Table 2.6: T test results of group comparisons; Percentage complex sentences**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | equal | 2.59 | 34 | 0.011* |
| **Comparison Normal and Fluent Aphasic** | unequal | 1.98 | 12.26 | 0.052 |
| **Comparison Non-Fluent and Fluent Aphasic** | equal | 0.253 | 20 | 0.642 |

**d) Percentage Discourse Markers**

Figure 2.4 and table 2.7 show the percentage of utterances containing discourse markers produced by the normal and aphasic groups. The production of discourse markers was considered to be an indicator of the coherence of the sample. Table 2.8 shows the results of the comparisons between the groups. The non-fluent aphasic group differed significantly from the normal group whereas the fluent group did not. There was, however, a significant difference between the two aphasic groups. As a group, the normal subjects produced a higher percentage of utterances with discourse markers. The production of discourse markers by individual normal subjects, however, varied considerably. All of the fluent aphasic subjects, therefore, fell within two standard deviations of the normal mean but at the lower end of the normal range. The non-fluent subjects produced fewer discourse markers than the normal subjects and the fluent aphasic subjects; nearly half of the non-fluent subjects produced no discourse markers at all.

**Table 2.7: Summary of group performance; Percentage discourse markers**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 20.9 | 9.4 | 0 | 36.2 |
| **Non-Fluent Aphasic** | 5.2 | 6.3 | 0 | 18.2 |
| **Fluent Aphasic** | 11.7 | 6.7 | 4.2 | 21.2 |

**Figure 2.4: Comparison of normal and aphasic groups: Percentage discourse markers**

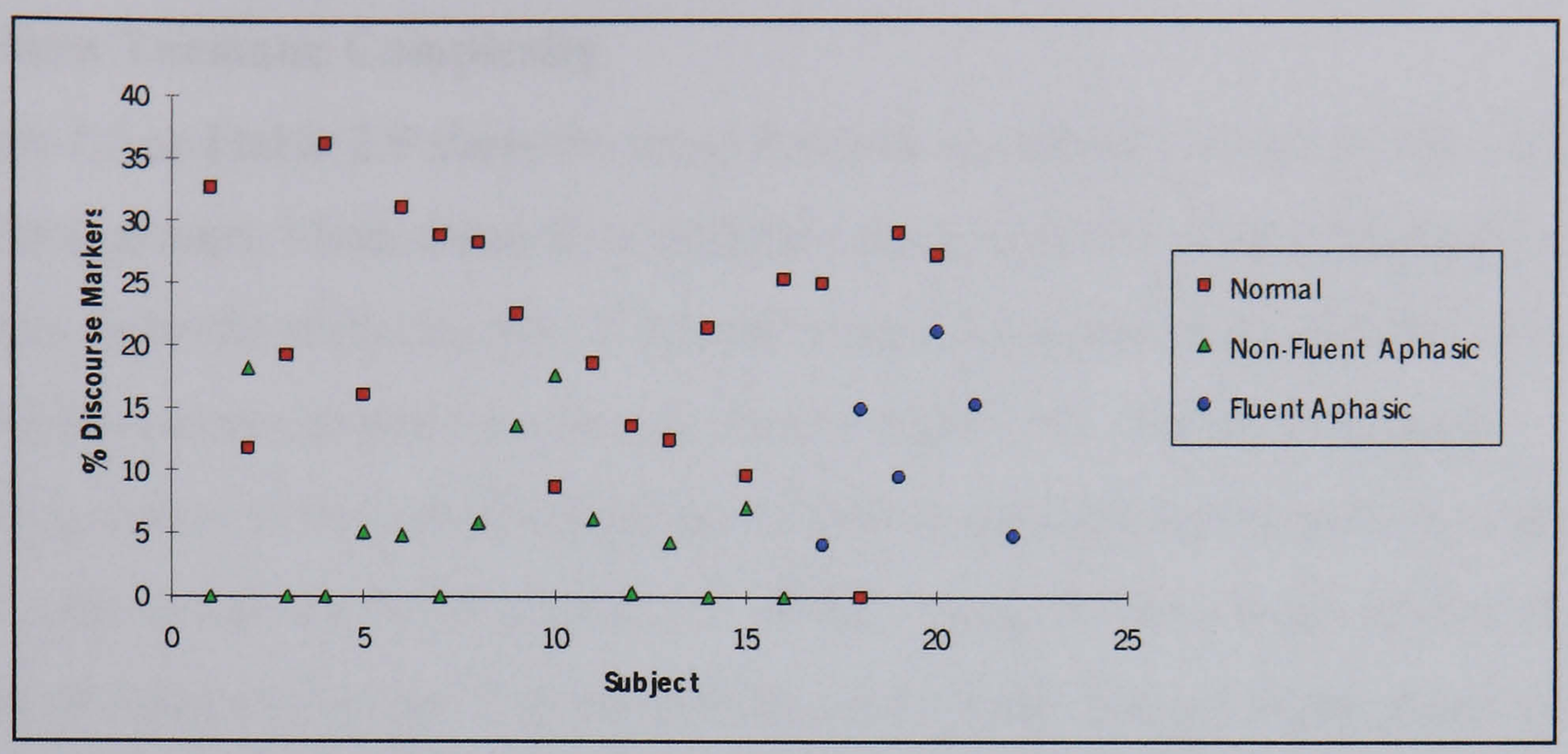



**Table 2.8: T test results of group comparisons; Percentage discourse markers**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | unequal | 5.97 | 33.01 | 0.000* |
| **Comparison Normal and Fluent Aphasic** | unequal | 2.67 | 11.68 | 0.018 |
| **Comparison Non-Fluent and Fluent Aphasic** | equal | 2.13 | 20 | 0.011* |

In summary, the non-fluent aphasic group differed from the normal group on the parameters coded under general information. The non-fluent subjects produced less analysable narrative, fewer complex sentences and fewer discourse markers. The fluent subjects produced a comparable number of discourse markers to the normal subjects but differed on the other parameters. These characteristics were not, however, evident in all of the subjects in the two aphasic groups. The normal subjects' production of complex sentences and discourse markers varied considerably. This normal variability

may account for some of the variability present in the performance of the subjects with aphasia.

### 2.4.2 Thematic Structure

**a) Mean Thematic Complexity**

Figure 2.5 and table 2.9 show the mean thematic complexity scores for the normal and aphasic groups. Mean thematic complexity was a measure of the complexity of utterances, in terms of the number of phrasal components used alongside the verb. The results of the group comparisons are reported in table 2.10. The mean thematic complexity scores of the non-fluent subjects differed significantly from those of the normal subjects and the fluent subjects; 13 of the 16 non-fluent aphasics produced less complex thematic structures than the normal group. There was a roughly equal split between those subjects with a complexity score of greater and less than two. The fluent subjects did not differ significantly from the normal subjects, with half of the group falling within normal limits. The other three fluent subjects, however, had a similar mean thematic complexity score to that of the non-fluent subjects. This overlap may account for the failure to find a significant difference between the fluent and non-fluent aphasic groups.

**Figure 2.5: Comparison of normal and aphasic groups; Mean thematic complexity**

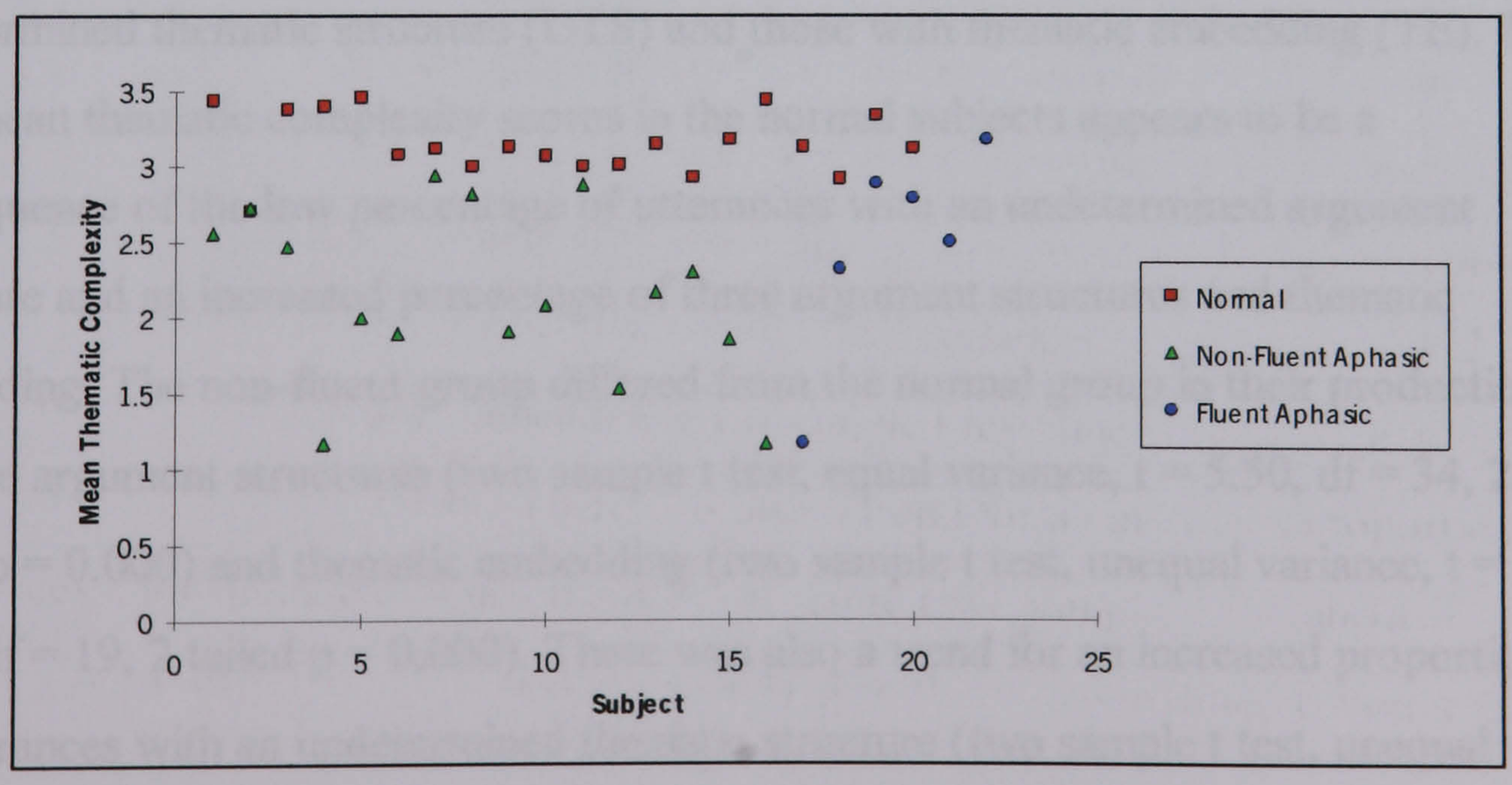


**Table 2.9: Summary of group performance; Mean thematic complexity**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 3.15 | 0.20 | 2.71 | 3.46 |
| **Non-Fluent Aphasic** | 2.16 | 0.56 | 1.17 | 2.94 |
| **Fluent Aphasic** | 2.48 | 0.71 | 1.17 | 3.18 |

**Table 2.10: T test results of group comparisons; Mean thematic complexity**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | unequal | 6.71 | 18.14 | 0.000* |
| **Comparison Normal and Fluent Aphasic** | unequal | 2.31 | 5.25 | 0.066 |
| **Comparison Non-Fluent and Fluent Aphasic** | equal | 1.107 | 20 | 0.159 |

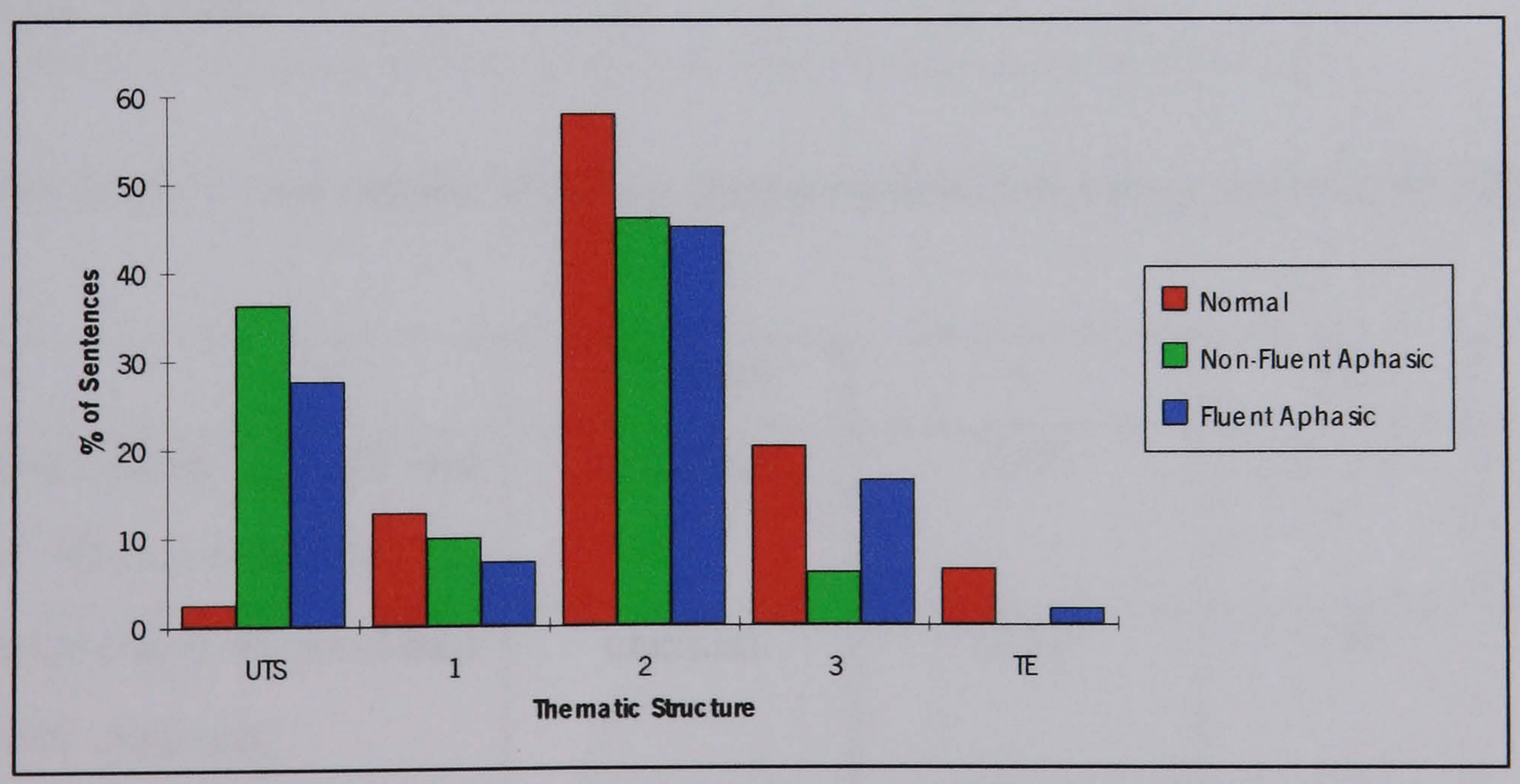
**b) Percentage Thematic Distribution**

The mean percentage distribution of thematic structures is presented in figure 2.6. This measure showed the relative proportions of different types of argument structure. Utterances were grouped into one, two and three argument structures, those with an undetermined thematic structure (UTS) and those with thematic embedding (TE). The high mean thematic complexity scores in the normal subjects appears to be a consequence of the low percentage of utterances with an undetermined argument structure and an increased percentage of three argument structures and thematic embedding. The non-fluent group differed from the normal group in their production of three argument structures (two sample t test, equal variance, $t = 5.50$, $df = 34$, 2 tailed $p = 0.000$) and thematic embedding (two sample t test, unequal variance, $t = 5.38$, $df = 19$, 2 tailed $p = 0.000$). There was also a trend for an increased proportion of utterances with an undetermined thematic structure (two sample t test, unequal variance $t = 4.74$, $df = 15.26$, 2 tailed $p = 0.003$). The fluent group differed from the

normal group in their performance on one argument structures (two sample t test, equal variance, t = 2.27, df = 24, 2 tailed p = 0.008) and thematic embedding (two sample t test, unequal variance, t = 3.26, df = 23.22, 2 tailed p = 0.001). In their production of undetermined thematic structures and two and three argument structures, the fluent group did not differ significantly from normal performance.

The results for the individual subjects can be found in appendix 7. The biggest single contributor to low mean thematic complexity scores was an increased proportion of utterances with an undetermined thematic structure. All, except one subject, who had a low mean thematic complexity score produced an increased proportion of single phrases and utterances containing no main verb. Some individual fluent and non-fluent subjects differed in their ability to produce two and three argument structures. The production of thematic embedding was not considered to be an appropriate comparative measure for individual subjects. Normal subjects varied extensively in their use of this feature, with some subjects producing no utterances containing thematic embedding.

**Figure 2.6: Comparison of normal and aphasic groups; Mean percentage distribution of thematic structure**



### c) Percentage Argument Omission

Table 2.11 shows the percentage argument omission for the normal and aphasic groups. Table 2.12 shows the results of the group comparisons. Percentage argument omission was a measure of the number of utterances requiring two or three arguments, in which one of the arguments had been omitted. The normal subjects rarely omitted verb arguments. Both of the aphasic groups appeared to omit a higher percentage of obligatory arguments, but this difference was not significant for either the non-fluent or fluent aphasic subjects. The omission of arguments was a feature of individual subjects in both groups; ten of the non-fluent subjects and four of the fluent subjects omitted verb arguments. The percentage of argument omission was, however, higher in the non-fluent group. This increase accounts for the significant difference observed in the group comparison of the aphasic subjects.

**Table 2.11: Summary of group performance; Percentage argument omission**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 0.2 | 0.5 | 0 | 1.61 |
| **Non-Fluent Aphasic** | 11.9 | 17.7 | 0 | 66.7 |
| **Fluent Aphasic** | 3.2 | 3.1 | 0 | 7.1 |

**Table 2.12: T test results of group comparisons; Percentage argument omission**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | unequal | 2.66 | 15.02 | 0.018 |
| **Comparison Normal and Fluent Aphasic** | unequal | 2.37 | 5.06 | 0.063 |
| **Comparison Non-Fluent and Fluent Aphasic** | unequal | 1.90 | 17.23 | 0.000* |

In summary, the performance of the non-fluent group was characterised by low mean thematic complexity scores, due to an increased proportion of UTS utterances and a decreased proportion of three argument structures and thematic embedding. Although capable of producing some two and three argument structures, these often involved the omission of obligatory arguments. The majority of the subjects in the non-fluent group displayed these characteristics. The group comparisons suggested that the fluent subjects were capable of producing thematic structure. The performance of some individual fluent subjects did, however, differ from the normal group. The performance of these subjects resembled that of the non-fluent group.

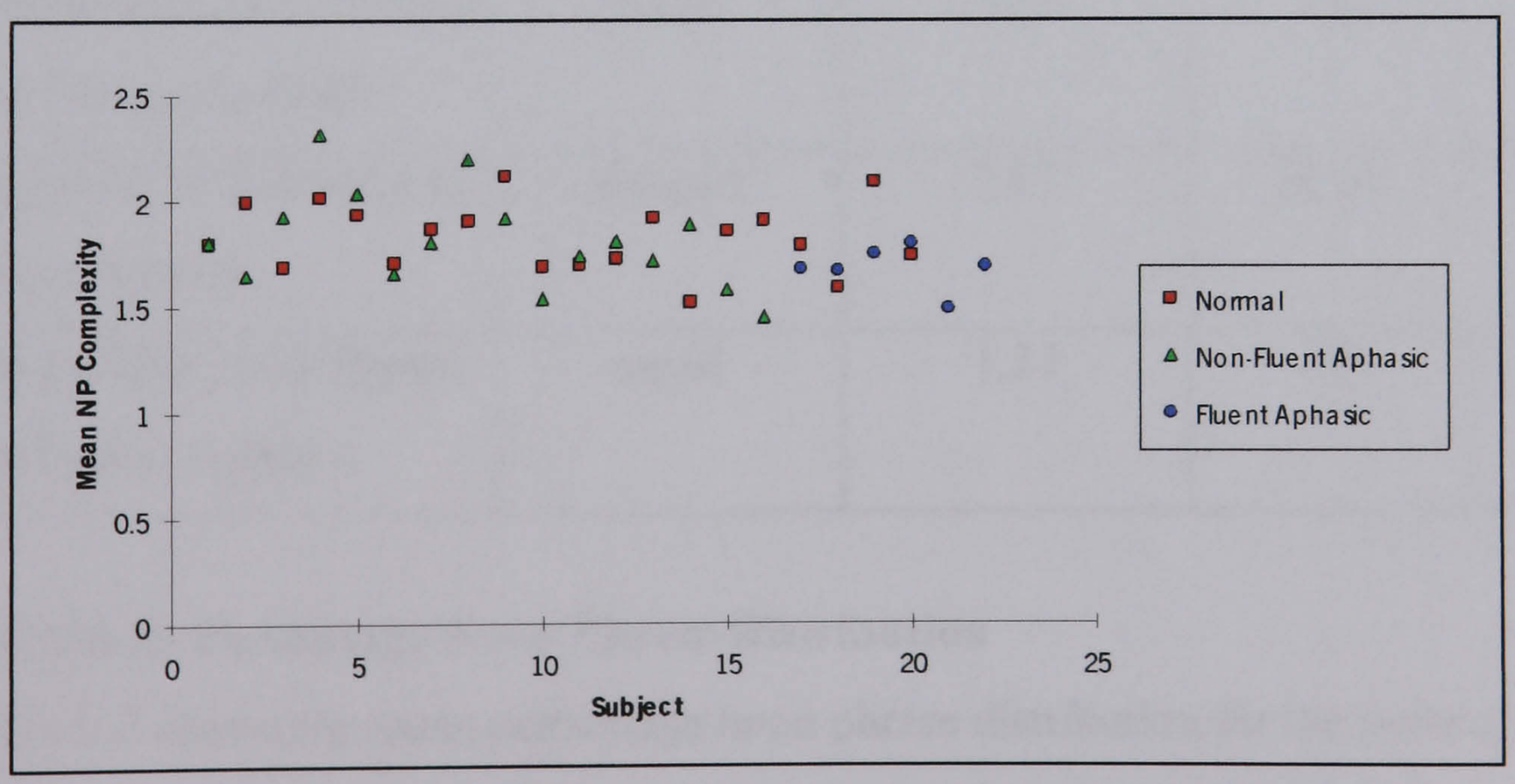
### 2.4.3 Phrasal Structure

#### a) Noun Phrase Structure

#### i) Mean Noun Phrase Complexity

Figure 2.7 and table 2.13 show the mean noun phrase complexity scores for the normal and aphasic groups. Mean noun phrase complexity was a measure of the number of components used in the noun phrase. The comparison of these scores between the groups can be seen in table 2.14.

**Figure 2.7: Comparison of normal and aphasic groups; Mean noun phrase complexity**



There was a lot of overlap between the scores of the normal and aphasic subjects on this parameter; the groups had very similar means and ranges. The non-fluent subjects did not differ significantly from either the normal or the fluent group. Only one of the non-fluent subjects produced noun phrases which were less complex than the normal subjects. The fluent group rather surprisingly did, however, differ from the normal group. The fluent group produced less complex noun phrases than the normal group. The complexity score of only one subject, however, fell outside normal limits. The other five fluent subjects produced noun phrases of comparable complexity to the normal group.

**Table 2.13: Summary of group performance; Mean noun phrase complexity**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 1.8 | 0.2 | 1.5 | 2.1 |
| **Non-Fluent Aphasic** | 1.8 | 0.5 | 1.5 | 2.3 |
| **Fluent Aphasic** | 1.7 | 0.7 | 1.5 | 1.8 |

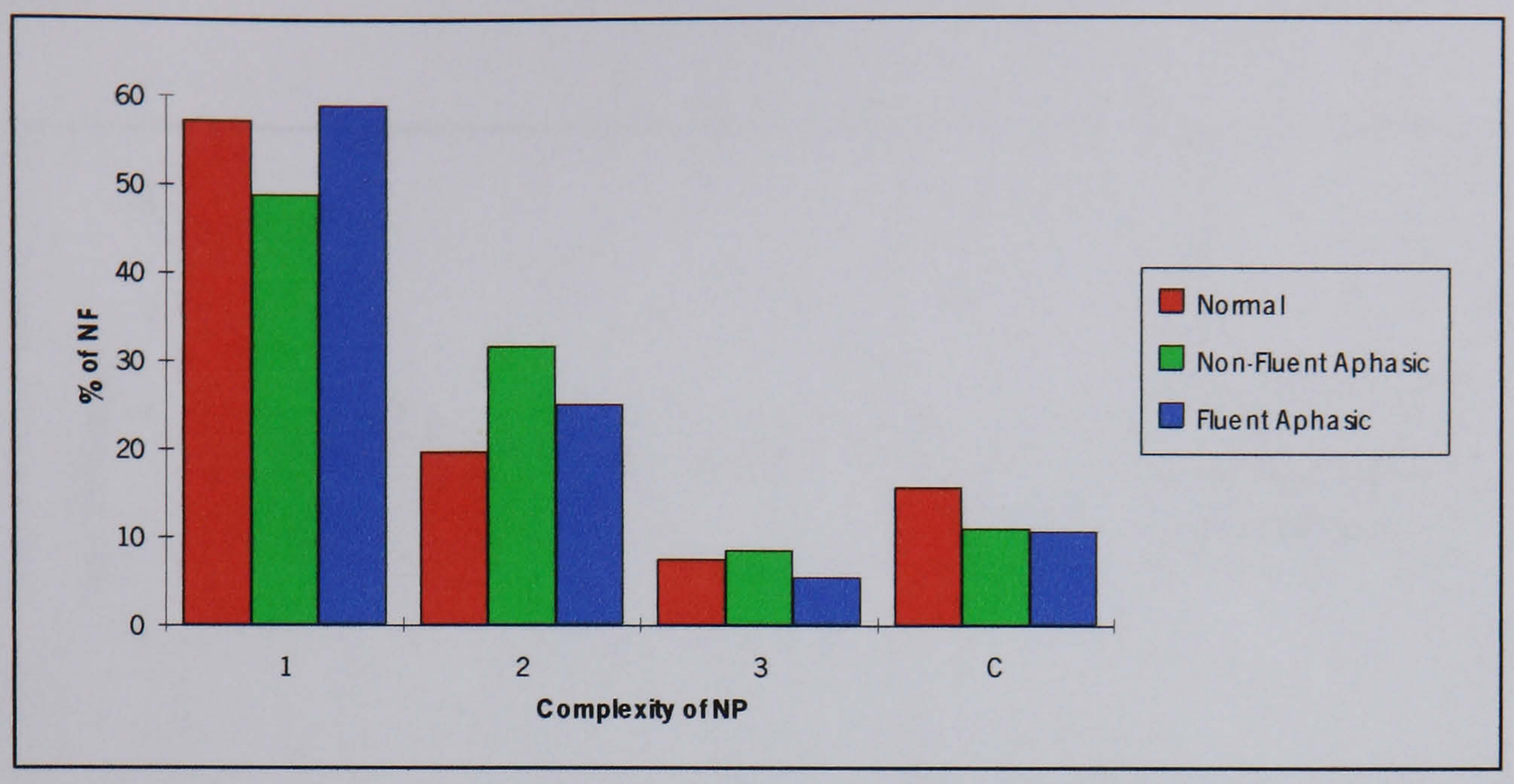
**Table 2.14: T test results of group comparisons; Mean noun phrase complexity**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | equal | 0.20 | 34 | 0.835 |
| **Comparison Normal and Fluent Aphasic** | unequal | 2.67 | 12.86 | 0.016* |
| **Comparison Non-Fluent and Fluent Aphasic** | equal | 1.37 | 20 | 0.064 |

### ii) Mean Percentage Noun Phrase Distribution

Figure 2.8 shows the mean percentage noun phrase distribution for the normal and aphasic subjects. The results for the individual aphasic subjects can be found in appendix 7.

**Figure 2.8: Comparison of normal and aphasic groups; Mean percentage distribution of noun phrase complexity**




This measure indicated the relative proportions of one, two and three component and complex noun phrases. The distribution of noun phrases across the four categories was similar for all three groups. The lower mean noun phrase complexity score in the fluent group appeared to be a consequence of the increased proportion of single component noun phrases and decreased proportion of complex phrases produced by one subject. As a group, the fluent subjects differed significantly from the normal group only in their production of complex noun phrases (two sample t test, unequal variance, $t = 2.66$, $df = 13.68$, two tailed $p = 0.014$).

**b) Verb Phrase Structure**

**ii) Mean Verb Phrase Complexity**

The mean verb phrase complexity scores for the normal and aphasic groups are shown in figure 2.9 and table 2.15. Mean verb phrase complexity was a measure of the number of components used alongside the main verb. The results of the group comparisons can be found in table 2.16. There was no significant difference between the performance of the normal, non-fluent aphasic and fluent aphasic groups in their production of verb phrases. In the production of verb phrases, there was less individual variation than noun phrase production. In the analysis of individual subjects, only three of the non-fluent subjects had a mean verb phrase which was lower than normal limits. All of the fluent subjects produced verb phrases of comparable complexity to the normal group.

**Figure 2.9: Comparison of normal and aphasic groups; Mean verb phrase complexity**

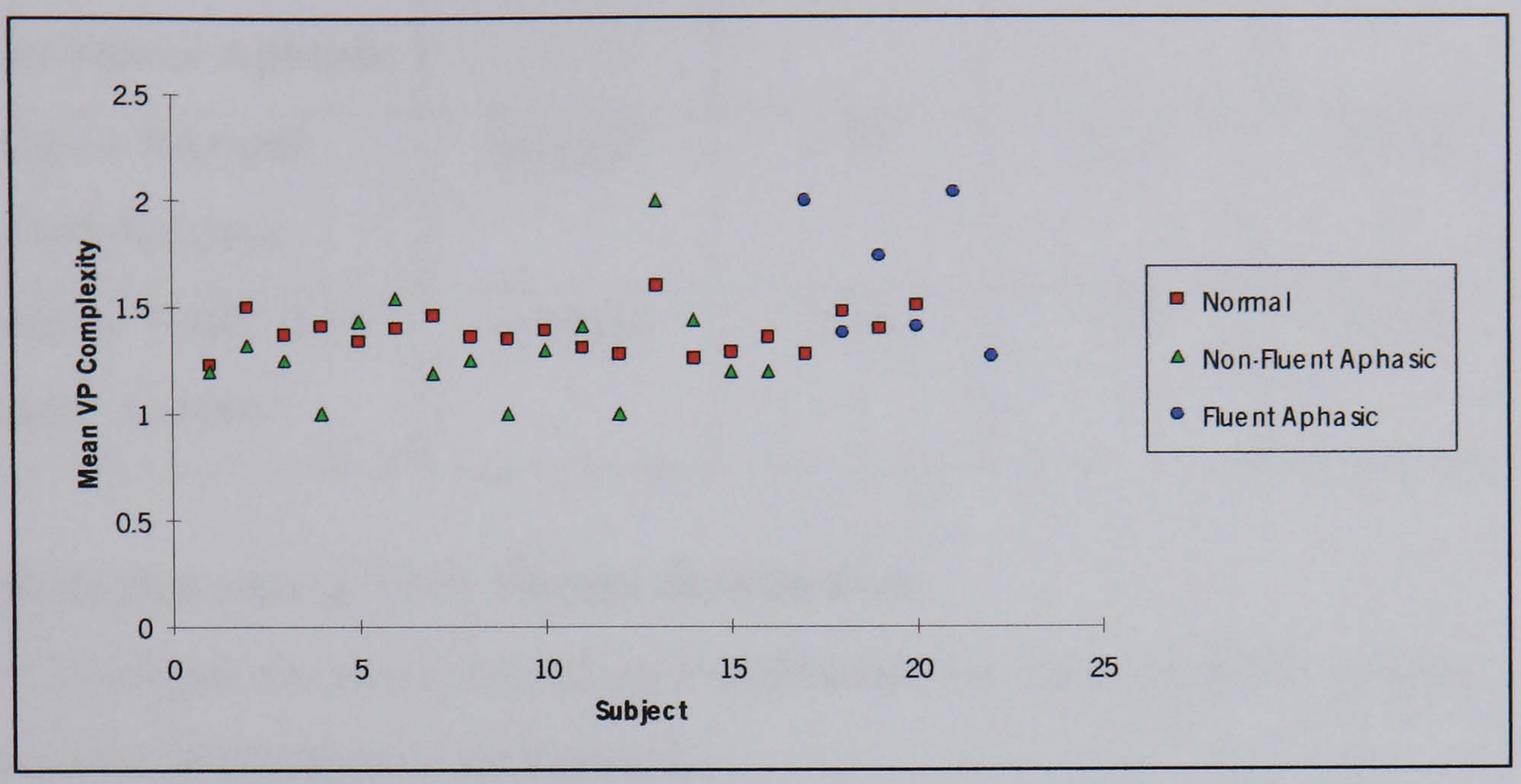



**Table 2.15: Summary of group performance; Mean verb phrase complexity**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 1.4 | 0.1 | 1.2 | 1.6 |
| **Non-Fluent Aphasic** | 1.3 | 0.3 | 1.0 | 2.0 |
| **Fluent Aphasic** | 1.6 | 0.3 | 1.3 | 2.0 |

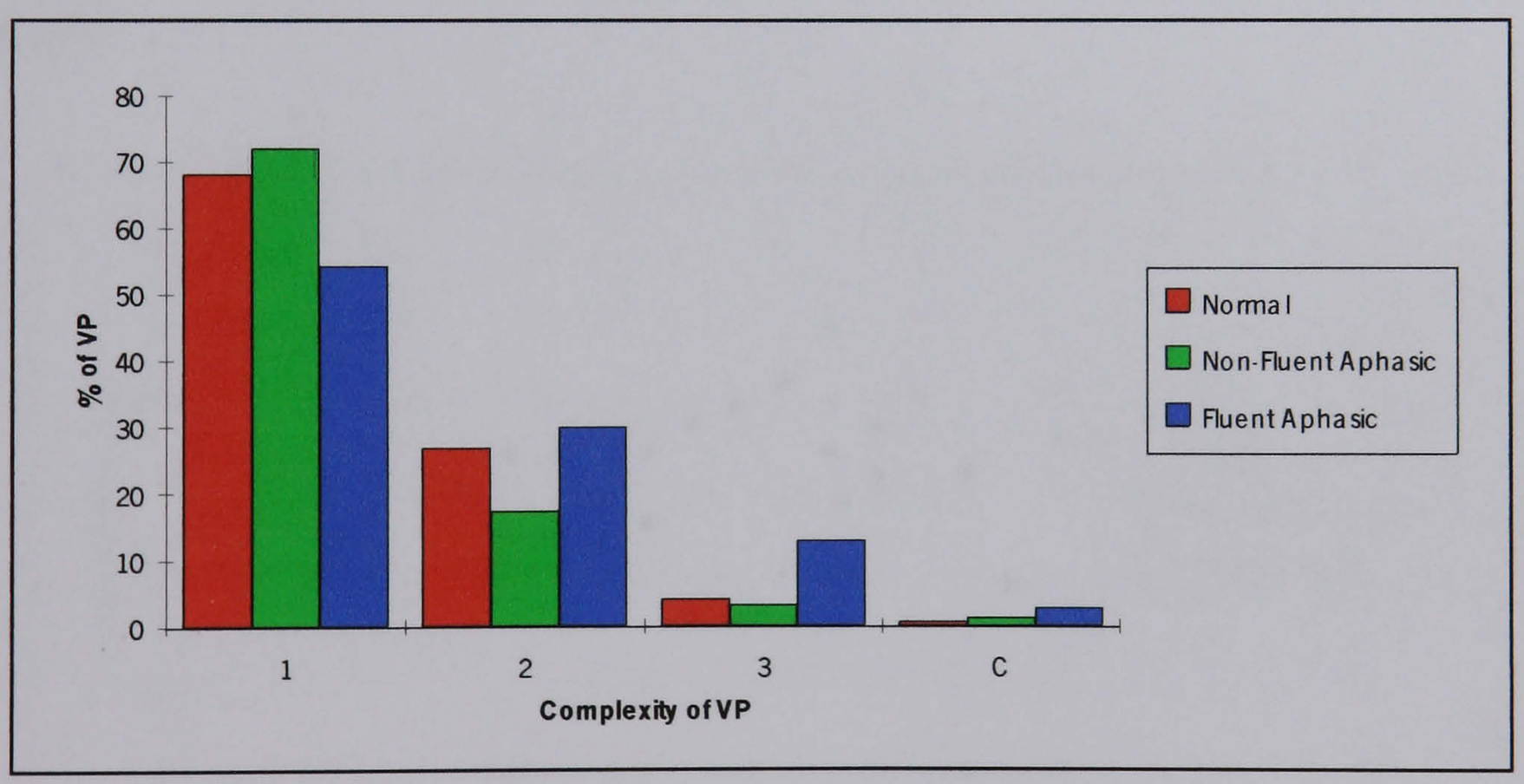
**Table 2.16: T test results of group comparisons; Mean verb phrase complexity**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | equal | 1.39 | 34 | 0.083 |
| **Comparison Normal and Fluent Aphasic** | unequal | 1.89 | 5.24 | 0.114 |
| **Comparison Non-Fluent and Fluent Aphasic** | unequal | 2.30 | 7.16 | 0.052 |

**ii) Mean Percentage Verb Phrase Distribution**

Figure 2.10 shows the mean percentage distributions for the normal and aphasic subjects in the production of verb phrases.

**Figure 2.10: Comparison of normal and aphasic groups; Mean percentage distribution of verb phrase complexity**




The results for the individual aphasic subjects can be found in appendix 7. This measure was used to indicate the relative proportion of one, two and three component and complex verb phrases. The subjects in all three groups produced predominantly one component verb phrases; only a small percentage of verb phrases containing auxiliaries and compound verbs were produced. The low mean verb phrase

complexity scores of the three non-fluent subjects were a consequence of a total reliance on single verbs.

**c) Adjectival Phrase Structure**

**i) Mean Adjectival Phrase Complexity**

The mean adjectival complexity scores for the normal and aphasic groups can be seen in figure 2.11 and table 2.17. Table 2.18 shows the data from the group comparisons. Mean adjectival phrase complexity was a measure of the number of components used in adjectival phrases. It can be seen that there was a lot of individual variability within all of the groups in their performance on this parameter. Neither the fluent or the non-fluent group differed significantly from the normal group with regard to adjectival phrase complexity. The analysis of individual subjects in the non-fluent group showed that four of the subjects produced adjectival phrases of reduced complexity to normal subjects and two subjects produced more complex phrases. Two subjects in the fluent group produced less complex adjectival phrases.

**Figure 2.11: Comparison of normal and aphasic groups; Mean adjectival phrase complexity**

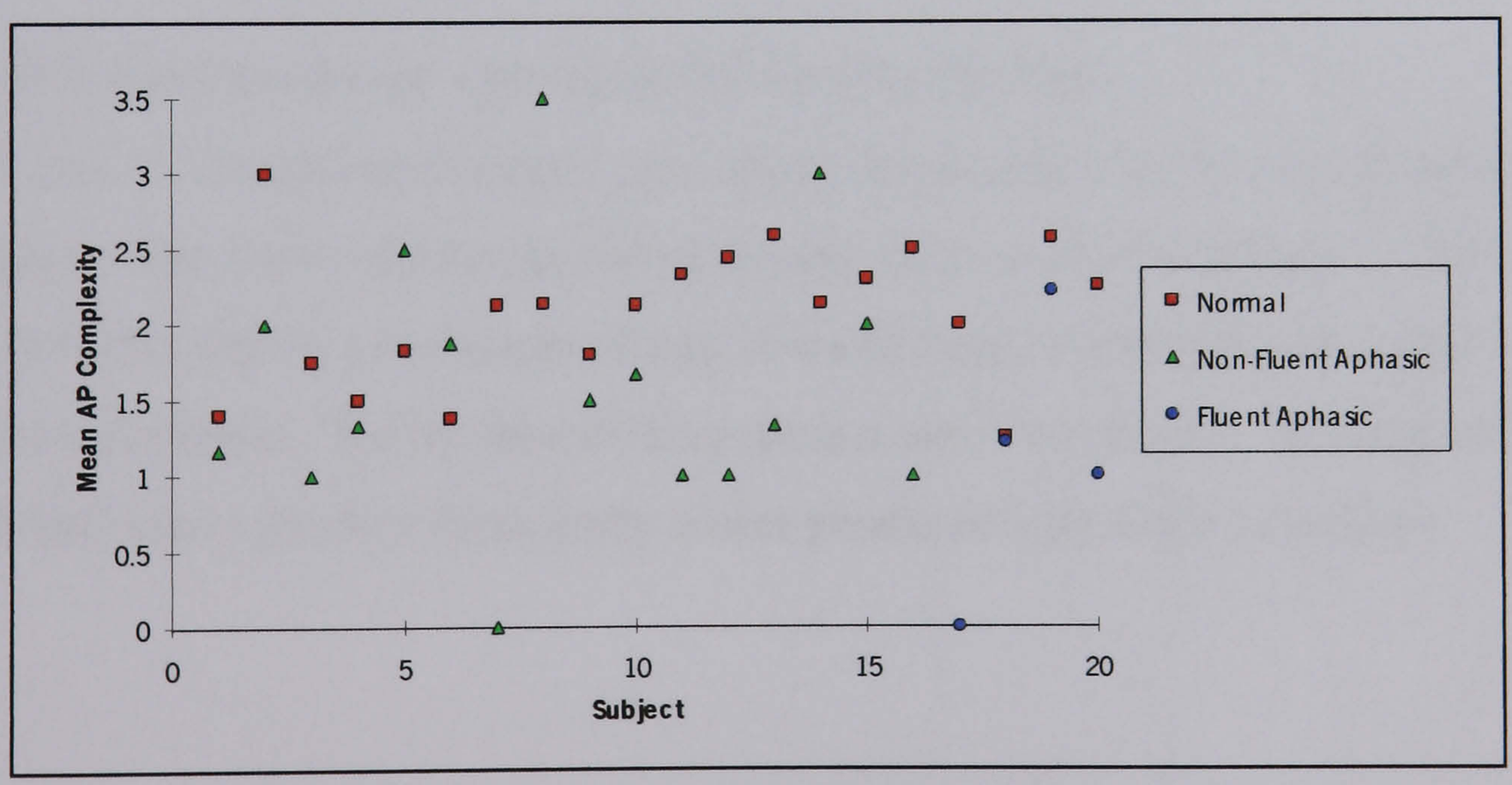


**Table 2.17: Summary of group performance; Mean adjectival phrase complexity**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 2.1 | 0.5 | 1.3 | 3 |
| **Non-Fluent Aphasic** | 1.6 | 0.9 | 0 | 3.5 |
| **Fluent Aphasic** | 1.2 | 0.8 | 0 | 2.2 |

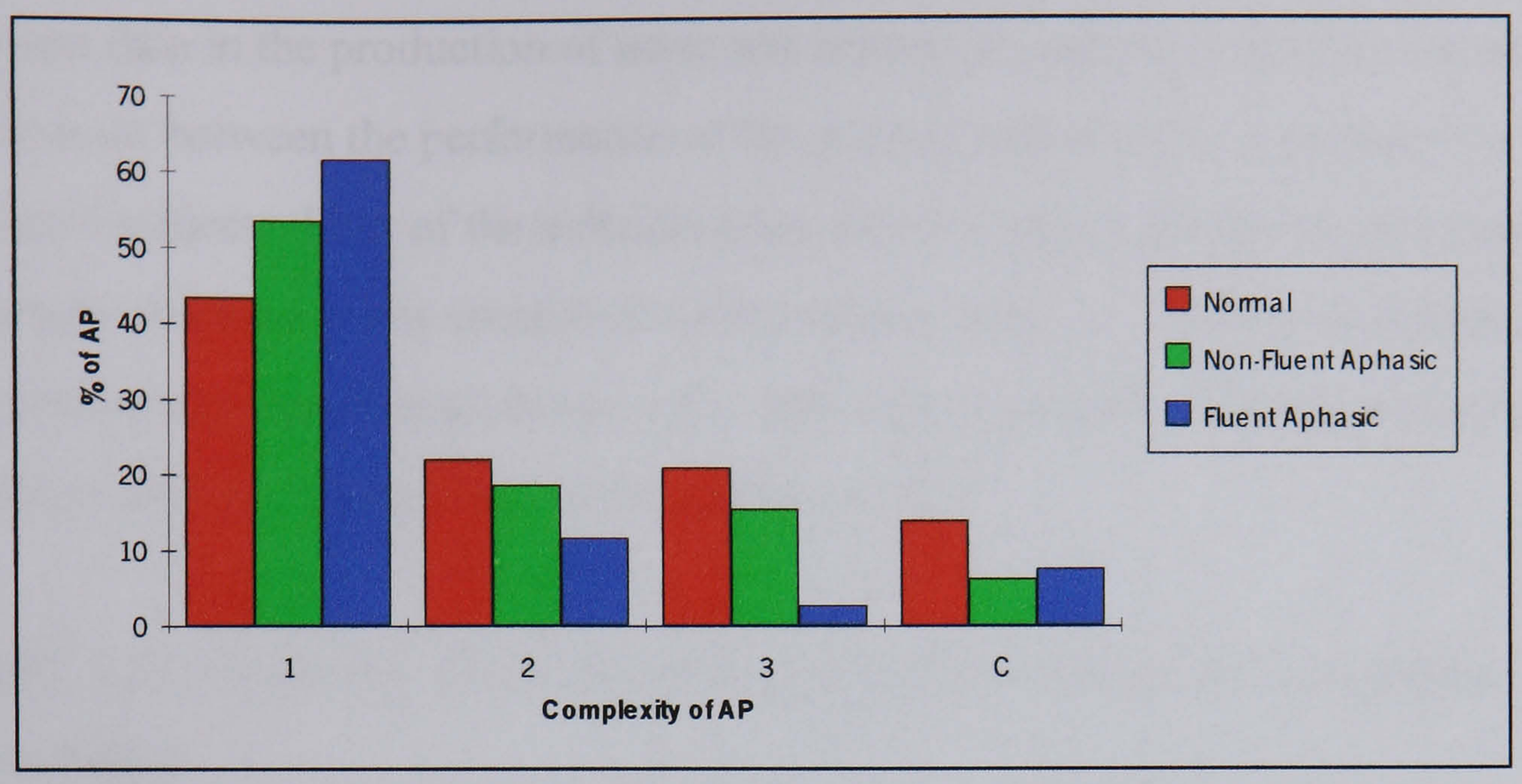
**Table 2.18: T test results of group comparisons; Mean adjectival phrase complexity**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | unequal | 1.90 | 21.76 | 0.066 |
| **Comparison Normal and Fluent Aphasic** | unequal | 2.52 | 6.08 | 0.045 |
| **Comparison Non-Fluent and Fluent Aphasic** | equal | 0.97 | 20 | 0.107 |

**ii) Mean Percentage Adjectival Phrase Distribution**

Figure 2.12 presents the mean percentage distributions for the normal and aphasic subjects. The results for the individual aphasic subjects are in appendix 7. This measure showed the relative proportions of one, two and three component and complex adjectival phrases. The profiles of three groups were very similar. The subjects with reduced mean adjectival complexity scores produced only single adjectives.

**Figure 2.12: Comparison of normal and aphasic groups; Mean percentage distribution of adjectival phrase complexity**

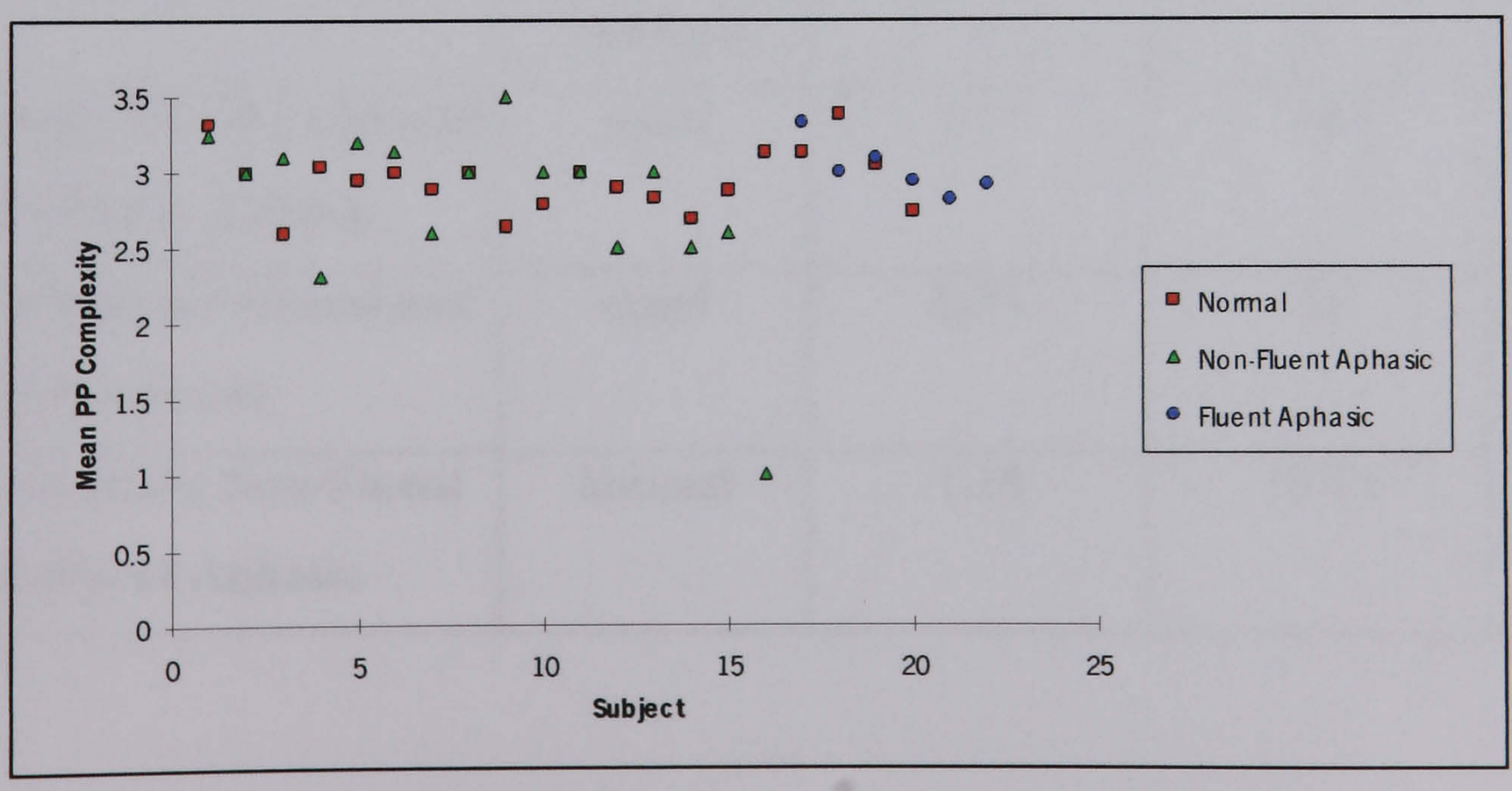



**d) Prepositional Phrase Structure**

**i) Mean Prepositional Phrase Complexity**

Figure 2.13 and table 2.19 present the mean prepositional phrase complexity scores for the normal and aphasic groups. The result of the group comparisons can be seen in table 2.20.

**Figure 2.13: Comparison of normal and aphasic groups; Mean prepositional phrase complexity**



Mean prepositional phrase complexity was a measure of the number of components used in prepositional phrases. There was a great deal of overlap between subjects in the normal and aphasic groups. There was less variability between subjects in the groups than in the production of noun and adjectival phrases. There was no significant difference between the performance of the normal and either the non-fluent or fluent aphasic subjects. Four of the individual non-fluent subjects produced prepositional phrases which were less complex than the normal subjects, whereas the fluent subjects all produced prepositional phrases of comparable complexity. This may account for the trend seen in the comparison of the aphasic groups.

**Table 2.19: Summary of group performance; Mean prepositional phrase complexity**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Group** | 2.95 | 0.20 | 2.60 | 3.38 |
| **Non-Fluent Aphasic** | 2.79 | 0.58 | 1.00 | 3.50 |
| **Fluent Aphasic** | 3.02 | 0.18 | 2.82 | 3.33 |

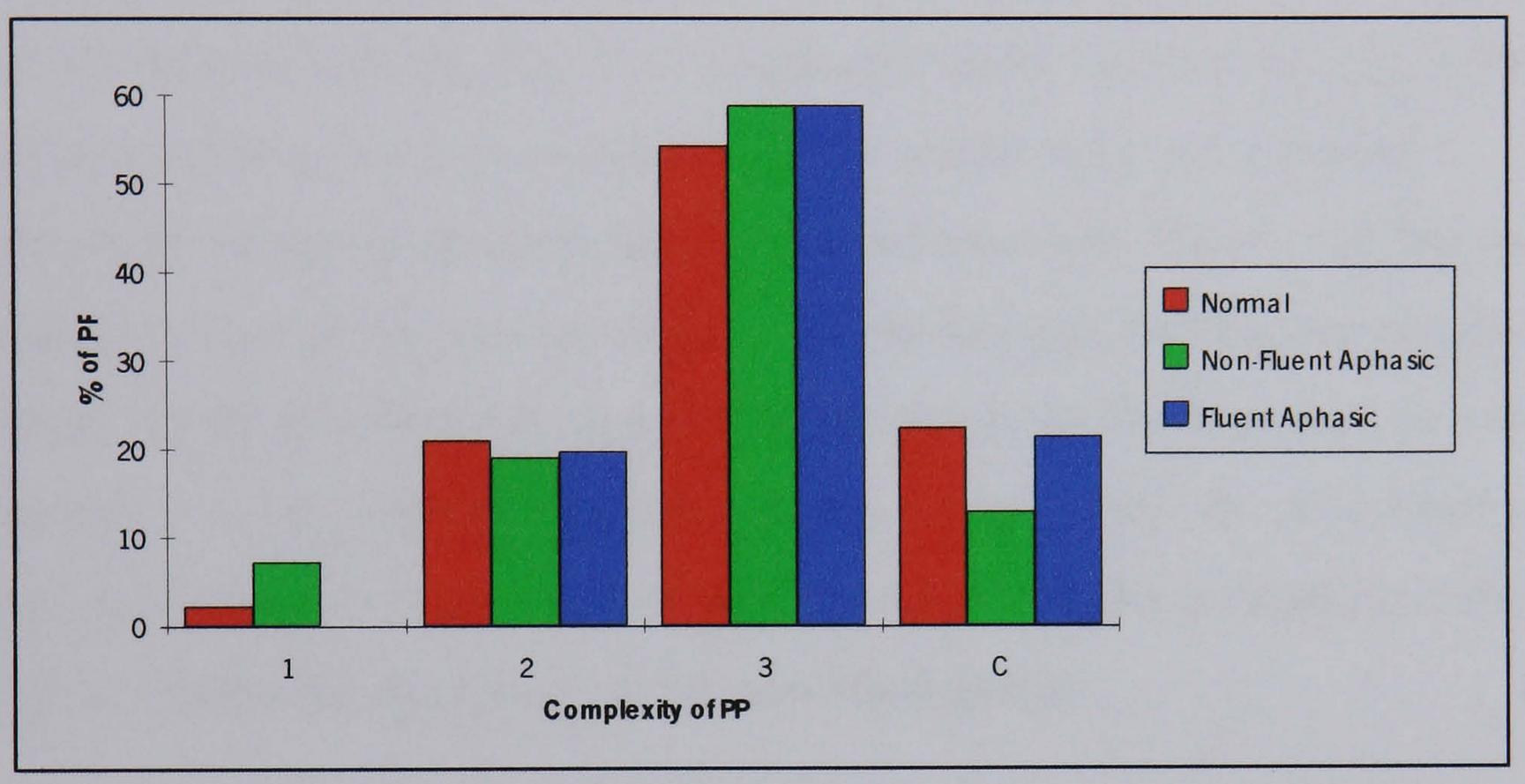
**Table 2.20: T test results of group comparisons; Mean prepositional phrase complexity**

| | Variance | t | df | p |
|---|---|---|---|---|
| **Comparison Normal and Non-Fluent Aphasic** | equal | 1.11 | 34 | 0.262 |
| **Comparison Normal and Fluent Aphasic** | equal | 0.74 | 24 | 0.216 |
| **Comparison Non-Fluent and Fluent Aphasic** | unequal | 1.38 | 19.75 | 0.035 |

**ii) Mean Percentage Prepositional Phrase Distribution**

The mean percentage distribution of prepositional phrases for the normal and aphasic groups can be seen in figure 2.14. The results for the individual aphasic subjects can be seen in appendix 7.

**Figure 2.14: Comparison of normal and aphasic groups; Mean percentage distribution of prepositional phrase complexity**




This measure was used to show the relative proportions of one, two and three component and complex prepositional phrases. The three subject groups had very similar distributions. In each case, the majority of prepositional phrases consisted of three components. The reduced prepositional phrase complexity of individual non-fluent subjects was a consequence of the increased number of single prepositions.

**e) Phrasal Errors**

The normal subjects produced a very low percentage of phrasal errors, in both the production of open and closed class vocabulary. The mean percentage of normal phrasal errors was always less than one percent. In addition, there were around another one percent of utterances in which a repair of an incorrect word had occurred. Table 2.21 shows the mean percentage of errors on each of the word classes tested for the aphasic groups. They produced an increased percentage of error on all

of the parameters tested. The performance of the individual aphasic subjects varied greatly within the aphasic group, both in terms of the percentage of error and the word classes affected (these will be discussed in section 2.7.5).

The phrasal errors produced for the closed class vocabulary consisted of both omissions and substitutions. The relative proportions of these types of error for the fluent and non-fluent groups can be found in table 2.22. There was no significant difference between the fluent and non-fluent groups in the overall proportion of omission and substitution errors. There was, however, some differences related to the class of words. In both the fluent and non-fluent groups, errors involving the use of pronouns and determiners were predominantly substitutions and omissions respectively. In the use of auxiliaries and prepositions there was some differences between the two aphasic groups. In the production of prepositions, the non-fluent subjects, mainly produced omission errors, whereas in the fluent group there was an equal split between omissions and substitutions. In the production of auxiliaries, both groups produced a mixture of errors, with substitution errors dominating in the fluent group and omissions dominating in the non-fluent group.

**Table 2.21: Aphasic Groups; Percentage Phrasal Errors**

| | | Non-Fluent | | | Fluent Group | |
|---|---|---|---|---|---|---|
| | **Mean** | **s.d.** | **Range** | **Mean** | **s.d.** | **Range** |
| **Determiner** | 17.21 | 16.57 | 50.00 | 5.46 | 6.97 | 16.67 |
| **Pronoun** | 2.42 | 5.57 | 18.52 | 10.20 | 11.41 | 23.37 |
| **Preposition** | 11.30 | 18.79 | 50.00 | 9.15 | 5.74 | 13.38 |
| **Auxiliary** | 17.12 | 23.52 | 66.67 | 9.08 | 8.01 | 18.18 |
| **Main Noun** | 5.39 | 5.71 | 22.22 | 10.38 | 13.11 | 33.33 |
| **Main Verb** | 2.91 | 8.51 | 33.33 | 13.14 | 18.47 | 48.08 |

**Table 2.22: Aphasic Groups; Phrasal Error Types**

| | Non-Fluent | Non-Fluent | Fluent | Fluent |
|---|---|---|---|---|
| | % Omission | % Substitution | % Omission | % Substitution |
| **Determiner** | 77.4 | 22.6 | 83.3 | 16.7 |
| **Pronoun** | 0 | 100 | 0 | 100 |
| **Preposition** | 80.0 | 20.0 | 50.0 | 50.0 |
| **Auxiliary** | 33.3 | 66.7 | 85.7 | 14.3 |
| **Total** | 57.1 | 42.9 | 35.6 | 64.4 |

In summary, the non-fluent group was able to produce phrases of comparable complexity to the normal group. Some individual subjects did, however, produce less complex phrases. The fluent group differed from the normal group in their ability to produce complex noun phrases. Errors involving the use of function words were characteristic of both the fluent and non-fluent subjects. There was no significant differences between the two groups with regard to the overall percentage of error, the word classes affected or the type of errors made.

### 2.4.4 Morphological Structure

#### a) Frequency of Morpheme Use

Examples of each of the grammatical morphemes were not produced in all of the samples. The frequency of use varied across the morphemes. The mean frequency of use in the samples for the individual morphemes is shown in the table 2.23. The aphasic subjects as a group used morphology less frequently than the normal subjects. Tables 2.24 and 2.25 show the results of the two sample t tests used to compare the frequency of use of the individual morphemes.

The performance of the aphasic groups differed significantly from the performance of the normal group. The non-fluent subjects differed significantly in the frequency with which six of the eight morphemes were used; only in their use of the progressive 'ing' form and the third person singular 's' form did the two groups not differ. The fluent subjects also produced the progressive 'ing' form and the third person singular 's'

form with comparable frequency to normal subjects. In addition, they did not differ significantly from the normal group in the frequency of use of the possessive 's' form, irregular past and irregular plurals. The comparisons of the non-fluent and fluent aphasic groups yielded no significant differences. The normal and aphasic groups all used the irregular past morpheme more than the other noun and verb morphology. The least frequent morphemes, possessive 's', irregular plurals and perfect 'en' were rarely used by any of the subject groups. The relative frequency of use of the other morphemes varied between subject groups. As with the production of closed class vocabulary, there was some individual variation in the use of individual morphemes.

**Table 2.23: Comparison of normal and aphasic groups; Frequency of correct morpheme use in narrative sample**

| Morpheme | Normal Group Mean | Non-Fluent Group Mean | Fluent Group Mean |
|---|---|---|---|
| **Regular Plural (Rpl)** | 10.60 | 4.63 | 6.17 |
| **Irregular Plural (Ipl)** | 1.85 | 0.48 | 1.00 |
| **Possessive 's' (Ps)** | 0.95 | 0.09 | 0.33 |
| **Regular Past (Red)** | 18.35 | 2.38 | 2.67 |
| **Irregular Past (Ied)** | 22.05 | 5.00 | 10.33 |
| **Progressive 'ing' (ing)** | 4.70 | 3.25 | 4.83 |
| **Perfect 'en' (en)** | 0.75 | 0.05 | 0.17 |
| **3rd Person 's' (3s)** | 1.15 | 1.63 | 8.33 |

**Table 2.24: T test results for comparison of normal and non-fluent aphasic groups; Frequency of correct morpheme use in narrative sample**

| Morpheme | Variance | t value | df | 2 tailed p value |
|---|---|---|---|---|
| **Regular Plural (Rpl)** | equal | 4.12 | 34 | 0.000* |
| **Irregular Plural (Ipl)** | unequal | 3.68 | 26.10 | 0.001* |
| **Possessive 's' (Ps)** | unequal | 3.33 | 19 | 0.002* |
| **Regular Past (Red)** | unequal | 7.58 | 22.98 | 0.000* |
| **Irregular Past (Ied)** | unequal | 4.90 | 26.43 | 0.000* |
| **Progressive 'ing' (ing)** | equal | 1.01 | 34 | 0.309 |
| **Perfect 'en' (en)** | equal | 2.80 | 34 | 0.007* |
| **3rd Person 's' (3s)** | equal | 0.64 | 34 | 0.521 |

* Significant difference between the normal and aphasic subjects.

**Table 2.25: T test results for comparison of normal and fluent aphasic groups; Frequency of correct morpheme use in narrative sample**

| Morpheme | Variance | t value | df | 2 tailed p value |
|---|---|---|---|---|
| **Regular Plural (Rpl)** | equal | 1.79 | 24 | 0.008* |
| **Irregular Plural (Ipl)** | equal | 1.21 | 24 | 0.023 |
| **Possessive 's' (Ps)** | equal | 1.11 | 24 | 0.111 |
| **Regular Past (Red)** | unequal | 6.41 | 22.01 | 0.000* |
| **Irregular Past (Ied)** | unequal | 2.09 | 10.19 | 0.050 |
| **Progressive 'ing' (ing)** | unequal | 0.07 | 10.37 | 0.935 |
| **Perfect 'en' (en)** | unequal | 2.00 | 22.12 | 0.015* |
| **3rd Person 's' (3s)** | unequal | 1.35 | 5.06 | 0.233 |

* Significant difference between the normal and aphasic subjects.

**b) Morphological Errors**

The normal group of subjects made a very low percentage of morphological errors, less than 1 percent on each of the morphemes. The mean percentage of errors for the aphasic groups are shown in table 2.26. The aphasic subjects only made errors on five of the eight morphemes. Their lack of errors in the production of Ps, Ipl and en, may reflect their low frequency of use in the sample. For both the fluent and non-fluent subjects, it was the third person 's' morpheme which was most frequently used in error. The hierarchy of error on the other morphemes varied between the subject groups. As with the production of closed class vocabulary, individual subjects varied in the percentage of error and the morphemes affected. These variations will be discussed in section 2.7.6. The majority of errors in both of the groups were omission errors (72.7% in the non-fluent group and 64.3% in the fluent group).

**Table 2.26: Frequency of Morphological Errors**

| | | Non-Fluent Group | | | Fluent Group | |
|---|---|---|---|---|---|---|
| | Mean | s.d. | Range | Mean | s.d. | Range |
| **Regular Plural (Rpl)** | 6.5 | 15.3 | 54.5 | 22.2 | 25.1 | 50 |
| **Irregular Plural (Ipl)** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Possessive 's' (Ps)** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Regular Past (Red)** | 10.3 | 20.5 | 50 | 0 | 0 | 0 |
| **Irregular Past (Ied)** | 5.3 | 11.4 | 33.3 | 3.9 | 6.81 | 16.7 |
| **Progressive 'ing' (ing)** | 0 | 0 | 0 | 6.7 | 16.3 | 40.0 |
| **Perfect 'en' (en)** | 0 | 0 | 0 | 0 | 0 | 0 |
| **3rd Person 's' (3s)** | 21.0 | 41.8 | 100 | 28.1 | 48.1 | 98.3 |

In summary, both the fluent and non-fluent groups had difficulty producing noun and verb morphology. The aphasic subjects produced most morphemes less frequently than the normal subjects. There is evidence that the aphasic subjects rely on the progressive 'ing' form of the verb. In addition, they often omitted morphology or used

it inappropriately. As with the phrasal errors, there was no significant differences between the fluent and non-fluent subjects in the percentage of error, the morphology affected or the type of errors made.

### 2.4.5 Summary of Results

The results of the group comparisons are summarised in table 2.27. The non-fluent and fluent groups differed from the normal group in their production of analysable narrative and complex sentences. The non-fluent subjects found it difficult to produce complex thematic structures; their sentence production was characterised by utterances with an undeterminable argument structure and omitted arguments. These features were also present in the speech of the fluent aphasics but to a lesser degree; their performance did not differ significantly from the normal group. The non-fluent aphasic group produced phrases of comparable complexity to the normal group; the fluent group, however, produced less complex noun phrases. Errors involving the use of function words were characteristic of both the fluent and non-fluent aphasics. There was no significant differences between the two groups, with regard to the overall percentage of error, the word classes affected or the type of errors made. Both the fluent and non-fluent groups also had difficulties producing noun and verb morphology. The aphasic subjects produced most morphemes less frequently than the normal subjects and often omitted morphology or used it inappropriately. As with the phrasal errors, there was no significant differences between the fluent and non-fluent subjects in the percentage of error, the morphemes affected or the types of errors made.

The examination of the performance of individual subjects questioned the prominence of some of these features of performance. On all of the parameters, the aphasic subjects demonstrated increased variability (as indicated by larger standard deviations) than the normal group. On each of the parameters tested, there was some overlap between the performance of individual aphasic and normal subjects, with some of the aphasic subjects not differing significantly from the normal group. In some cases, the observed group differences seemed to be a consequence of the performance of a minority of individual subjects.

**Table 2.27: Summary of comparisons between normal and aphasic groups**

| | Comparison Normal and Non-Fluent | Comparison Normal and Fluent | Comparison Fluent and Non-Fluent |
|---|---|---|---|
| **GENERAL INFORMATION** | | | |
| **Rate of Speech** | + | + | + |
| **Percentage Narrative** | + | + | - |
| **Percentage Complex Sentences** | + | + | - |
| **Percentage Discourse Markers** | + | + | + |
| **THEMATIC STRUCTURE** | | | |
| **Mean Thematic Complexity Score** | + | - | - |
| **Percentage Argument Omission** | + | - | + |
| **PHRASAL STRUCTURE** | | | |
| **Mean Noun Phrase Complexity Score** | - | + | - |
| **Mean Verb Phrase Complexity Score** | - | - | - |
| **Mean Adjectival Phrase Complexity Score** | - | + | - |
| **Mean Prepositional Phrase Complexity Score** | - | - | - |

+ = Significant difference - = Non-significant difference

## 2.5 Discussion of Comparisons of Normal and Aphasic Groups

The aim of the narrative analysis was to characterise the features of sentence production in the narratives of non-fluent and fluent aphasic subjects compared to that of normal speakers. The analysis investigated the realisation of thematic, phrasal and morphological structure. This discussion is divided into three sections. Initially the importance of obtaining normal data will be discussed, with reference to the characteristics identified in normal speakers. Secondly, hypothesis one will be

evaluated by examining whether the features observed in the non-fluent and fluent speakers are consistent with agrammatism and paragrammatism respectively. Finally the validity of hypothesis two will be discussed by comparing the performance of the fluent and non-fluent subjects.

### 2.5.1 Characteristics of Normal Sentence Production

Previous analyses of aphasic sentence production have not obtained comprehensive information about normal performance; these studies have often relied on a limited number of normal subjects and have focused their investigation on a particular level of linguistic structure. This study, therefore, represented the first attempt to describe the narrative speech of a group of 20 normal speakers in terms of thematic, phrasal and morphological structure. The production of a fairy tale proved to be a good way of obtaining a sample of sentences with a relatively predictable content. All of the normal subjects were able to convey the main events of the story, although they varied in the amount of detail given and thus the length of the sample. As predicted, the telling of a story resulted in the production of thematically complete sentences; there was a very low percentage of argument omission. The normal subjects also produced very few errors in their realisation of function words and inflections and almost all of these were self-corrected. On other parameters investigated in the analysis, normal performance was characterised by more extensive variability between subjects. On some parameters, this variability was so great, as indicated by large standard deviations, that the parameter was not considered an adequate comparative measure.

The normal subjects varied quite extensively in their rate of speech, although all subjects gave the impression of fluent, coherent speech. All of the normal subjects produced a consistently high percentage of speech which formed part of the narrative and a low percentage of repair, repetition and unrelated speech. In the production of complex sentences and discourse markers, the performance of normal subjects was characterised by extensive variability. In some normal speakers, complex sentences and discourse markers were very prevalent features of performance, in others these aspects were not present at all. The telling of the story of Cinderella resulted in the production of a range of thematic structures. The normal subjects all produced a low percentage

of single phrases, preferring the production of sentences. These sentences consisted of one, two and three argument structures, containing optional and obligatory verb arguments and non-arguments. The performance of the normal subjects was relatively consistent across these parameters. In the production of thematic embedding, the same level of consistency was not present; some normal subjects did not use thematic embedding at all. The production of the narrative involved the production of noun, verb, adjectival and prepositional phrases. Noun, verb and prepositional phrases were produced frequently by the normal subjects; adjectival phrases, although present in all samples, were a more variable feature of normal performance. The noun phrases produced by the normal subjects consisted of single nouns, pronouns, two and three component phrases and complex phrases. Individual subjects in the normal group produced these different noun phrases with roughly comparable frequency to each other. The majority of the normal subjects produced examples of regular and irregular plural morphemes but the possessive 's' morpheme was used infrequently. In the production of verb phrases, single component verb phrases dominated the samples of the normal subjects. Normal subjects showed a limited use of auxiliaries and compound verbs; this resulted in low mean verb phrase complexity scores. The use of three component phrases and complex verb phrases was very variable in normal subjects. The telling of the story relied predominantly on the expression of simple past tense; this may account for the limited use of auxiliaries and the limited frequency of some verb morphology in the normal samples. In the production of prepositional phrases, the normal subjects relied predominantly on the production of a preposition, determiner and noun structure. Evidence of other types of prepositional phrases was not present in all of the normal samples. In the production of adjectival phrases, subjects not only varied in the frequency of use, but also in the complexity of the phrases. Adjectival complexity scores varied extensively between individual subjects in the normal group.

The results of the normal subjects highlight the value of a task in eliciting particular types of linguistic structure and the variability present in individual performance. These are both factors which should be considered when interpreting the patterns seen in aphasic sentence production deficits. An analysis of normal subjects provides the

researcher with an increased awareness of the aspects which should be present in the sample. Without this knowledge, unrealistic expectations may be imposed on the aphasic subjects, due to idealistic impressions of normal performance. Not all aspects which people assume to be characteristic of normal performance are present in every task. In the narrative task, the lack of complex verb phrases and the use of limited verb morphology is characteristic of normal performance, although it is assumed that normal subjects are able to produce them. The lack of evidence of complex verb phrases and the limited use of morphology in the narratives of the subjects with aphasia, therefore, should not be considered indicative of a deficit. Further investigations of the production of verb morphology, in contexts where normal subjects do produce complex verb phrases, would be required. Variability between different individuals in their performance on a task, may reflect individual styles or preferences. The variable use of thematic embedding, complex adjectival phrases, complex sentences and discourse markers by the normal subjects are perhaps indicative of certain narrative styles; this variability in style should also be considered a normal aspect of aphasic performance. The comparison of individual aphasic performance on these parameters should be treated with an appropriate caution. More reliable comparisons can be made between the aphasic and normal groups on parameters where there is some consistency in normal performance. The extent of performance variability may be task dependent; for example, the production of thematic embedding may be a consistent feature of conversational speech (as in the normal subjects analysed by Whitworth 1995a), but not in narrative speech. In this case, the limited production of thematic embedding in aphasic speakers may be indicative of a deficit. Alternatively, the consistent presence of thematic embedding may reflect the more limited samples of normal data which were analysed by Whitworth in her study. This highlights the need to obtain comprehensive normal data on a range of tasks and then choose an appropriate task (or combination of tasks) to assess the parameters of interest.

### 2.5.2 Characteristics of Sentence Production in Non-Fluent and Fluent Aphasic Speakers

The aphasic subjects were grouped according to the fluency of the speech as this seemed to be the major feature which distinguished agrammatism and paragrammatism (Saffran et al 1989). By definition, the non-fluent subjects differed from the normal group in their rate of speech, due to increased hesitations and pauses. This resulted in the apparently dysprosodic speech characteristic of agrammatism. Rate of speech was not, however, a discrete characteristic but a continuum across the two aphasic groups. As predicted, both groups of aphasic speakers produced a lower percentage of analysable narrative, compared to normal speakers. The aphasic narratives were characterised by repair, repetition and the production of inappropriate material. Previous research has suggested that complex sentences are produced less frequently by both fluent aphasic (Edwards 1995) and non-fluent agrammatic speakers (Goodglass et al 1973). A similarly low percentage of complex sentences in the fluent and non-fluent groups provides some support for these findings. The performance of individual subjects in the two groups, however, questions the prevalence of these deficits in producing complex sentences. Only half of the non-fluent subjects and two fluent subjects produced fewer complex sentences than normal subjects; the other subjects were within normal limits. Poor production of complex sentences, therefore, cannot be considered a consistent pattern of deficit in either group. The performance of the aphasic subjects may partially reflect the variability in the performance of normal subjects on these parameters. The limited use of complex sentences in some subjects may, therefore, be a consequence of normal stylistic variation. Edwards (1995) suggested that fluent subjects were impaired in their use of grammatical devices to link clausal and phrasal structure; it was predicted that this may result in a decreased percentage of discourse markers. The fluent subjects, however, produced a comparable number of discourse markers to the normal subjects. The total lack of discourse markers in the narratives of some non-fluent subjects does, however, seem to extend beyond normal variability. Further investigations would be needed to determine

whether these subjects were capable of producing these aspects in contexts in which they were essential.

Previous descriptions of agrammatic speech have identified simplified sentence structure with a reliance on simple one and two argument structures (Goodglass et al 1973, Saffran et al 1989, Thompson et al 1997). It was, therefore, predicted that the non-fluent subjects in this study would have a reduced mean thematic complexity score. This predicted pattern of performance was evident in the majority of subjects within the non-fluent group. The low mean thematic complexity scores were predominantly a consequence of the production of single phrases, particularly nouns, and utterances with omitted verbs. These results are consistent with verb retrieval deficits. When argument structures were produced, there was a reliance on simple one and two argument structures. In particular, there was a lack of three argument structures. As predicted, many of the non-fluent subjects who attempted to produce two and three argument structures, omitted arguments. The comparison of the non-fluent and normal groups, however, resulted in only a non-significant trend for argument omission. Omitted arguments may be the consequence of word finding difficulties or difficulties in the assignment of thematic roles (Whitworth 1995a). It is unclear from the narrative data to what extent these deficits are contributing to the performance of individual subjects, although in certain subjects the omission of an argument was preceded by large pauses indicative of word retrieval problems. In contrast to the non-fluent group, it was predicted that the fluent subjects would not be impaired in their ability to produce a wide range of thematic structures but might omit arguments as a consequence of word retrieval difficulties. The fluent aphasic group did not differ from normal subjects in their ability to produce complex thematic structures and realise all of the obligatory arguments within those utterances. Their mean thematic complexity scores, however, did not differ from those of the non-fluent subjects either; their production of thematic structure seemed to lie between normal and agrammatic performance. This is supported by the examination of individual fluent subjects. Some fluent subjects had low mean thematic complexity scores which resembled those of the non-fluent group. These findings may provide additional

evidence that thematic difficulties are not restricted to non-fluent, agrammatic speakers (Martin and Blossom-Stach 1986, Whitworth 1995a).

Previous research into agrammatism (for example Menn and Obler 1990) has suggested that agrammatic subjects produce less complex phrases than normal subjects. It was, therefore, predicted that the non-fluent subjects would produce phrases with a lower mean phrasal complexity than the normal subjects. Contrary to this prediction, subjects in the non-fluent group were able to produce phrases of comparable complexity to the normal subjects. There were only a few individual subjects who relied predominantly on the production of single word phrases. In the production of verb phrases, it could be argued that the performance of the aphasic subjects is comparable because of the limited phrasal expansion present in normal subjects. Limited phrasal expansion cannot, however, explain the comparable performance of non-fluent subjects in the production of noun and prepositional phrases. In the production of these phrasal types, there is evidence of the use of multi-component phrases. Due to the variability in the frequency of use and the complexity of the adjectival phrases used, the comparisons made of these phrases in the normal and aphasic groups should be treated with caution. The results of the aphasic subjects, whose adjectival phrases were less complex than those of the normal subjects, but who showed no other phrasal complexity differences, perhaps need further investigation. It was predicted that the fluent subjects would be capable of producing phrases of comparable complexity to normal subjects. The fluent group, however, differed from the normal group in their noun phrase complexity scores. The reduced complexity scores may reflect an excessive reliance on pronouns, a feature which has been associated with the paragrammatic speech seen in Wernicke's aphasia (Gleason et al 1980). This was certainly true in the narrative of PW who was the only subject who fell outside normal limits of noun phrase complexity.

Agrammatism and paragrammatism are both associated with errors involving the use of function words and morphology; the definitions of the two patterns of sentence production, however, suggest that different errors are produced (Saffran et al 1989). It was, therefore, predicted that omission errors would be observed in the non-fluent group and substitution errors would be produced by the fluent group. The lack of

errors involving the use of function words and morphology seen in the normal group meant that any errors were an abnormal feature of performance. In both the fluent and non-fluent groups, errors were present in the use of all but the least frequently used inflectional morphemes. The production of phrasal and morphological errors was not, however, characteristic of all of the non-fluent subjects and there was variation in the morphemes affected and in the percentage of errors made. Non-fluent subjects were capable of using function words correctly in some contexts to build phrases of comparable complexity to the normal subjects. The errors produced by this group were not restricted to the omission of function words and inflections; the non-fluent group also produced a high proportion of substitution errors. Within the fluent group, there was also individual variability in the number and type of errors made, with a similar mixture of omission and substitution errors. The distribution of function word errors was not, therefore, consistent with the predicted patterns for the fluent and non-fluent aphasic subjects.

In the production of inflectional morphemes, both non-fluent and fluent performance was dominated by decreased morpheme production. The retention of 'ing' is a feature commonly reported in agrammatic speech (Goodglass et al 1968b); it was, however, retained in both the non-fluent and fluent groups. Although the use of the simple past tense also dominated aphasic performance, irregular and regular past tense forms were used significantly less frequently than in normal samples. In both groups, the majority of errors were the omission of, rather then the inappropriate use of, morphemes. Errors in the use of inflectional morphemes were slightly more prevalent in the narratives of the fluent subjects, in terms of the proportion of the subjects who produced errors. All of the fluent subjects made some morphological errors. This is in contrast to the prediction that the omission of morphology would be more prevalent in non-fluent subjects. The production of individual morphemes will be discussed in section 2.7.6.

The investigation of the group of non-fluent subjects identified many of the characteristics encompassed in the definition of agrammatism; group performance was characterised by simplified sentence structure and the poor production of morphology (Saffran et al 1989). The fluent group showed some of the characteristics of

paragrammatic speech, the misuse of grammatical markers and evidence of co-occurring word retrieval difficulties. As a group, they did not differ from normal subjects in their ability to produce complex thematic structures. These results would seem to provide some evidence to support the first hypothesis that agrammatism and paragrammatism are associated with non-fluent and fluent speakers respectively. Non-fluent subjects, however, were capable of producing some complex phrases and their production of function words was characterised by substitution errors as well as omissions. In a similar way, fluent subjects produced a high percentage of omission errors. In addition, the fluent subjects did not differ from the non-fluent subjects in their production of thematic structure. The distinction between the groups was, therefore, less clear cut than the definitions of agrammatism and paragrammatism would suggest. This lack of distinction increased when the performance of individual subjects was considered. Although the groups demonstrated these features, none of the individual subjects demonstrated all of the features which were consistent with the results of the group comparisons. Not all of the non-fluent and fluent subjects showed patterns of performance consistent with agrammatism and paragrammatism respectively. Some fluent subjects had patterns of deficit more consistent with agrammatic speech and vice versa. Both fluent and non-fluent subjects seem to display some patterns of performance which have traditionally been associated with agrammatism or paragrammatism.

### 2.5.3 Comparison of the Non-Fluent and Fluent Subjects with Aphasia

In the comparison of the patterns of performance seen in the fluent and non-fluent groups, there was a great deal of overlap between the groups in their realisation of thematic and phrasal structure and the production of phrasal and morphological errors. This similarity between the errors seen in the non-fluent and fluent subjects mirrors the observations of Berndt (1991) and Butterworth and Howard (1987). In the analysis of the performance of individual subjects, the overlap becomes more evident. On every parameter, deficits were observed in both fluent and non-fluent subjects and on every parameter (with the exception of the percentage narrative of fluent subjects), there was evidence of retained ability in some fluent and non-fluent subjects. This does not mean

that the two groups did not display some differences in the extent to which certain aspects of performance were prominent but no distinguishing features could be identified. The identified overlap and the lack of distinguishing features questions the validity of hypothesis two. The deficits seen in the fluent and non-fluent aphasic subjects do not seem to be discrete differentiable disorders. The following section will investigate whether the deficits seen in non-fluent and fluent subjects are a continuum dependent on the rate of speech.

## 2.6 Aphasic Sentence Production Deficits as a Continuum with Normal Performance

In the previous section, it was suggested that the deficits seen in the non-fluent and fluent subjects were not discrete disorders. This section will test the alternative hypothesis:-

3. The sentence production deficits in aphasia represent a continuum, with the severity of impairment (as indicated by rate of speech) determining the features which are evident.

### 2.6.1 Introduction

In section 2.4.1, it was suggested that although subjects were grouped into fluent and non-fluent groups, rate of speech was in fact a continuum. Rate of speech may be considered as a reflection of the severity of the sentence production difficulties. This section will, therefore, consider the relationship between fluency (as determined by the rate of speech) and other parameters of sentence production. It is hypothesised that if sentence production deficits are a continuum, the overlap between the non-fluent and fluent groups may be a consequence of the smooth transition in the prominence of features as rate of speech increases.

### 2.6.2 Method

Five parameters were selected to investigate the relationship between fluency and sentence production. The mean thematic complexity score and the percentage omission

of arguments were considered measures of thematic structure. As measures of phrasal production, the mean phrasal complexity score and the mean percentage of phrasal and morphological errors was calculated. Simple correlations between each of the parameters and rate of speech were then performed.

### 2.6.3 Results

The relationship between rate of speech and the other parameters of sentence production are shown in figures 2.15 to 2.19. The results of the correlations can be found in table 2.28.

**Figure 2.15: Relationship between rate of speech and mean thematic complexity scores**

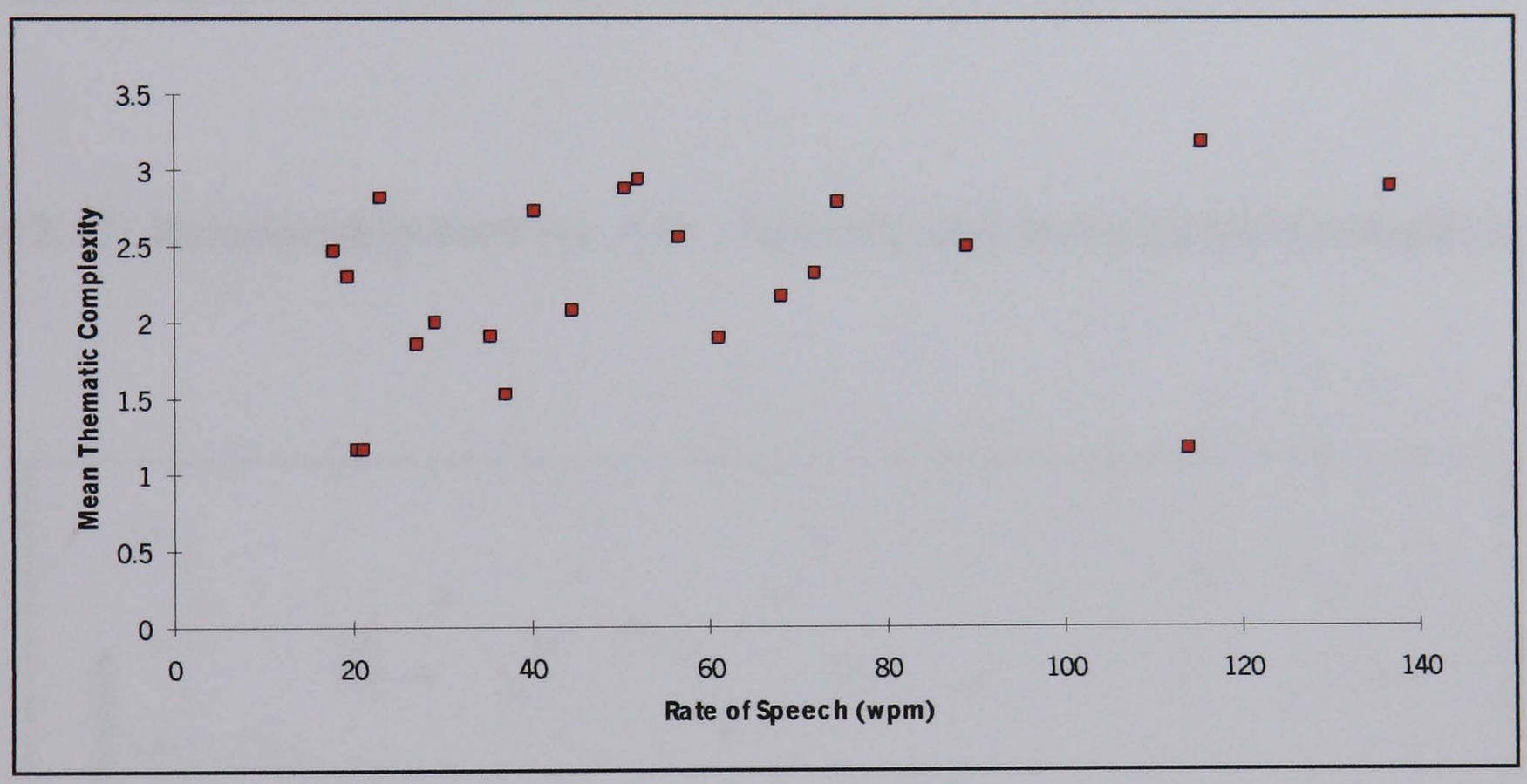


**Figure 2.16: Relationship between rate of speech and percentage argument omission**

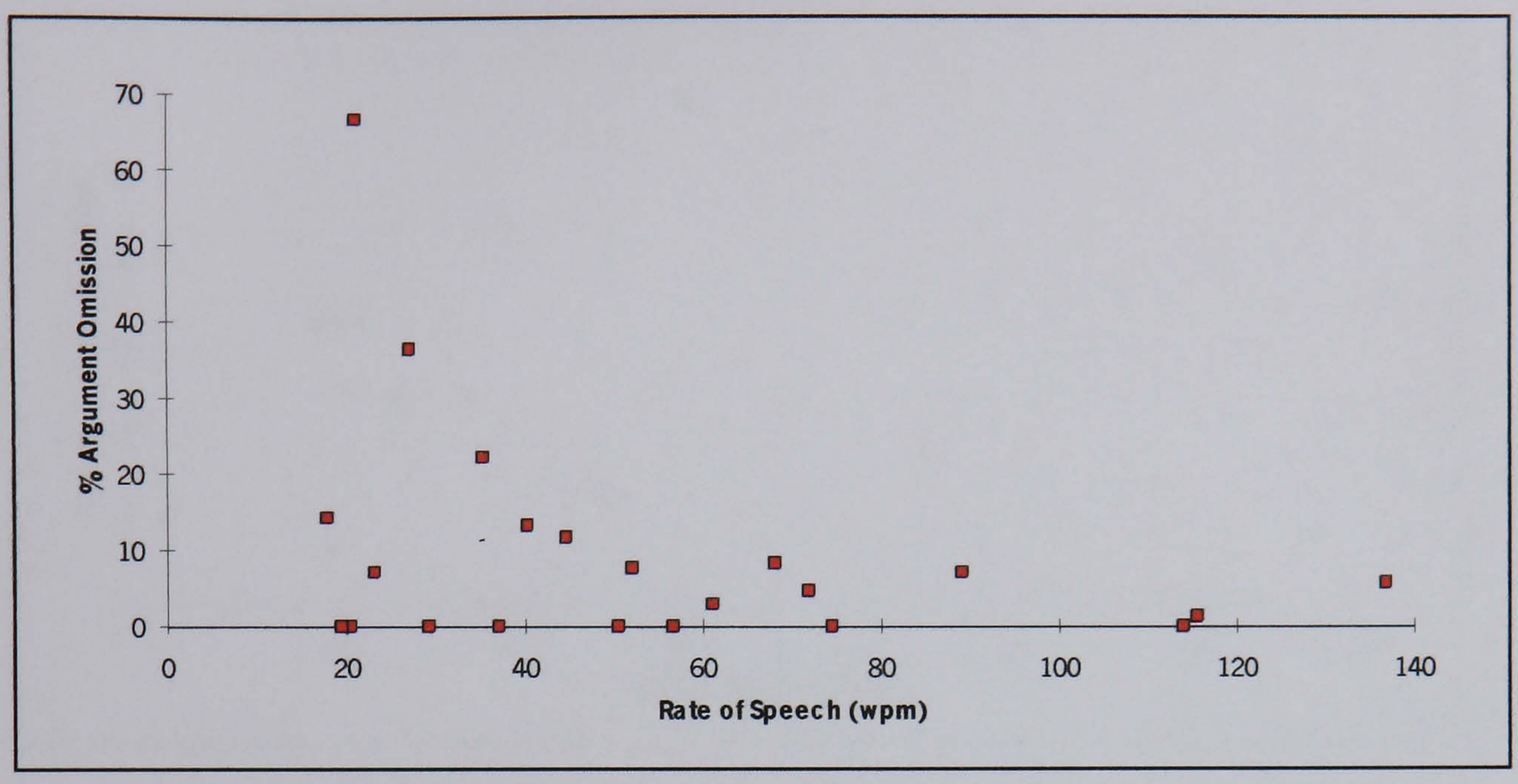



**Figure 2.17: Relationship between rate of speech and mean phrasal complexity scores**

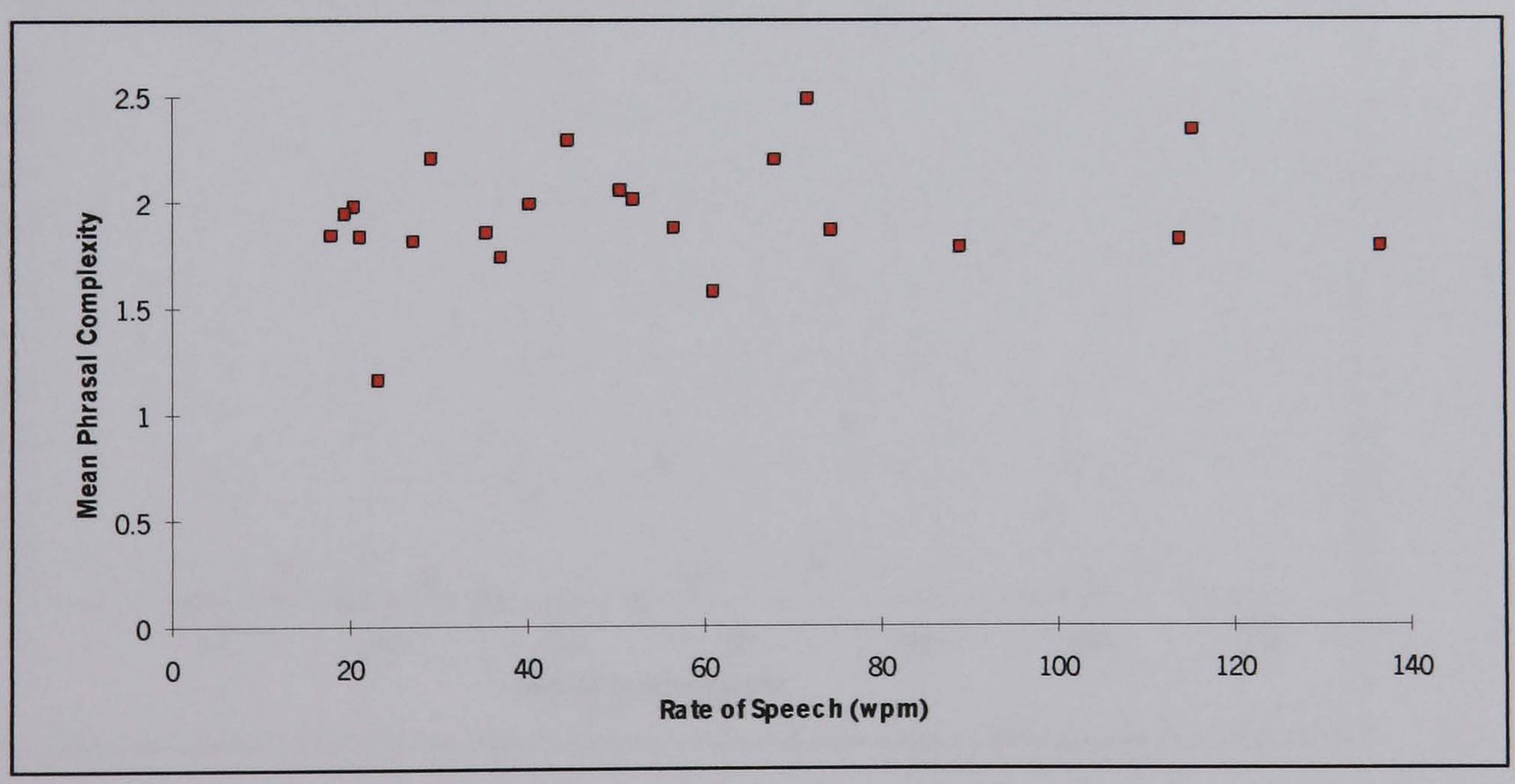


**Figure 2.18: Relationship between rate of speech and mean percentage of function word errors**

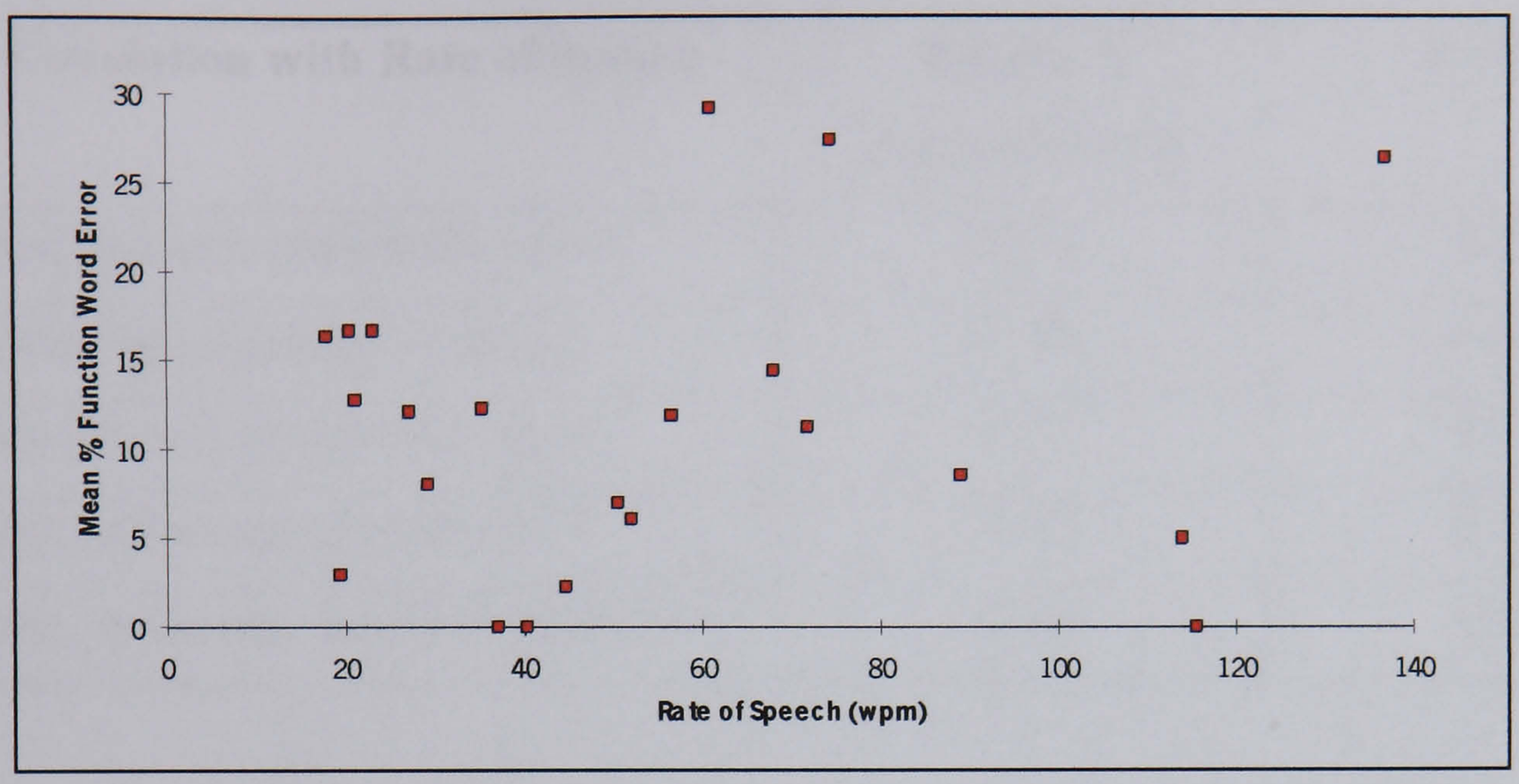



**Figure 2.19: Relationship between rate of speech and mean percentage of morphological errors**

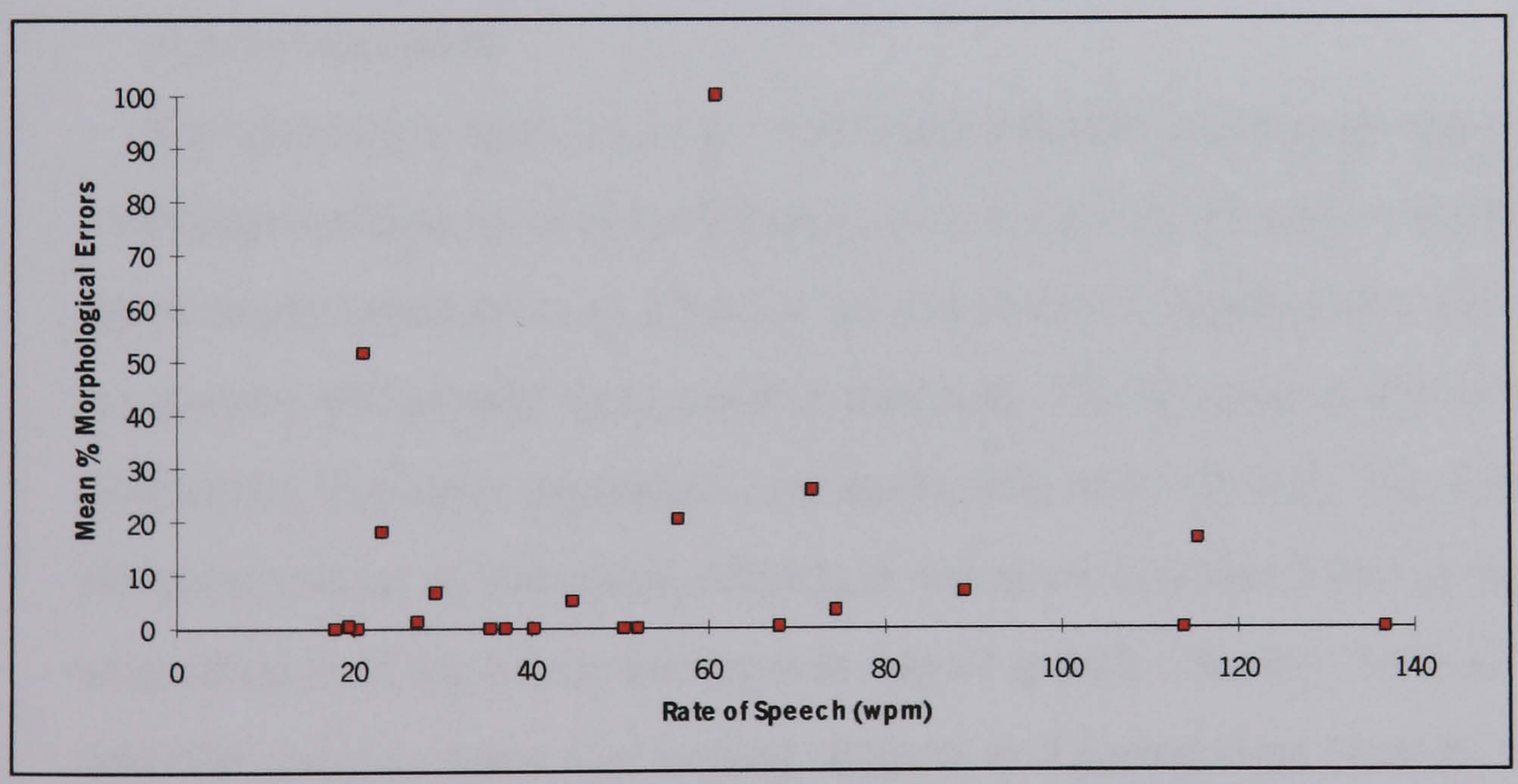


**Table 2.28: Results of correlations between rate of speech and other parameters of sentence production**

| Correlation with Rate of Speech | Results of Correlation (r) | P Value |
|---|---|---|
| Mean thematic complexity score | 0.312 | 0.158 |
| Percentage argument omission | 0.338 | 0.124 |
| Mean phrasal complexity score | 0.175 | 0.437 |
| Mean percentage phrasal errors | -0.129 | 0.568 |
| Mean percentage morphological errors | -0.011 | 0.963 |

It can be seen that for no parameter was there a significant correlation with rate of speech. The complexity of thematic structure, the complexity of phrasal structure, the omission of arguments and the production of phrasal errors and morphological errors were not dependent on fluency.

### 2.6.4 Discussion

The aim of this section was to investigate whether sentence production deficits are a continuum related to severity. Fluency, as indicated by the rate of speech, was used as the determinant of severity. Fluency did not correlate significantly with any of the parameters of thematic and phrasal production. The hypothesis that sentence production disorders represent a continuum was thus rejected. The overlap between the performance of individual subjects in the fluent and non-fluent groups is not a consequence of the continuum seen in rate of speech. Fluency does not seem to provide a useful means of grouping subjects as it provides no clues to the pattern of performance which would be evident in any single aphasic subject. It is acknowledged that this may be a consequence of differential adaptive strategies. It is however suggested that the lack of a relationship between fluency and patterns of deficit means that sentence production deficits should be conceived in a different way, perhaps as the result of damage to discrete aspects of sentence processing.

## 2.7 The Description of Aphasic Sentence Production Deficits in terms of Models of Normal Sentence Production

The aim of this section was to investigate the performance of individual subjects in terms of Schwartz's elaboration of Garrett's model of normal sentence production (described in section 1.5.1).

### 2.7.1 Introduction

Models of normal sentence production can provide a framework for interpreting the outward symptoms in terms of damage to particular levels of processing. In this way, the location of an individual's deficit(s) can be identified. Individual case studies can provide insight into the nature of normal processing; dissociations between aspects of performance suggest that those symptoms result from damage to distinct processes. Schwartz's (1987) model predicts that certain associations and dissociations will be evident in the performance of aphasic subjects. Data from subjects with aphasia, therefore, provides an opportunity to evaluate the adequacy of that and other models of sentence production.

### 2.7.2 Method

In section 1.5.2, it was suggested that functional and positional level processing are of particular importance in the characterisation of sentence production deficits. The narrative analysis was designed to capture the information specified at these levels of representation. The thematic structure specified at the functional level was analysed in relation to the PAS of the verb and thematic role assignment within the PAS. The positional level representation was analysed in terms of the phrasal structure of noun, verb, adjectival and prepositional phrases and the use of noun and verb morphology. It was hypothesised that difficulties producing the functional level representation would result in reduced mean thematic complexity scores (due to an increased proportion of utterances with an undetermined thematic structure and an increased reliance on simple one and two argument structures) and the omission of obligatory arguments. Positional

level difficulties were predicted to result in reduced phrasal complexity and the production of function word and morphological errors. The performance of each of the subjects with aphasia on these five parameters was compared to that of normal subjects. As previously discussed, individual subjects were considered to differ from normal subjects if they fell outside two standard deviations of the normal mean. The relationship between processes at the same and different levels of processing was analysed by investigating the associations and dissociations evident in the performance of different subjects. Finally, the relationship between different function word classes and classes of inflectional morphemes was investigated.

### 2.7.3 Predictions

At the broadest level of distinction, Schwartz's model predicts a distinction between functional and positional level processes; this could result in dissociations between the production of thematic structure at the functional level and the production of phrasal structure at the positional level. In addition, Schwartz's model predicts that certain patterns of performance in relation to different phrasal types and the retrieval of content words, function words and inflectional morphemes may be evident. These predictions are summarised in table 2.29. Table 2.29 also summarises the predictions that some of the other models of sentence production introduced in sections 1.7 and 1.8 would make regarding these aspects of performance.

**Table 2.29: Predictions of sentence production models**

| | **Schwartz (1987)** | **Kempen and Hoenkamp (1987)** | **Lapointe and Dell (1989)** |
|---|---|---|---|
| **Lexical Retrieval** | Dual Retrieval<br>FL Semantic<br>PL - Phonological | Dual retrieval | Spreading activation |
| **Function Word Retrieval** | In syntactic frame at PL | Insertion at FL | Insertion at PL |
| **Retrieval of Morphology** | In syntactic frame at PL | Insertion at PL | Insertion at PL |
| **Contrast between Phrasal Categories** | No apparent difference | Yes<br>Different specialist procedures | Yes<br>Notion stores ordered by category |
| **Contrast between Content/ Function Words** | Yes<br>Different location and mechanisms of retrieval | Yes<br>Different calling procedures | Yes<br>Different location and mechanisms of retrieval |
| **Contrast between Function Words/Inflections** | No<br>Both retrieved as part of syntactic frame | Yes<br>Different location and mechanism of retrieval | Yes<br>Different mechanisms of retrieval and insertion |

### 2.7.4 Functional and Positional Level Processing

The results for the individual aphasic subjects on the parameters of functional and positional level processing are summarised in table 2.30.

**Table 2.30: Summary of performance on aspects of functional and positional level processing**

| | Functional | Level | Positional | Level | |
|---|---|---|---|---|---|
| | Thematic Complexity | Omission Arguments | Phrasal Complexity | Function Word Errors | Errors with Morphology |
| **Non-Fluent** | | | | | |
| **AL** | - | - | + | - | - |
| **AM** | - | - | + | + | + |
| **BG** | - | - | + | - | + |
| **BM** | - | - | - | - | + |
| **CG** | - | + | - | - | - |
| **DM** | - | + | - | - | - |
| **GW** | + | - | + | - | + |
| **HW** | - | - | + | - | + |
| **IB** | - | - | - | - | - |
| **JM** | - | + | + | - | + |
| **KD** | - | + | + | - | - |
| **MK** | + | - | + | - | - |
| **RS** | + | + | + | - | + |
| **SS** | - | - | + | - | + |
| **TF** | + | - | + | - | - |
| **TJ** | - | + | - | + | + |
| **Fluent** | | | | | |
| **JS** | + | - | + | - | - |
| **ML** | + | - | + | - | - |
| **NB** | - | - | + | - | + |
| **PW** | - | - | - | - | - |
| **RN** | + | + | + | - | - |
| **VC** | - | + | + | + | - |

Key: + = retained (within normal limits), - = deficit (outside 2 s.d. of normal mean)

It can be seen that the majority of subjects had a combination of functional level and positional level deficits. There was, however, some evidence of some dissociations between functional and positional level processing. Subjects RN and RS retained the ability to produce complex thematic structures but were impaired in their ability to produce phrasal structure. RN had widespread phrasal difficulties, whereas RS had a specific difficulty producing function words. In contrast, subject AM was impaired in her ability to produce thematic structure at the functional level representation but was able to produce phrasal structure which was equivalent to that of normal subjects. Her difficulties with noun retrieval can be attributed to functional level deficits; all of her errors were semantic paraphasias. Within the production of the functional and positional representations, there were some dissociations between the aspects of performance which were observed to be impaired in particular subjects. In the production of thematic structure, there were dissociations between subjects' ability to produce structures of comparable complexity to normal subjects and the ability to realise all of the obligatory arguments within that structure. Subjects GW, MK, TF, JS and ML produced complex thematic structures but omitted obligatory arguments. In contrast, subjects CG, DM, JM, KD, TJ and VC had lower mean thematic complexity scores but produced all of the verb arguments within those structures. This lack of association was also seen in the low correlation between mean thematic complexity and percentage argument omission ($r = -0.353$, $p = 0.107$).

In the production of phrases at the positional level representation, there were some individual differences in the phrasal types which differed from normal performance. The results for individual phrasal types can be found in appendix 7. Due to the variability present in the normal production of adjectival phrases, subjects (GW, RS and RN) who only presented with difficulties in the production of these phrases were not considered to have a deficit in the production of complex phrases. Six subjects produced noun and/or verb and/or prepositional phrases which were less complex than those of normal subjects. Of those six subjects, three (PW, BM and CG) were impaired in the production of a single phrasal type and three (IB, DM and TJ) were impaired in the production of two phrasal types. There was no consistency in the phrasal types affected.

In the production of the positional level representation, there were dissociations between the ability to produce phrases of comparable complexity to normal subjects and the ability to produce function words and inflectional morphemes correctly. Correlations between mean phrasal complexity and mean percentage function word error and mean percentage morphological error were r = - 0.4116 (p = 0.057) and r = - 0.2319 (p = 0.299) respectively. Subjects AL, MK and TF were capable of producing complex phrasal structure but produced errors when producing function words and morphology. In contrast, TJ appeared to use function words and inflections appropriately when they were used, but often phrases consisted of single content words; this resulted in reduced phrasal complexity scores.

In the production of the positional level representation, there was also an apparent dissociation between the production of function words and the production of inflections. Subject VC produced function words without error but was impaired in her ability to produce inflections. Subjects BG, BM, GW, HW, JM, RS, SS and NB made errors in their use of function words but used morphology appropriately. The correlation between the percentage of function word and morphological errors was r = 0.419, p = 0.052. It would seem, therefore, that there is trend that with increased function word errors, there was a corresponding increase in morphological errors. This trend approached but did not reach significance.

### 2.7.5 The Production of Phrasal Errors

The results for the production of the main noun and verb and the production of function words can be found in table 2.31. It can be seen that there was significant variability between subjects in the percentage of error and the items affected. All of the aphasic subjects produced some examples of determiners, prepositions and pronouns; four of the subjects did not, however, use auxiliaries. In the production of phrasal errors, dissociations were identified in the production of nouns and verbs, the production of function words and content words and the production of individual classes of function words.

**Table 2.31: Percentage of phrasal errors produced by individual aphasic subjects**

| | Main Verb | Main Noun | Determiner | Pronoun | Preposition | Auxiliary |
|---|---|---|---|---|---|---|
| **AL** | 4.55* | 7.14* | 10.00* | 12.50* | 0.00 | 25.00* |
| **AM** | 0.00 | 4.17* | 0.00 | 0.00 | 0.00 | 0.00 |
| **BG** | 0.00 | 33.33* | 15.38* | 0.00 | 0.00 | 16.67* |
| **BM** | 0.00 | 11.76* | 0.00 | 0.00 | 50.00* | NA |
| **CG** | 0.00 | 0.00 | 15.38* | 0.00 | 0.00 | 16.67* |
| **DM** | 22.22* | 5.88* | 37.50* | 0.00 | 50.00* | NA |
| **GW** | 3.57* | 0.00 | 3.33* | 0.00 | 0.00 | 16.67* |
| **HW** | 0.00 | 5.88* | 16.67* | 7.69* | 0.00 | 0.00 |
| **IB** | 0.00 | 0.00 | 50.00* | 0.00 | 0.00 | NA |
| **JM** | 0.00 | 0.00 | 15.79* | 0.00 | 33.33* | 0.00 |
| **KD** | 7.14* | 8.57* | 0.00 | 0.00 | 0.00 | 9.09* |
| **MK** | 6.25* | 9.52* | 20.00* | 0.00 | 25.00* | 0.00 |
| **RS** | 0.00 | 0.00 | 38.89* | 0.00 | 11.11* | 55.56* |
| **SS** | 2.78* | 0.00 | 9.52* | 18.52* | 0.00 | 0.00 |
| **TF** | 0.00 | 0.00 | 42.86* | 0.00 | 0.00 | 66.67* |
| **TJ** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | NA |
| **Subjects Outside Normal Range** | **6** | **8** | **12** | **3** | **5** | **7** |
| **JS** | 7.04* | 1.92* | 5.41* | 25.37* | 10.34* | 16.67* |
| **ML** | 0.00 | 1.96* | 0.00 | 0.00 | 4.76* | 7.14* |
| **NB** | 0.0 | 10.00* | 10.71* | 4.17* | 15.38* | 18.8* |
| **PW** | 18.18* | 50.00* | 16.67* | 23.33* | 11.11* | 0.00 |
| **RN** | 0.00 | 0.00 | 38.89* | 8.33* | 11.11* | 55.56* |
| **VC** | 33.33* | 4.17* | 0.00 | 0.00 | 0.00 | 0.00 |
| **Subjects Outside Normal Range** | **3** | **5** | **4** | **4** | **5** | **4** |

* = > 2 s.d. from the normal mean, NA = not present in narrative

Of the 22 subjects, seven (AL, DM, KD, MK, JS, PW and VC) produced errors in their production of both nouns and verbs. These errors were a mixture of semantic and phonemic paraphasias and the inappropriate production of a light verb. An additional two subjects (GW and SS) produced errors in their retrieval of the main verb within the narrative and five subjects (AM, BG, BM, HW and ML) produced errors in their retrieval of the main noun. There was, therefore, evidence of dissociations between the retrieval of nouns and verbs. Of these subjects, AM and VC produced no errors in the retrieval of function words. In contrast, subjects CG, IB, JM, RS, TF and RN produced nouns and verbs correctly within the narrative but function words were omitted or used inappropriately. Within the production of function words, there was some variation in the number and type of function words affected. Of the 19 subjects who produced some errors in their production of function words, only three (JS, NB and RN) had consistent difficulties with all four classes of function word. Three of the subjects (BM, IB and KD) had apparently selective deficits with one class of function word (prepositions, determiners and auxiliaries respectively). A weighted logistic regression of the function word errors (via a three dimensional contingency table) revealed a significant effect of subjects and function words ($X^2 = 77.524$, df = 24, p = 0.000) and a significant interaction ($X^2 = 93.389$, df = 58, p = 0.0022). The significant interaction indicates that within individual subjects, different function words were subject to error. No consistent hierarchy of difficulty was identified.

### 2.7.6 The Production of Morphological Errors

The results for the production of individual morphemes can be found in table 2.32.

**Table 2.32: Percentage of morphological errors produced by individual non-fluent aphasic subjects**

| | Rpl | Ipl | Ps | Red | Ied | ing | en | 3s |
|---|---|---|---|---|---|---|---|---|
| **AL** | 0.00 | 0.00 | NA | 42.86* | 0.00 | 0.00 | 0.00 | 100.00* |
| **AM** | 0.00 | NA | NA | 0.00 | 0.00 | NA | NA | NA |
| **BG** | 0.00 | NA | NA | 0.00 | 0.00 | 0.00 | NA | NA |
| **BM** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **CG** | 0.00 | 0.00 | NA | NA | 33.33* | 0.00 | NA | 100.00* |
| **DM** | NA | NA | NA | NA | NA | NA | NA | 100.00* |
| **GW** | 0.00 | 0.00 | NA | 0.00 | 0.00 | 0.00 | NA | 0.00 |
| **HW** | 0.00 | NA | NA | NA | 0.00 | 0.00 | NA | 0.00 |
| **IB** | 54.55* | NA | NA | NA | 0.00 | 0.00 | NA | NA |
| **JM** | 0.00 | NA | NA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **KD** | 18.18* | 0.00 | NA | NA | 12.50* | 0.00 | 0.00 | 0.00 |
| **MK** | 25.00* | NA | NA | 50.00* | 28.87* | 0.00 | NA | NA |
| **RS** | 0.00 | 0.00 | NA | 0.00 | 0.00 | 0.00 | NA | NA |
| **SS** | 0.00 | 0.00 | NA | 0.00 | 0.00 | 0.00 | NA | NA |
| **TF** | 0.00 | NA | NA | NA | NA | 0.00 | NA | 10.00* |
| **TJ** | 0.00 | NA | NA | NA | 0.00 | 0.00 | NA | 0.00 |
| **Subjects Outside Normal Range** | **3** | **0** | **0** | **1** | **3** | **0** | **0** | **3** |
| **JS** | 0.00 | 0.00 | NA | 0.00 | 0.00 | 0.00 | 0.00 | 1.67* |
| **ML** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | NA | 2.94* |
| **NB** | 0.00 | 0.00 | NA | 0.00 | 6.67* | 0.00 | NA | NA |
| **PW** | 50.00* | NA | NA | NA | 16.67* | 40.00* | NA | 100.0* |
| **RN** | 33.33* | NA | NA | 0.00 | 0.00 | 0.00 | 0.00 | 7.69* |
| **VC** | 50.00* | NA | NA | NA | 0.00 | 0.00 | NA | NA |
| **Subjects Outside Normal Range** | **3** | **0** | **0** | **0** | **2** | **1** | **0** | **4** |

* = > 2 s.d. from the normal mean, NA = not present in sample

The analysis of morphological errors was restricted by the limited range of morphemes used and the lower frequency of use in the aphasic subjects, compared to the normal control subjects. The 'en', possessive 's' and irregular plural forms were not present in many of the aphasic narratives. When they were used, however, they were used appropriately. The progressive 'ing' form of the verb was the most frequently used. It was present in all but two of the samples (AM and DM); all of the other subjects with the exception of PW used this morpheme appropriately. Nine of the 22 subjects produced the four morphemes (Rpl, Red, Ied and 3s) correctly. Of the remaining 13 subjects, the majority made errors on a single morpheme, three produced errors on two morphemes and two produced errors in the realisation of three classes of morpheme. A weighted logistic regression on Rpl, Red, Ied and 3s revealed a significant effect of subject and morpheme ($X^2 = 76.910$, df = 23, p = 0.000) but no significant interaction ($X^2 = 19.548$, df = 47, p = 0.9999). This lack of a significant interaction suggests there was consistency across subjects in the morphemes which produced errors. From the results of AL, CG, DM, IB, TF, JS, NB and VC, there is evidence to suggest that noun and verb morphology may be impaired selectively.

### 2.7.7 Discussion

The aim of this section was to investigate the performance of individual subjects in relation to models of normal sentence production, with a view to identifying the location of their deficits. It was proposed that the identification of associations and dissociations within and between individuals would enable the evaluation of current models of sentence production. The narrative analysis captured the levels of linguistic structure coded in the production of the functional and positional levels of representation. Reduced mean thematic complexity scores and the omission of obligatory arguments were thought to be indicative of deficits in the creation of the functional level representation and reduced phrasal complexity and errors involving the use of function words and inflections were thought to reflect positional level deficits.

The majority of the subjects presented with a combination of functional and positional level deficits. There was, however, evidence of a double dissociation in the ability of subjects to produce the functional and positional level representations.

Subject AM had a specific deficit in the production of thematic structure at the functional level representation, whereas RN and RS had a specific deficit in the creation of the positional level representation. There is thus some support for the suggestion that different processes are involved in the creation of thematic and phrasal structure. This would correspond to the separation of processes involved in the production of functional level and positional level processing suggested by Garrett's model and other models of sentence production.

Within the production of the functional and positional level representations, there were some dissociations between the aspects of performance which were observed to be impaired in particular subjects. These dissociations may require the modification of the current models of sentence production or an additional consideration of the processes responsible for the production of each level and the use of adaptive strategies. In the production of thematic structure, there were dissociations between subjects' ability to produce structures of comparable complexity to normal subjects and the ability to realise all the obligatory argument structures. It is probable that different severities of impairment or different underlying impairments to the processes producing this level of structure may account for the observed deficits. For example, in the cases of JS and ML who retained the ability to produce complex thematic structures, but who occasionally omitted arguments, the omission of arguments may be the result of transitory word finding difficulties. In the cases of DM, KD, TJ and VC who had very low thematic complexity scores but who did not omit obligatory arguments, their low thematic complexity scores may have been a consequence of poor verb retrieval resulting in poor production of the PAS. This gives a very low number of identifiable structures where arguments could be omitted. On the occasions where verbs were retrieved, however, these subjects were able to retrieve all of the arguments. These possibilities cannot, however, be evaluated on the basis of performance on this task alone, further investigations are necessary.

In the production of the positional level of representation, there was a similar dissociation between the ability to produce complex phrases and the ability to produce function words and morphology correctly. This suggests that some subjects were able to create the phrasal frames but were unable on some occasions to retrieve the function words that filled the slots within those structures. In those subjects in which

phrasal complexity was reduced, this seemed to be a consequence of a reliance on single content words. It is unclear to what extent this reflects a reliance on a particular strategy, a failure to create phrasal frames or an inability to retrieve the appropriate function words to fill the slots within the phrases. For example, PW's reliance on pronouns, and thus her increased production of single component noun phrases seemed to reflect the use of a strategy to overcome her severe word finding difficulties. In the production of phrases of different types, there were some differences in complexity of different phrasal types, with some subjects selectively impaired in their ability to produce phrases of certain types. Excluding the production of adjectival phrases, which were too variable in all three groups for adequate conclusions to be drawn, selective deficits were evident in the production of noun, verb and prepositional phrases. This may be a consequence of selective deficits in the production of the function words associated with each of those phrases or it may suggest that different mechanisms are involved in the creation of the different phrasal frames. Garrett's model does not state explicitly either how the function words which form part of the syntactic frame are retrieved or how different phrasal frames are created. In the level of detail that is currently stated, there is an apparent assumption that all phrasal types are created in the same way. This model cannot, therefore, explain the observed differences and the dissociations between phrases of different types. Two current models of speech production offer some explanation of the observed differences seen between phrases of different types. Kempen and Hoenkamp (1987) in their incremental model of sentence production proposed that there are different specialist procedures involved in the creation of different phrasal types. This might imply that these procedures may be differentially impaired in aphasia. Alternatively, Lapointe and Dell (1989) in their elaboration of positional level processing, suggested that the notion stores which contain function words are organised by phrasal category and that different procedures are thus used for their retrieval and assembly into phrasal frames. More controlled investigations into the production of noun, verb, adjectival and prepositional phrases would be necessary to investigate the validity of these suggestions.

In the production of the positional level representation, there was also an apparent dissociation between the production of function words and the production of

inflectional morphology. Subjects KD and VC produced function words without error but were impaired in their ability to produce noun and/or verb morphology. In contrast, subjects BG, BM, GW, HW, JM, RS, SS, JS and NB made errors in their realisation of some classes of function words but used morphology appropriately. This does not, however, mean that these subjects used morphology with comparable frequency to the normal subjects. These apparent dissociations are consistent with the findings of Miceli et al (1989). These results suggest that different mechanisms are involved in the production of function words and inflectional morphemes. This is in line with the modifications to Garrett's model suggested by Lapointe and Dell (1989) in which inflectional affixes are retrieved as part of the syntactic frame and function words are retrieved from a separate store. Due to the limited range of morphology produced by the normal subjects and the small number of errors elicited in the narrative sample, however, further clarification of these dissociations should be sought. Within the individual classes of function words, there were also some apparent dissociations. individual subjects produced different classes of function words with apparently differing degrees of accuracy. This may be indicative of different storage and retrieval procedures associated with different morphemes, which can be selectively impaired. Alternatively, it may reflect the limited samples obtained in the narrative task, and thus the failure to identify consistent hierarchies of difficulty. In the same way, the apparent dissociation between the production of noun and verb morphology needs to be investigated with additional examples. In the retrieval of inflections, although there were dissociations between the retrieval of individual morphemes, this hierarchy was consistent across individual subjects. This may suggest that the results are a consequence of identifiable characteristics, such as frequency or semantic content, rather than impairment to specific, distinct procedures.

## 2.8 General Discussion

The aim of this part of the study was to characterise sentence production in aphasia. The narrative analysis was designed to analyse thematic, phrasal and morphological aspects of sentence production simultaneously. In this way, a complete profile of a subject's performance was determined allowing a more accurate comparison with other subjects within each group and between groups of fluent and non-fluent subjects. Of importance to the study was the collection of adequate normal data. This allowed abnormal patterns of production to be identified without relying on idealistic impressions of normal performance and with an awareness of the variability present in normal speakers. The analysis of normal performance also highlighted the validity of the narrative analysis in the investigation of some aspects of production and the limitations present in the analysis of other parameters. The investigation of some aspects of phrasal production, for example adjectival phrases, complex verb phrases and inflectional morphology, was limited. If deficits are suspected in these areas, additional elicitation tasks may be necessary.

Three hypotheses were investigated relating to the characteristics of the non-fluent and fluent group and the relationship between them. From the analysis of the group data, the non-fluent and fluent groups showed many of the features characteristic of agrammatism and paragrammatism respectively. The groups, although differing in the extent to which certain characteristics were evident, showed extensive overlap particularly in phrasal production. This overlap increased with the consideration of the performance of individual subjects within the two groups, None of the subjects demonstrated all of the features associated with their respective groups and some subjects in the fluent group showed patterns more consistent with agrammatism and vice versa. The characterisation of the deficits seen in the non-fluent and fluent groups as agrammatism and paragrammatism was therefore rejected. The subjects in the non-fluent group were, however, very similar in their production of thematic structure. These similarities suggest that specific hypotheses relating to the production of thematic structure could be tested using this group of subjects (see chapter three).

Fluent and non-fluent subjects were identified who showed almost identical patterns of deficit. It was, therefore, suggested that the patterns of deficit seen in these two group was not distinct. Fluency, as measured by rate of speech, did not fall into

two distinct bands but was a continuum across non-fluent, fluent and normal speakers. A third hypothesis suggested that the overlap between the two aphasic groups may be a consequence of this continuum. Fluency was not, however, found to be significantly correlated with the complexity of thematic or phrasal structure, the omission of arguments or the production of phrasal and morphological errors. The characterisation of sentence production deficits as a continuum related to the severity of the impairment, as indicated by the rate of speech, was thus also rejected.

In the identification of the deficits which are contributing to the performance of individual subjects with aphasia, it would seem beneficial to view deficits in relation to current models of sentence production. The relationship between the levels of linguistic structure analysed in this analysis and the representations specified at the functional and positional level representations allowed the location of the deficits in terms of normal sentence processing to be identified. This grouping perhaps provides a more accurate way of grouping subjects who may perform similarly on other tasks and may benefit from similar treatment programs (see chapter four). The observation of the patterns of performance resulting from damage provides insight into the nature of normal sentence production. The analysis of aphasic performance is thus a means of testing the adequacy of current models of sentence production and suggesting ways in which they must be elaborated or changed. The dissociations seen in the performance of RS, RN and AM provided evidence of the distinction between thematic and phrasal processing at the equivalent of a functional and positional level representation. The dissociations observed within thematic and phrasal processes need additional consideration. These dissociations require further investigation of the strategies which subjects may be using to overcome their difficulties or consideration of the sub-processes which are responsible for the production of each level of representation. The use of compensatory strategies may emphasise certain aspects of performance making those more prominent and possibly masking the underlying impairment. Sub-processes which contribute to the production of each level of representation have the potential to be impaired differentially with different consequences for performance. In the production of the functional level representation, it is difficult to test these hypotheses from the results of the narrative analysis; insufficient information about the retrieval of the semantic representations of

nouns and verbs, the creation of the PAS and thematic role assignment is available. The production of the functional level representation will therefore be investigated in chapter four. In the production of the positional level representation, the results of this analysis provide additional evidence of dissociations between function words and inflections and variation between individual function words. These findings support processing models in which these distinctions have been incorporated. The results of the analysis, however, cannot distinguish between the models of Lapointe and Dell (1989) and Kempen and Hoenkamp (1987). Function word deficits do not seem to occur solely with functional level deficits as would be suggested by Kempen and Hoenkamp. Their characterisation of functional level processing is, however, so different to Schwartz that it is difficult to equate the narrative analysis with their levels of processing. Lapointe and Dell's elaboration of positional level processing may have some validity, but the nature of the processes still needs increased investigation with more detailed tasks and with more adequate samples of production.

# Chapter 3: Investigation of the interaction between thematic and phrasal structure.

This part of the study investigated the effect of the functional level representation on the creation of the positional level representation. Three specific hypotheses were investigated.

1. The complexity of the predicate argument structure specified at the functional level affects the subsequent realisation of phrases at the positional level of representation.
2. The argument or non-argument status of a phrase affects the ease with which it is realised at the functional level and the subsequent realisation of the phrase at the positional level.
3. The thematic role assigned to an item within the predicate argument structure affects its subsequent phrasal realisation. Thematic roles are generally associated with particular sentence positions. The realisation of phrases within different phrasal positions was thus also investigated.

## 3.1 Introduction

Garrett's model of sentence production was described in section 1.5.1. This model specifies distinct levels of representation associated with particular aspects of linguistic structure. The extent to which these levels interact and influence each other is not, however, evident from the model. Garrett's model has been used to describe the sentence production difficulties seen in subjects with aphasia (see section 1.5.2). Of particular interest in the description of these subjects is the thematic representation specified at the functional level and the phrasal and morphological structure specified at the positional level. Chapter two described an analysis of narrative speech which investigated these features in a group of fluent and non-fluent subjects, compared to normal subjects. This part of the study used some of the data obtained during the narrative analysis to investigate the extent to which thematic structure influences subsequent phrasal realisation in a sub-set of the non-fluent subjects.

The non-fluent subjects described in chapter two showed many of the characteristics traditionally associated with agrammatism. All of the non-fluent subjects made some errors in the use of function words and/or inflectional morphology,

considered to be the defining feature of agrammatism (Saffran et al 1989), although these errors consisted of a combination of omissions and substitutions. Almost all of the subjects produced an increased proportion of single phrases and a reduced number of complex sentence structures. The subjects were, therefore, considered to have a combination of thematic and phrasal difficulties, resulting from a combination of functional and positional level deficits. The processing and adaptation accounts of agrammatism described in section 1.1.3 suggest that agrammatic speech is an adaptation to limited processing resources (Isserlin 1922, Kolk and Van Grunsven 1985). Agrammatic speakers are considered to reduce the processing demands associated with speech by producing only the informative words. In some contexts, however, the strategy is not used and subjects produce the grammatical content of the sentence (Kolk and Heeschen 1990). Processing capacity accounts have also been used to account for the performance of agrammatic aphasic subjects on comprehension and grammaticality judgement tasks (Linebarger et al 1983, Kolk and Weijts, 1996). Linebarger et al (1983) suggested that the apparent dissociation between performance on grammaticality judgement and comprehension tasks could be a consequence of the selective allocation of limited processing resources between thematic and syntactic processing. The selective allocation of processing resources between thematic and syntactic processing in sentence production has not been investigated. The allocation of limited processing resources between functional and positional level processing may result in a trade-off between the production of thematic and phrasal structure. An increase in the complexity of thematic structure may, therefore, result in a decrease in phrasal complexity. The analysis of subjects who have deficits at these levels provides a way of investigating these possibilities.

The complexity of thematic structure and phrasal structure are difficult aspects to measure. Various measures of predicate argument structure (thematic) complexity have been proposed; these were discussed in section 1.7.2. These measures have encompassed both the number of different PAS arrangements (Shapiro et al 1987, 1989) and the number of thematic roles associated with the verb (Ahrens and Swinney 1995). Schwartz et al (1995) and Whitworth (1995b) suggested that aphasic subjects had increased difficulty with sentences with increasing number of arguments. It was, therefore, decided to use this as the measure of thematic complexity in this study. This measure was thought to encompass the number of thematic roles associated with the

verb and the increased demands on word retrieval. The notion of the number of possible argument structure arrangements was not considered in the study; almost all of the verbs produced in the narrative had multiple PAS arrangements (as indeed do the majority of English verbs). The thematic role fulfilled by an argument may also influence its realisation. Thompson et al (1997) concluded that goal and location roles were produced less accurately than the other thematic roles. No studies have, however, investigated the effect of thematic role on the complexity of the phrases used to realise them.

Saffran (1987) suggested that the complexity of processing increased with the expansion of phrases. This increased complexity was thought to explain some subjects' reliance on unexpanded phrases. The complexity of phrasal structure can be considered a reflection of the process of assembling lexical items with their inflections and function words. The complexity of phrasal structure could, therefore, be considered in terms of morphemes or in terms of words. There is of course a high correlation between these two measures of complexity. As the number of words was considered to be an adequate measure, which was more easily and reliably obtained (without the need to identify inflectional and derivational morphemes), this measure was used.

In addition to verb arguments, non-arguments were also produced in the sentences used in the narrative task. Non-arguments were discussed in section 1.7.3. It was proposed that different mechanisms may be involved in the production of arguments and non-arguments (Byng and Black 1989, Martin and Blossom-Stach 1986). In considering the interaction between thematic and phrasal structure, the argument or non-argument status of a phrase may influence its production, in terms of the ease of production, the complexity of the individual phrase and the complexity of the utterance as a whole. A consideration of argument and non-argument production in subjects with functional and positional level deficits provides an opportunity to contrast their production.

## 3.2 Method

### 3.2.1 Subjects

The subjects consisted of the twenty normal subjects and fourteen of the non-fluent, aphasic subjects described in chapter 2. Two of the non-fluent subjects (IB and

TJ) were excluded due to their minimal production of utterances with a determinable argument structure.

### 3.2.2 Method

The analysis of narrative speech described in chapter 2 resulted in the following information used in this part of the study:-

The complexity of the argument structure.

The argument status of the phrases.

The thematic roles which the arguments were fulfilling.

The complexity of the phrases within the sentence.

The presence of phrasal (function word) and morphological errors.

Utterances with an undetermined thematic structure, thematic embedding or omitted obligatory arguments were excluded from the analysis. In all of these cases, the underlying thematic structure of the utterance could not be determined and it was thus not considered appropriate to use these utterances. In a similar way, phrases with missing components were not coded in the phrasal complexity analysis, as the underlying target phrase could not be determined. As the number of phrases with omitted components was quite low; the exclusion of such phrases should not significantly influence the results. The influence of thematic complexity on the production of phrasal and morphological errors was considered separately.

## 3.3 Hypothesis 1.

The complexity of the predicate argument structure specified at the functional level affects the subsequent realisation of phrases at the positional level of representation.

### 3.3.1 Method

The complexity of the predicate-argument structure was defined as the number of phrasal components used in association with the verb (labelled one, two, three or four respectively). Utterances were then split into those containing non-arguments (NA) and those containing only optional or obligatory verb arguments. It was thought important to introduce this distinction in case the presence of non-arguments significantly influenced complexity (see hypothesis 2). Phrasal complexity was defined

as the number of words within each phrase (labelled one, two and three respectively). In addition, these was an additional category of phrases labelled complex (those containing more than three words or post-modifying phrases or clauses). These complex phrases were given a value of four.

The effect of argument complexity on the phrases produced was measured in two ways:- sum of phrasal complexity (S) and mean phrasal complexity (M). The sum of phrasal complexity was defined as the combined complexity of all of the phrases within the utterance. The mean phrasal complexity was defined as the mean complexity of the phrases within the utterance. In analysing the interaction between argument structure complexity and phrasal complexity, utterances were grouped into their respective categories:- 1, 2NA, 2, 3NA, 3 and 4NA. The mean S and the mean M was then calculated for each subject and then for each group of subjects. Statistical comparisons were performed on the data. All of the subjects did not necessarily produce utterances of each type; this led to some missing values in the data set. For this reason a generalised linear model was used for the statistical analysis.

From the narrative analysis, the location of phrasal and morphological errors within one, two or three argument structures was coded. Due to the limited number of errors, no distinction was made between 2 and 2NA, and 3 and 3NA utterances. The mean percentage of phrasal and morphological errors for each of the utterance types (1, 2 or 3) was then calculated. The mean percentage of phrasal errors was defined as the mean percentage of errors involving the use of determiners, prepositions, pronouns and auxiliaries. The mean percentage of morphological errors was defined as the mean percentage of errors involving the use of the following morphemes:- regular plural, irregular plural, possessive, regular past, irregular past, perfect tense, progressive tense and third person singular. These were again calculated initially for each subject and then for each group of subjects.

### 3.3.2 Predictions

For the normal subjects, it was predicted that with an increasing number of phrasal components, there would be a corresponding increase in the sum of phrasal complexity. The effect on mean phrasal complexity of increasing argument structure complexity was less easy to predict. Subjects might produce utterances of comparable length (in terms of number of words), without regard to the number of arguments. In

this case, with an increase in argument structure, there would be a corresponding decrease in mean phrasal complexity. The normal subjects should have sufficient processing capacity to produce the relatively simple sentences used in the narrative task; this decrease would therefore not be a consequence of limited resources. Theories of agrammatism suggesting a general processing deficit and the selective allocation of resources would predict that there may be a trade-off between the resources allocated to functional and positional level processing. Two patterns of performance would, therefore, be predicted for the non-fluent aphasic subjects:-

a. The more complex the predicate argument structure, the lower the mean phrasal complexity of the phrases used to express the arguments.

b. The more complex the predicate argument structure, the more errors (phrasal and morphological) present in the phrases used to express the arguments.

### 3.3.3 Results

Table 3.1 and figure 3.1 show the group mean of the sum complexity scores (mean S) for each of the utterance types. The comparison between the normal and aphasic subjects resulted in a significant effect of verb argument type ($F = 146.05$, $df = 5, 114$, $p = < 0.001$). There was, however, no significant interaction between verb argument type and subject group ($F = 1.808$, $df = 5, 138$, $p = 0.12$). The same pattern of performance was seen in the two subject groups. As thematic complexity increased (in terms of the number of phrasal components associated with the verb), the sum phrasal complexity increased. There was no apparent difference in the complexity of utterances only containing verb arguments and those containing non-arguments.

**Table 3.1: Comparison of normal and aphasic groups: Complexity of argument structure and sum of phrasal complexity**

| | 1 | 2NA | 2 | 3NA | 3 | 4NA |
|---|---|---|---|---|---|---|
| **Normal Group** | | | | | | |
| Mean | 3.05 | 5.39 | 5.37 | 7.24 | 7.16 | 9.26 |
| s.d. | 0.35 | 0.46 | 0.41 | 0.85 | 0.83 | 1.86 |
| Min | 2.50 | 4.50 | 4.36 | 5.50 | 5.00 | 7.00 |
| Max | 3.80 | 6.00 | 6.10 | 8.67 | 8.20 | 12.33 |
| **Aphasic Group** | | | | | | |
| Mean | 3.21 | 5.59 | 4.88 | 7.33 | 7.47 | 8.50 |
| s.d. | 0.75 | 0.65 | 0.56 | 0.26 | 0.24 | 2.12 |
| Min | 2.00 | 4.50 | 4.00 | 7.00 | 7.00 | 7.00 |
| Max | 4.50 | 6.71 | 5.80 | 7.50 | 7.50 | 10.00 |

**Figure 3.1: Comparison of normal and aphasic groups: Complexity of argument structure and mean sum of phrasal complexity.**

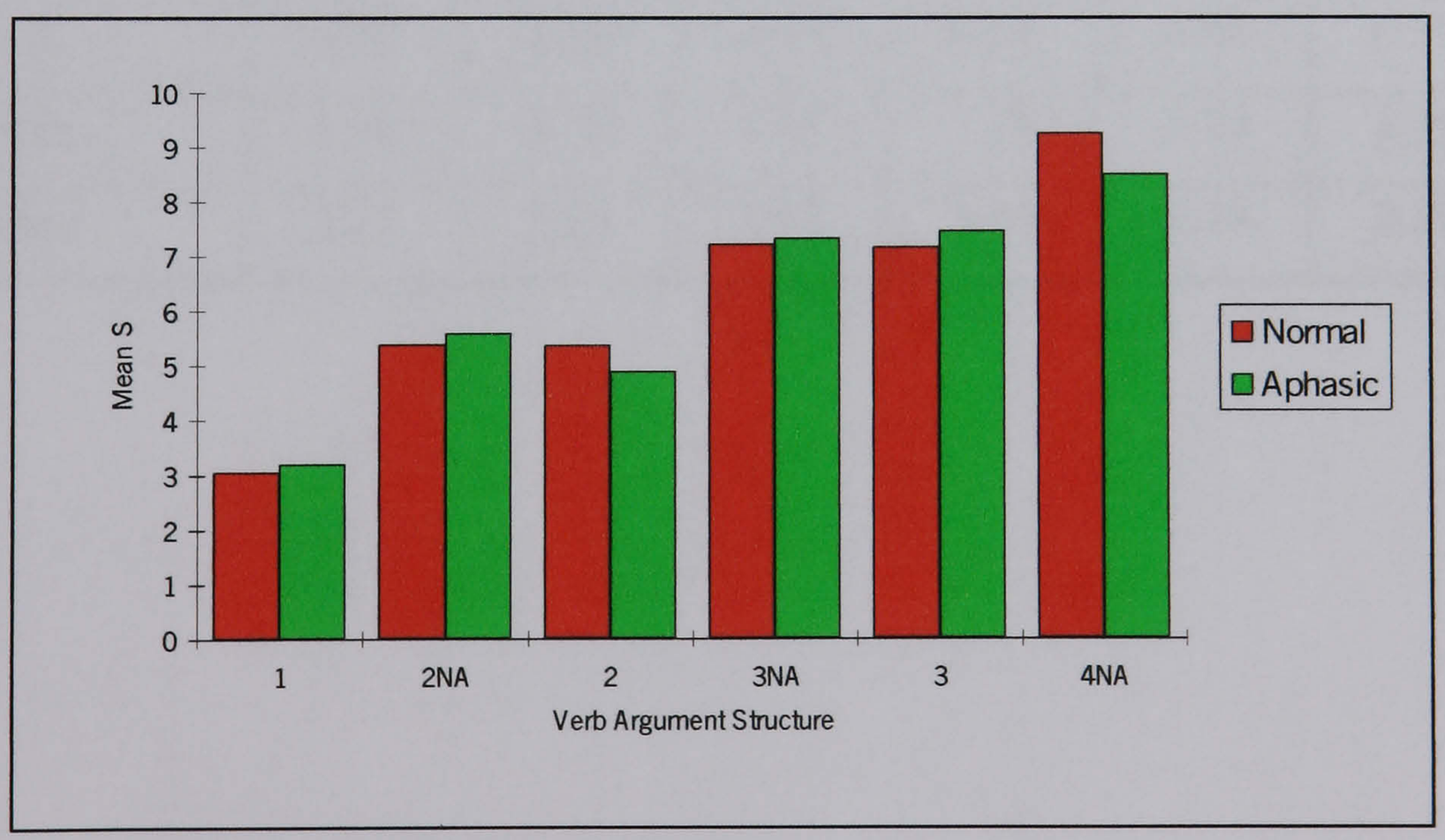



Table 3.2 and figure 3.2 show the group mean of the mean complexity scores (mean M) for each of the utterance types. The comparison between the normal and aphasic subjects resulted in a significant main effect of verb argument type ($F = 11.760$, $df = 5, 114$, $p = < 0.001$). There was again no significant interaction between

verb argument type and subject group ($F = 1.470$, $df = 5, 138$, $p = 0.20$). The pattern for the two groups of subjects on this parameter was similar to the pattern seen for the mean sum of phrasal complexity. As the complexity of the predicate argument structure increased, the mean complexity of the component phrases also increased. There was again no apparent difference between the mean complexity of phrases in utterances containing only verb arguments and those containing non-arguments.

**Table 3.2: Comparison of normal and aphasic groups: Complexity of argument structure and mean phrasal complexity**

| | 1 | 2NA | 2 | 3NA | 3 | 4NA |
|---|---|---|---|---|---|---|
| **Normal Group** | | | | | | |
| Mean | 1.53 | 1.81 | 1.81 | 1.88 | 2.04 | 1.98 |
| s.d. | 0.169 | 0.15 | 0.15 | 0.24 | 0.28 | 0.42 |
| Min | 1.25 | 1.50 | 1.56 | 1.50 | 1.67 | 1.50 |
| Max | 1.88 | 2.03 | 2.10 | 2.31 | 2.67 | 2.68 |
| **Aphasic Group** | | | | | | |
| Mean | 1.60 | 1.89 | 1.64 | 1.89 | 2.03 | 2.13 |
| s.d. | 0.37 | 0.20 | 0.18 | 0.11 | 0.20 | 0.53 |
| Min | 1.00 | 1.50 | 1.33 | 1.75 | 1.75 | 1.75 |
| Max | 2.25 | 2.24 | 1.93 | 2.03 | 2.29 | 2.50 |

**Figure 3.2: Comparison of normal and aphasic groups: Complexity of argument structure and mean phrasal complexity**

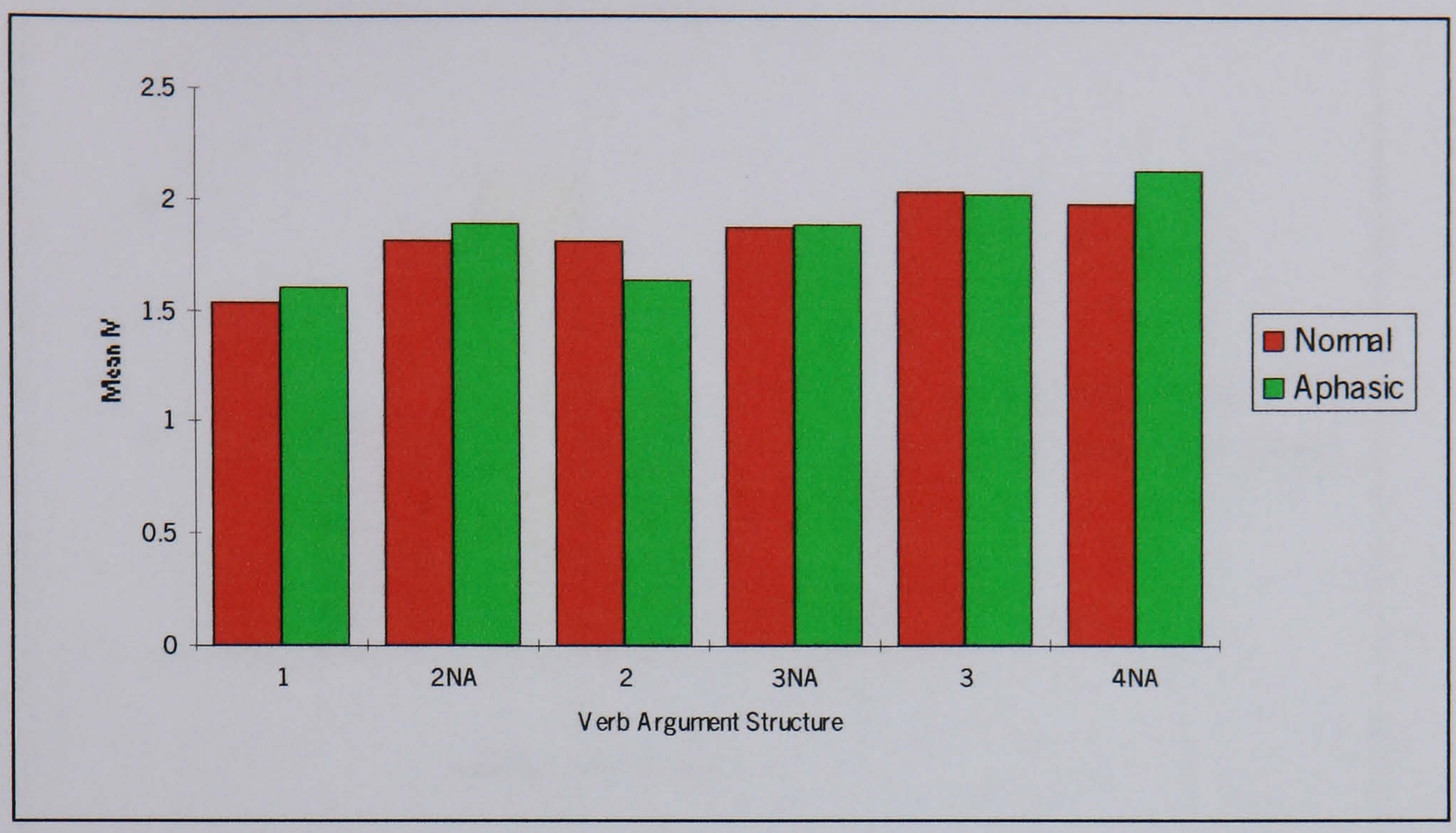



**Table 3.3: Aphasic group: Percentage phrasal and morphological errors in one, two and three argument structures**

| | 1 Argument Structures | 2 Argument Structures | 3 Argument Structures |
|---|---|---|---|
| **% PHRASAL ERRORS** | | | |
| **Mean** | 10.54 | 21.14 | 7.5 |
| **s.d.** | 19.13 | 19.32 | 14.88 |
| **Min** | 0 | 0 | 0 |
| **Max** | 50 | 66.67 | 40 |
| **% MORPHOLOGICAL ERRORS** | | | |
| **Mean** | 10.71 | 11.63 | 8.75 |
| **s.d.** | 28.95 | 19.65 | 18.75 |
| **Min** | 0 | 0 | 0 |
| **Max** | 100 | 66.67 | 50 |

**Figure 3.3: Aphasic group: Mean percentage phrasal and morphological errors in one, two and three argument structures**


Table 3.3 and figure 3.3 present the mean phrasal and morphological error scores produced by the aphasic subjects across different verb argument structures. There was an increase in the mean percentage of errors in the production of two argument structures in comparison to one argument structures. There was, however, no similar increase in the number of errors in three argument structures. The mean percentage morphological errors followed the same pattern as the mean percentage phrasal errors.

### 3.3.4 Summary

In the normal group, the expected increase in sum phrasal complexity with increasing argument structure complexity was identified. There was also a corresponding increase in mean phrasal complexity scores. The non-fluent aphasic subjects displayed the same pattern of performance. There is, therefore, no evidence to suggest that there is a trade-off between the resources allocated to functional and positional level processing, in the production of one, two and three argument structures. In addition, the production of phrasal and morphological errors seemed to be independent of the complexity of the argument structure in which the phrases were embedded. The results concerning the complexity of utterances containing only verb arguments and those including non-arguments will be discussed in section 3.4.

## 3.4 Hypothesis 2.

The argument or non-argument status of a phrase affects the ease with which it is realised at the functional level and the subsequent production of the phrase at the positional level.

### 3.4.1 Method

In the analysis of the narratives, distinctions were made between the phrases realising arguments and non-arguments. As an extension of this, those utterances containing only arguments and those with additional non-arguments were identified. The relative ease of production of utterances containing arguments and non-arguments was investigated by examining the percentage of two and three component structures containing non-arguments. The production of utterances containing non-arguments by the non-fluent group was compared to that of the normal subjects. From the analysis for hypothesis one, the mean S and mean M of utterances with only verb arguments and those including non-arguments was compared. In addition, the mean complexity of individual phrases was analysed for argument and non-argument prepositional and adjectival phrases. These two types of phrase were the only ones used frequently as arguments and non-arguments. The distribution of function word and morphological errors within arguments and non-arguments was not investigated. On initial examination of the data, it was obvious that there were insufficient examples of errors to make a comparison reliable, particularly as auxiliaries and pronouns were almost exclusively used within verb arguments.

### 3.4.2 Predictions

It was predicted for the normal group, that if different mechanisms are involved in the production of verb arguments and non-arguments then there may be a difference in the complexity of the phrases used to realise them. It was thought, however, that the normal subjects would be able to produce verb arguments and non-arguments with comparable ease. For the aphasic subjects, it was predicted that the proposed differences between the production of verb arguments and non-arguments may result in differences in phrasal complexity and the ease of production. Following Byng and

Black's (1989) findings, described in section 1.7.3, three patterns of performance were predicted:-

a. Utterances containing non-arguments will be easier to produce than utterances of the same argument complexity containing only obligatory or optional verb arguments. This increased ease of production will result in an increased proportion of utterances containing non-arguments.

b. Utterances containing non-arguments will have higher sum and mean phrasal complexities than those containing only obligatory or optional verb arguments.

c. Phrases which are expressing non-arguments will be more complex than those expressing verb arguments.

### 3.4.3 Results

Table 3.4 shows the percentage of utterances containing non-arguments for the normal and non-fluent groups. The pattern of results for the normal and the agrammatic aphasics was again very similar. An ANOVA revealed no significant effect of subject group ($F = 3.70$, $df = 1$, $p = 0.06$). It must be considered, however, that the overall percentage of three argument structures was lower in the aphasic group. In each group, the percentage of utterances containing two phrasal components, one of which, was a non-argument was quite low. In the production of utterances with three phrasal components, there was a much higher frequency of non-argument production. This difference, however, was not significant ($F = 3.54$, $df = 1$, $p = 0.07$). There was no significant interaction ($F = 3.68$, $df = 1$, $p=0.07$) between subject group and argument structure. In the previous section, no difference between the sum and mean phrasal complexity scores in utterances containing only verb arguments and in utterances containing non-arguments was identified. Table 3.5 compares the complexity of two particular types of phrase when they realised verb arguments and non-arguments. It can be seen that there was no difference between the complexity of the adjectival and prepositional phrases used to realise arguments and non-arguments for either subject group. In each case, there was no significant difference between subject group, phrase complexity and in neither case was there a significant interaction.

**Table 3.4: Comparison of the normal and aphasic groups: Percentage of utterances containing non-arguments**

| | Mean | s.d. | Min | Max |
|---|---|---|---|---|
| **Normal Control Group** | | | | |
| % 2 Argument Structures with Non-Arguments | 27.83 | 7.71 | 7.69 | 42.86 |
| % 3 Argument Structures with Non-Arguments | 62.83 | 21.36 | 0.00 | 90.91 |
| **Aphasic Group** | | | | |
| % 2 Argument Structures with Non-Arguments | 32.97 | 16.20 | 0 | 66.67 |
| % 3 Argument Structures with Non-Arguments | 70.00 | 35.02 | 0 | 100 |

**Table 3.5: Comparison of normal and aphasic groups: Production of argument and non-argument adjectival and prepositional phrases**

| | Argument | Non-Argument |
|---|---|---|
| **Normal Group** | | |
| Mean Complexity AP | 2.23 | 2.01 |
| Mean Complexity PP | 2.96 | 2.97 |
| **Aphasic Group** | | |
| Mean Complexity AP | 1.55 | 1.50 |
| Mean Complexity PP | 2.93 | 2.98 |

### 3.4.4 Summary

In the normal group, there was no evidence to suggest that non-arguments were realised differently than verb arguments. Utterances containing non-arguments did not differ in terms of phrasal complexity to utterances containing only verb arguments. In addition, the complexity of individual phrases realising arguments and non-arguments did not differ. Non-arguments were, however, frequently used particularly in three

component structures. The non-fluent aphasic group showed a similar pattern of performance to the normal subjects. There was no evidence to support the notion that the aphasic subjects rely on the production of non-arguments in order to increase the complexity of their utterances. Their production of non-arguments in two and three component argument structures was comparable to the normal group. As with the normal subjects, the complexity of utterances containing non-arguments was comparable to that of utterances containing only verb arguments. The complexity of individual argument and non-argument phrases was also comparable.

## 3.5 Hypothesis 3.

The thematic role assigned to an item within the predicate argument structure affects its subsequent phrasal realisation.

### 3.5.1 Method

As part of the narrative analysis, phrases were coded for the thematic role they were fulfilling. Only noun phrases were investigated during this part of the study, as these were the only phrasal components which fulfilled a large variety of thematic roles. The complexity of each noun phrase was calculated and its thematic role and position in the sentence was noted. The noun phrases were then grouped according to thematic role (agent, patient, experiencer, possessor, locative, attributive and benefactive) and sentence position (NP1 - pre-verb, NP2 immediately post-verb and NP3 post-NP2). The mean complexity of the noun phrases was then calculated for each subject and then for the group. Statistical comparisons were performed on the data. Due to the presence of missing values, a generalised linear model was used.

### 3.5.2 Predictions

It was predicted that in the normal group, the complexity of a phrase would be influenced by the thematic role it was expressing. This might reflect the different sorts of information expressed by each of the thematic roles. It was predicted that the aphasic subjects would show a similar pattern of performance to the normal subjects. When considering the realisation of thematic roles, the contribution of sentence position to phrasal complexity must also be evaluated. Certain thematic roles are

predominantly associated with certain sentence positions, for example, agents and possessors with sentence initial positions, locatives and attributives with post-verbal positions. If differences in phrasal complexity are observed, it may partially reflect differences due to position. English is a 'right-branching' language; it is predicted, therefore, that phrasal expansion will occur at the end of the sentence.

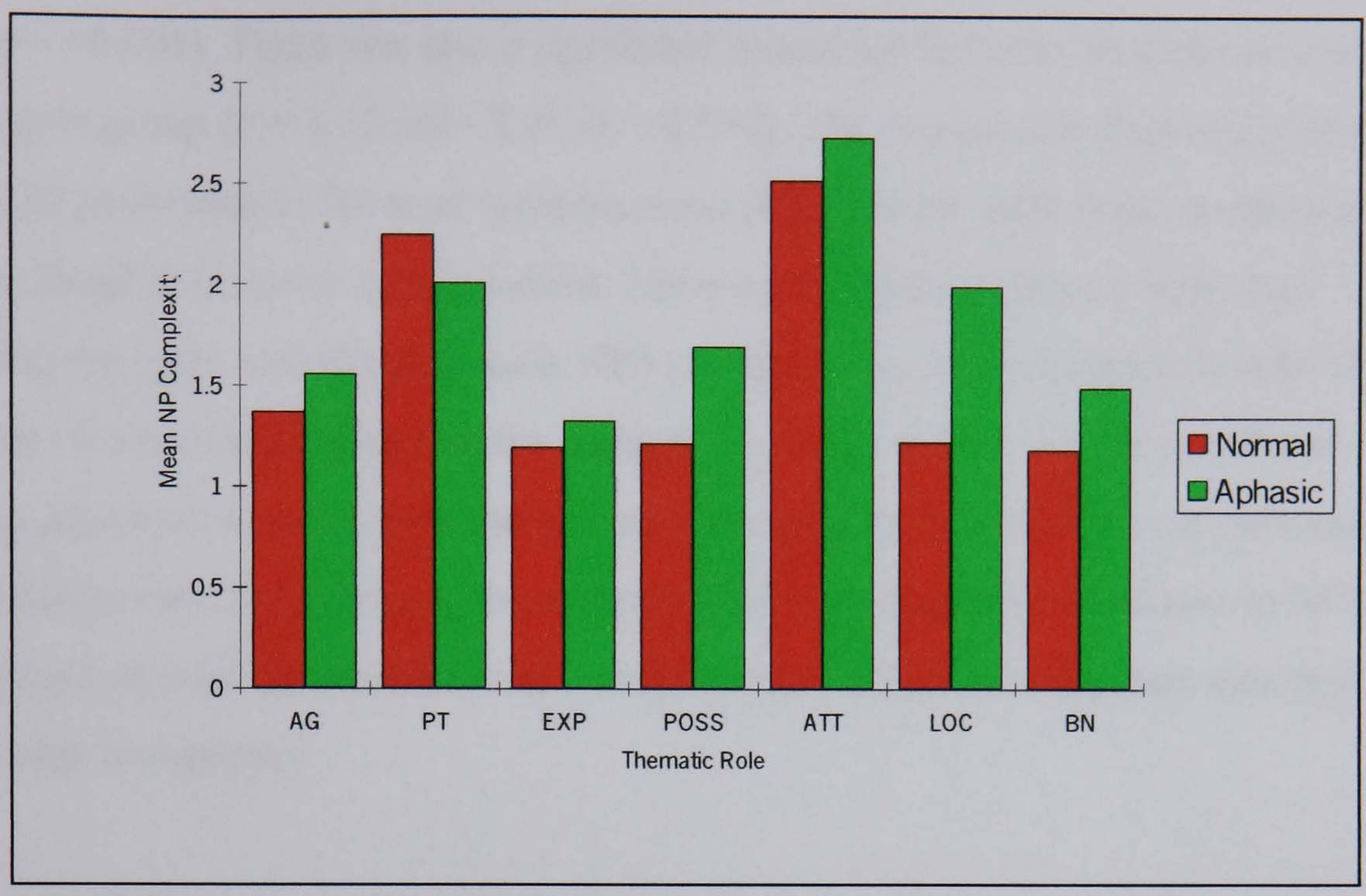
### 3.5.3 Results

Table 3.6 and figure 3.4 show the group mean of the noun phrase complexity scores for the realisation of the various thematic roles.

**Table 3.6: Comparison of normal and aphasic groups: Phrasal realisation of thematic roles**

| | **Agent (AG)** | **Patient (PT)** | **Experiencer (EXP)** | **Possessor (POSS)** | **Attributive (ATT)** | **Locative (LOC)** | **Benefactive (BN)** |
|---|---|---|---|---|---|---|---|
| **Normal Group** | | | | | | | |
| Mean | 1.37 | 2.25 | 1.20 | 1.22 | 2.52 | 1.23 | 1.19 |
| s.d. | 0.14 | 0.35 | 0.63 | 0.33 | 0.92 | 0.42 | 0.38 |
| Min | 1.12 | 1.33 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Max | 1.73 | 2.70 | 3.00 | 1.80 | 4.00 | 2.50 | 2.00 |
| **Aphasic Group** | | | | | | | |
| Mean | 1.56 | 2.01 | 1.33 | 1.70 | 2.73 | 2.00 | 1.50 |
| s.d. | 0.35 | 0.28 | 0.58 | 1.17 | 0.82 | 0.98 | 0.00 |
| Min | 1.20 | 1.40 | 1.00 | 1.00 | 1.50 | 1.00 | 1.50 |
| Max | 2.36 | 2.50 | 2.00 | 4.00 | 4.00 | 3.50 | 1.50 |

**Figure 3.4: Comparison of normal and aphasic groups: Mean noun phrase complexity in the realisation of thematic roles**



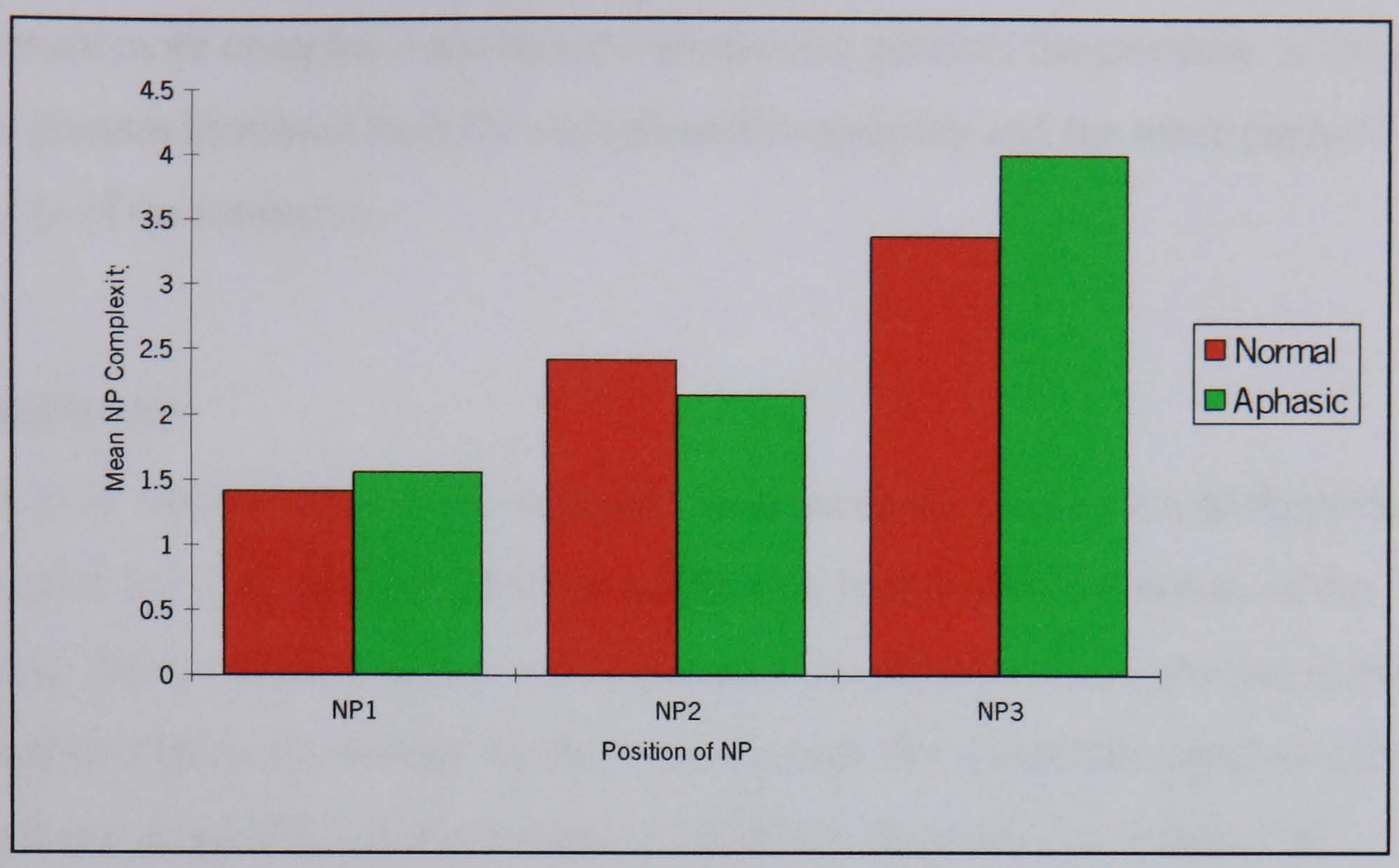

The comparison of the normal and the aphasic subjects revealed a significant main effect of thematic role on the mean complexity of the noun phrase ($F = 2.68$, $df = 6, 119$, $p = 0.018$). There was also a significant interaction between thematic role and subject group ($F = 2.31$, $df = 6,119$, $p = 0.038$). The results of the normal group show that the most complex noun phrases were used in the realisation of the patient and attributive roles. The other thematic roles were realised with less complex noun phrases, of roughly equivalent complexity. The aphasic group produced phrases of comparable complexity for the majority of thematic roles. The observed interaction would appear to result from the increased complexity of the phrases used to realise possessor, locative and benefactive roles. These three thematic roles were produced less frequently than the other thematic roles. Less than half of the aphasic subjects produced examples of these thematic roles; only one of the aphasic subjects produced a noun phrase realising the benefactive role. In contrast, the majority of the normal subjects produced examples of these thematic roles. This difference in frequency of use may have resulted in increased weight been given to individual complex phrases produced by the subjects with aphasia.

Table 3.7 and figure 3.5 show the group mean of the mean NP complexity scores for the realisation of pre- and post-verb noun phrases. There was a significant effect of noun phrase position on the complexity of the noun phrases produced ($F = 89.26$, $df = 2,44$, $p = <0.001$). There was also a significant interaction between sentence position and subject group ($F = 4.72$, $df = 2,44$, $p = 0.014$). The two groups displayed a similar pattern of performance; the least complex noun phrases were used in the realisation of phrases found in sentence initial position. More complex noun phrases were used following the verb, with the phrases in NP3 position being more complex than in NP2 position. The interaction found in the comparison of the normal and the non-fluent subjects appeared to result from the increased complexity of the NP3 noun phrases in the aphasic group. Only three of the aphasic subjects produced noun phrases in NP3 position and as with the realisation of certain thematic roles, this may have distorted the average complexity.

**Table 3.7: Comparison of normal and aphasic group: Phrasal realisation of pre- and post-verb noun phrases**

| | NP1 | NP2 | NP3 |
|---|---|---|---|
| **Normal Group** | | | |
| **Mean** | 1.42 | 2.43 | 3.38 |
| **s.d.** | 0.14 | 0.27 | 0.94 |
| **Min** | 1.22 | 1.78 | 1.00 |
| **Max** | 1.74 | 2.85 | 4.00 |
| **Aphasic Group** | | | |
| **Mean** | 1.56 | 2.16 | 4.00 |
| **s.d.** | 0.27 | 0.46 | 0 |
| **Min** | 1.17 | 1.33 | 4.00 |
| **Max** | 2.14 | 3.00 | 4.00 |

**Figure 3.5: Comparison of normal and aphasic groups: Mean noun phrase complexity in the realisation of pre- and post-verb noun phrases**




### 3.5.4 Summary

The predicted differences between the complexity of the phrases used to realise particular thematic roles were identified. These differences seemed to be a reflection of the position of the phrase within the sentence. Post-verbal phrases were more complex than pre-verbal noun phrases. The patterns seen in the non-fluent aphasic subjects mirrored those seen in the normal subjects; the significant interaction appeared to be a consequence of the low frequency of certain thematic roles, particularly those occurring in the NP3 position (for example, noun phrase locatives and attributives).

## 3.6 Summary of Results

There was little evidence to suggest qualitative differences between the performance of the normal subjects and the non-fluent aphasic subjects. The observed interactions in the realisation of thematic roles and in sentence position were probably due to the limited examples of certain thematic roles and NP3 noun phrases. The complexity of phrases in both the normal and non-fluent groups was determined by:-

1. The complexity of the argument structure in which it occurred.
2. The thematic role it was realising.
3. The position of the phrase within the sentence.

The complexity of a phrase was not, however, influenced by its argument status. These results seem to be linked with each other. As the complexity of the argument structure increased, there were more post-verbal phrases. These post-verbal noun phrases were more complex than the pre-verbal noun phrases; the presence of these complex phrases increased both the sum phrasal complexity and the mean phrasal complexity of the utterance.

## 3.7 Discussion

This study has investigated the relationship between the production of thematic structure and the subsequent production of phrases. In this way, the nature of the relationship between the processes which produce the functional and positional level representations has been studied. In the normal group, there was the expected increase in sum phrasal complexity as the number of phrasal components increased. The corresponding increase in the mean phrasal complexity appeared to be a consequence of the production of more complex post-verbal phrases. Subjects did not produce sentences of comparable complexity; the complexity of the utterance was dependent on the number of phrasal components used in association with the verb. The phrasal complexity of any individual phrase appeared to be a consequence of the information which the phrase conveyed. This was reflected in the differences between the noun phrases used to realise particular thematic roles. Alongside this, the position of the phrases within the sentence influenced their realisation. Within a narrative sample, pre-verbal noun phrases (agents, possessors and patients) were predominantly nominal or pronominal phrases which referred to previously mentioned participants. Post-verbal noun phrases (patients, attributives and locatives), in contrast, typically gave new information about participants or events. With the expression of new information came the need for expanded phrases. In the production of structures with three phrasal components, there was not only an increase in new information, but there was also an increased chance of one of those components being a clausal complement, for example, 'she told Cinderella she could go to the ball'.

The performance of the agrammatic subjects was qualitatively similar to that of the normal subjects. The complexity of their phrases also seemed to depend on the information to be conveyed. There was no evidence to suggest that the complexity of

phrases was constrained by the allocation of limited processing resources between the mechanisms which produce the functional and positional levels of representation. With an increase in the complexity of argument structure, there was no decrease in phrasal complexity and no increase in phrasal or morphological errors. This evidence does not argue against processing theories of agrammatism; there may be an overall decrease in processing resources. It does, however, suggest that there is no trade-off between the resources allocated to the production of the functional level and positional level representations. It remains unclear, however, if a trade-off would be evident if the complexity of the processing increased or if subjects had a more severe aphasia.

The subjects with aphasia used in the study were all able to produce some sentence structure and some complex phrases. In this way, they were probably less severe than some of the agrammatic subjects reported in the literature. Within the group, there was, however, a range of severity; the ability to produce sentences with a determinable argument structure ranged from 35 - 93% of utterances (see section 2.4.2). There was also some variation in the percentage of phrasal and morphological errors observed (see sections 2.4.3 and 2.4.4). A trade-off in processing may be evident in subjects with a more severe aphasia. It would be interesting to investigate the effects of increasing the complexity of the sentences or the phrases required. In the narrative task, both the normal and aphasic subjects relied predominantly on the use of simple sentences and phrases; it could be that as a consequence of this, processing demands did not exceed available resources.

In contrast to previous research (Byng and Black 1989, Shapiro et al 1992), this study found no evidence to suggest any differences between the production of arguments and non-arguments. The two groups of subjects did not differ in the relative percentage of two and three component utterances containing arguments and non-arguments. There was thus no evidence to suggest that aphasic subjects produced non-arguments in order to increase the complexity of their utterances. Their use of non-arguments in two and three component sentences followed the normal pattern. The high percentage of non-arguments in utterances with three phrasal components would appear to reflect the low percentage of verbs requiring three verb arguments and the dominant use of transitive structures. In addition, there was no difference between the phrasal realisation of arguments and non-arguments. Utterances containing arguments and non-arguments and individual phrases realising arguments and non-arguments

were of comparable complexity. This may offer preliminary support to the suggestion that similar processes are involved in the production of arguments and non-arguments at the phrasal level. This does, however, require further investigation. Future research could examine the prevalence and nature of phrasal and morphological errors in argument and non-argument phrases. If the same mechanism is used in the production of argument and non-argument phrases, there should be no differences in the frequency and type of errors produced in the two types of phrases.

The results overall support the independence of the processes used in the creation of thematic and phrasal structure. This would, therefore, support the dissociation between the processes which produce the functional and positional levels of representation in Garrett's model. Processing at the positional level is not constrained by the resources allocated to the creation of the functional level representation. Both levels, however, are constrained by the information specified at the message level (the information to be conveyed by the utterance). This information influences both the number of phrasal components produced alongside the verb and the complexity of the phrases used to realise them. The similar treatment of arguments and non-arguments requires modification to Garrett's model. In the original model, the production of the functional level representation revolves around the creation of the predicate-argument structure; no explanation is given about the way non-arguments are produced. Martin and Blossom-Stach (1986) suggested that there was a distinction between arguments and non-arguments at the functional level, with preferential processing of arguments. This distinction is not supported by this study; arguments and non-arguments appear to be processed in a similar way at both the functional and positional levels of processing. Garrett's (1982) model, therefore, requires modification with the information coded in non-arguments being processed in a similar way to that within verb arguments.

# Chapter 4: The Production of the Functional Level Representation

## 4.1 Introduction

The aim of this part of the study was to investigate the processes responsible for the production of thematic structure at the functional level representation. The performance of four subjects, identified as having functional level deficits, was contrasted. Schwartz (1987) suggested that three sub-processes were involved in the production of the functional level representation:- the retrieval of semantic information, the creation of the predicate argument structure (PAS) and the assignment of lexical items to thematic roles within the PAS; these were discussed in section 1.7. The existence of these sub-processes has not been determined experimentally. Caramazza and Hillis (1989) suggested that if sub-processes exist in the creation of a particular level of representation, then these sub-processes have the potential to be differentially impaired, with different consequences for performance. The study of subjects identified as having thematic difficulties in narrative speech, therefore, offers a way of investigating the existence of the sub-processes. If Schwartz's suggested sub-process are responsible for the production of the functional level representation, then deficits in producing the functional level representation may have a number of different origins:-

1. Difficulty in retrieving the semantic representations of the content words within the sentence resulting in word retrieval difficulties.
2. Difficulty in accessing information about the verb's predicate argument structure and the subsequent creation of an appropriate argument structure.
3. Difficulty in accessing lexical mapping information and the subsequent assignment of thematic roles within the PAS.

Different underlying impairments and their contrasting effects on performance may account for the different manifestations of the functional level deficits seen in the narratives of individual subjects (see discussion in section 2.8).

## 4.2 Method

### 4.2.1 Subjects

Four of the subjects, previously described in chapter two, participated in this part of the study; the subjects are described in table 4.1.

**Table 4.1: Subject details**

| Subject | Sex | Date of Birth | Time post-onset when first tested | Previous Occupation |
|---|---|---|---|---|
| **GW** | M | 29.1.1957 | 8 years | Aerial Rigger |
| **JM** | F | 29.7.1936 | 18 months | Psychiatric Sister |
| **KD** | M | 22.10.1949 | 6 months | Shipyard Worker |
| **TJ** | M | 14.6.1941 | 2 years | University Lecturer |

GW, KD and TJ were aphasic following a single left hemisphere CVA. Unfortunately no CT Scan information for these subjects was available. JM's aphasia resulted from surgery to clip a left middle cerebral artery aneurysm. All of the subjects were at least 6 months post-onset at the time of testing. GW, JM and TJ were no longer receiving speech and language therapy; KD was seen during a break from his regular therapy.

### 4.2.2 Subject Selection

These subjects were selected from those involved in the study of narrative production described in chapter two. All of the subjects were part of the non-fluent group. The subjects were all thought to have difficulty in constructing the functional level representation of sentences, as indicated by a low mean thematic complexity score compared to normal subjects. Three of the subjects (JM, KD and TJ) produced a different distribution of thematic structures from normal subjects with an increased proportion of undetermined thematic structure and a reduced proportion of definite argument structures. GW showed a normal pattern of performance in terms of the overall distribution of thematic structures, but omitted obligatory arguments. The

results for the production of thematic structure in the narrative analysis are shown in table 4.2.

**Table 4.2: Results from Cinderella narrative**

| | Normal Mean Score | Normal Range (2 s.d.) | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|
| **Mean Thematic Complexity** | 3.15 | 2.74-3.56 | 2.47* | 2.56* | 2.00* | 1.17* |
| **% Undetermined Thematic Structure** | 2.54 | 0-8.45 | 2.35 | 12.5* | 46.15* | 91.3* |
| **% 1 Argument** | 12.83 | 2.91-22.74 | 14.71 | 21.88 | 10.26 | 0 |
| **% 2 Argument** | 58.02 | 41.37-74.67 | 52.94 | 62.50 | 41.03 | 8.7* |
| **% 3 Argument** | 20.28 | 7.48-33.08 | 8.82 | 3.13* | 0.03* | 0* |
| **% Thematic Embedding** | 6.33 | 0-16 | 0 | 0 | 0 | 0 |
| **% Omission of Obligatory Arguments** | 0.15 | 0-1.09 | 8.82* | 0 | 0 | 0 |

* Indicates outside normal range (2 s.d. from the mean of the normal group)

From this initial sample , it was thought that these subjects were all having difficulty in producing the functional level of representation, although the extent of these difficulties varied. Due to the limited nature of the original sample, it was thought important to confirm the presence of these deficits by analysing utterances obtained using other stories. GW, KD and TJ only knew Snow White in addition to Cinderella. JM knew the stories of Snow White and Red Riding Hood. The results, from the combined analysis of these narratives, are shown in the table 4.3.

**Table 4.3: Results from combined narratives**

| | Normal Mean Score | Normal Range (2 s.d.) | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|
| **Mean Thematic Complexity** | 3.15 | 2.74-3.56 | 2.43* | 2.69* | 2.21* | 1.51* |
| **% Undetermined Thematic Structure** | 2.54 | 0-8.45 | 26.79* | 14.92* | 37.36* | 71.43* |
| **% 1 Argument** | 12.83 | 2.91-22.74 | 12.50 | 11.94 | 5.13 | 5.71 |
| **% 2 Argument** | 58.02 | 41.37-74.67 | 51.76 | 63.43 | 56.23 | 22.86* |
| **% 3 Argument** | 20.28 | 7.48-33.08 | 8.93 | 8.21 | 0.02* | 0* |
| **% Thematic Embedding** | 6.33 | 0-16 | 0 | 1.49 | 2.21 | 0 |
| **% Omission of Obligatory Arguments** | 0.15 | 0-1.09 | 4.41* | 4.78* | 10.72* | 4.17* |

* Indicates outside normal range (2 s.d. from the mean of the normal group)

It can be seen that the thematic complexity score remained outside the normal range for all of the subjects. In all cases, the reduced thematic complexity score seemed to result from an increased number of utterances with an undetermined thematic structure. TJ showed very limited production of utterances with a determinable argument structure. Within the larger samples, there was also evidence that all of the subjects sometimes omitted obligatory arguments. The results from the larger narrative sample confirmed the initial impression that these subjects either had difficulty retrieving the information necessary to construct or in constructing the functional level representation. It was, therefore, decided to test these subjects in more depth, with a view to pinpointing the nature of their underlying deficits.

### 4.2.3 Method

The subjects had already been tested on the Comprehensive Aphasia Test (CAT) (Swinburn et al 1997); the results are shown in appendix 4. Despite some difficulties in auditory single word and sentence comprehension, all of the subjects had sufficiently good functional comprehension to understand the requirements of each

task. In order to minimise the effect of auditory comprehension and short term memory difficulties, in the tasks where words were given to subjects, the words were presented in written form and also read aloud by the researcher. None of the four subjects presented with significant visual perception difficulties, and were, therefore, considered capable of interpreting visual stimuli. In addition, the presence of event perception difficulties was investigated (see section 1.5.2). The subjects were asked to identify the active participant in some of the pictures used in the sentence production tasks. All of the subjects were able to perform this task without difficulty, and thus, their difficulties with sentence production were not considered to be a consequence of event perception difficulties.

Subjects were tested on a battery of tests, roughly grouped into three categories:-

1. Access to semantic information and the subsequent retrieval of words
2. Access to information about the verb's predicate argument structure (PAS) and the subsequent creation of an appropriate argument structure.
3. Access to mapping information and the assignment of thematic roles within the PAS.

It is, however, recognised that it is a challenge to assess these aspects independently of each other and independently of other aspects of production. It was particularly difficult to assess the assignment of thematic roles within the PAS, without its association with word order. In production, thematic role assignment was, therefore, investigated alongside the mapping of those thematic roles onto syntactic positions in canonical sentences. In comprehension, thematic role assignment was considered subsequent to the parsing of word order. It was suggested in section 1.6 that the processes involved in sentence production rely to an extent on information coded within the lexical entry of the verb. It was suggested that this lexical information may be used in both production and comprehension tasks. The study, therefore, assessed access to relevant lexical information in the performance of comprehension and grammaticality judgement tasks, alongside tests of sentence production. Due to the limited availability of published tests assessing these aspects of production, many of the tests were designed specifically for this study. In some cases, the tests were used to assess more than one aspect of production, and therefore, sub-components of the test are reported in separate sections. Details of individual tests are presented in sections 4.3 to 4.7, alongside predictions of performance and the results for each

subject. The performance of each subject is summarised at the end of each group of tests and on the battery of tests as a whole.

## 4.3 Access to Semantic Information and the Retrieval of Words

The aim of these tests was to assess access to semantic information, with reference to nouns and verbs. Access to semantic information and semantic deficits in aphasia were discussed in section 1.7.1. As semantic information is considered central to both production and comprehension, both sorts of tasks were used. The subsequent access to phonological information during word retrieval was also tested. In the retrieval of verbs, Marshall (1995) suggested that semantic selection restrictions are encoded alongside a verb's core meaning; for this reason, awareness of semantic selection restrictions was also investigated in this part of the study.

### 4.3.1 Testing Materials

#### a) The Verb and Noun Test (Bird and Webster 1997)

This test was designed in conjunction with another PhD student. The manual and score sheets for the test can be found in appendix 8.

**Aims of Test**

This test was used to assess the retrieval of nouns and verbs in isolation, allowing specific word class deficits to be identified. This test was also used to assess the effect of frequency, length and imageability on word retrieval.

**Test Design**

Video stimuli were used in order to maximise the range of verbs which could be depicted. Nouns and verbs were controlled for frequency and length, but not for imageability. Although all the items were necessarily of high imageability, there was found to be no overlap in the estimated imageability of nouns and verbs; the nouns were always considered to be of higher imageability than the verbs. The effects of frequency, length and imageability were investigated within each word class. In addition, information about the number and type of different argument structures in which the verbs could occur was included.

**Presentation**

The test consisted of 54 verbs and 67 nouns, presented separately (only 54 nouns and verbs were compared directly, the other items were included to allow the effects of frequency and length within classes to be investigated). Each clip was shown for 5 seconds, followed by a 3 second pause for the item to be named. Subjects were asked to watch until the screen went blank and then tell the researcher, either what was happening (verbs) or what it was (nouns). In both cases, subjects were asked to respond using one word. Subjects were given as long as required to produce the target word.

**Scoring**

The final response was scored. Phonemic paraphasias and semantic paraphasias were scored as incorrect. Inflected forms of the target were accepted as correct.

**Normal Data**

Naming agreement was obtained from 30 control subjects, aged 49 - 85. None of the subjects had any history of brain damage or any signs of dementia. It was decided to split the subjects into two groups according to their age, as the more elderly subjects consistently scored less well than their younger counterparts. The results can be seen in table 4.4.

**Table 4.4: Normal performance on VAN test**

| Age | Group | Total mean | Range | HiIm mean | LoIm mean | HiFr mean | LoFr mean | Long mean | Short mean |
|---|---|---|---|---|---|---|---|---|---|
| **VERBS** | | | | | | | | | |
| 49-69 | N=17 | 50.3 | 44-53 | 19.4 | 17.6 | 18.0 | 18.9 | 14.8 | 14.2 |
| 70+ | N=13 | 48.5 | 43-52 | 19.4 | 16.2 | 16.9 | 17.7 | 13.7 | 14.0 |
| **NOUNS** | | | | | | | | | |
| 49-69 | N=17 | 52.6 | 49-53 | 19.7 | 19.2 | 19.6 | 19.1 | 14.7 | 14.7 |
| 70+ | N=13 | 50.8 | 47-54 | 19.4 | 17.4 | 18.7 | 18.4 | 13.9 | 14.7 |
| | n | 54 | | 20 | 20 | 20 | 20 | 15 | 15 |

In addition to the noun component of this test, the CAT (Swinburn et al 1997) also included a section on noun naming. This sub-test investigated the retrieval of a small set of nouns controlled for frequency, imageability, length and familiarity.

**b) Spoken and Written Word Picture Matching Tasks**

Sub-tests of CAT (Swinburn et al 1997)

**Aims of Tests**

These tests were used to assess access to semantic information about noun stimuli from auditory and written input.

**Test Design**

The tests involved the identification of the corresponding noun from a selection of pictures including semantically related, phonologically related and unrelated distracters.

**c) The Birkbeck Verb Video (described in Byng 1988)**

**Aims of Test**

This task was used to test the comprehension of verbs from auditory input. The test assessed access to both semantic and lexical mapping information.

**Test Design**

Three types of verbs were included in this test:- reverse role verbs, for example buy and sell, reverse action verbs, for example catch and throw, and reverse direction verbs, for example rise and fall. The reverse action and reverse direction verbs rely on accessing semantic information in order to identify them. The reverse role verbs rely on accessing semantic and thematic information about the verbs and the mapping of this thematic role information onto the participants within the scene (Byng 1988).

**Presentation**

Depictions of the target verb and an unrelated or related distracter were presented on the video, initially separately and then simultaneously using split screen presentation. The subject had to match the spoken form of the word with the corresponding scene.

**Scoring**

Correct responses were scored for each type of verb separately. For the incorrect responses it was noted whether the subject chose the related or unrelated distracter.

**Normal Data**

No normal data was available for this test. Of particular interest in this study was the subject's comparative performance on different verb types.

**d) Grammaticality Judgement Task: Semantic Appropriacy and Mapping Aims**

This task was used to test access to two types of information encoded within a verb's representation:- semantic selection restriction information and lexical mapping information. Access to semantic selection restrictions may be considered part of the overall semantic representation of the verb and is thus discussed in this section. Access to lexical mapping information will be discussed in section 4.5.

**Test Design**

A subset of the verbs used in the sentence generation task (see section 4.4.1) were used in this task. Three groups of verbs were chosen:- the fixed transitive, fixed intransitive and variable transitive and intransitive verbs. Correct sentences were generated using each verb in all its appropriate classifications. The sentences typically took the form of noun phrase and verb, with an accompanying noun phrase (if required). For each group of intransitive sentences, five were presented as an intransitive sentence with no accompanying non arguments, for example, ' the cars collided', five were presented as the intransitive sentence with a non-argument prepositional phrase, for example, 'the girl sympathised with the man' and five were presented as the intransitive sentence and a non-argument temporal phrase, for example, 'the couple marry next week'. The sentences were presented in a mixture of present and past tense.

Two types of ungrammatical sentences were created:-

1. Semantically anomalous sentences - these sentences violated the selection restrictions of the verb.
2. Sentences with mapping anomalies - these sentences violated the lexical mapping rules of the verb.

Semantically anomalous sentences were created by changing the agent noun phrase to something inappropriate or very unlikely. This often involved changing the animacy of the head noun. Mapping anomalies were only created for the subset of transitive verbs and involved the switching the position of the two noun phrases. For two of the

transitive verbs 'marry' and 'meet', this switching did not produce an inappropriate sentence, so additional semantic anomalies were created for these two verbs.

The test, therefore, consisted of 150 sentences:-

30 correct transitive sentences

(15 fixed transitive verbs, 15 variable transitive/intransitive)

e.g. 'the man mowed the lawn'

30 correct intransitive sentences

(15 fixed intransitive verbs, 15 variable transitive/intransitive)

e.g. 'the woman is baking'

28 incorrect transitive sentences (mapping anomalies)

(15 fixed transitive, 13 variable transitive/intransitive)

e.g. 'the lawn mowed the man'

32 incorrect transitive sentences (semantic anomalies)

(15 fixed transitive verbs, 17 variable transitive/intransitive)

e.g. 'the bag mowed the lawn'

30 incorrect intransitive sentences (semantic anomalies)

(15 fixed intransitive verbs, 15 variable transitive/intransitive)

e.g. ' the bucket is baking'

**Presentation**

Sentences were presented in a random order. The subjects were asked to listen to the sentences and decide whether they were 'good' (made sense) or 'bad' (did not make sense) sentences. Examples were given before the test sentences. Sentences were repeated if requested. Testing was done over more than one session if the subject became tired.

**Scoring**

The total number of correct responses was recorded (correct acceptance of a grammatical sentence, correct rejection of an ungrammatical sentence). The total number of correct rejections of semantic anomalies and mapping anomalies were calculated separately. Incorrect responses were divided into false positive responses (incorrect acceptance of an ungrammatical sentence) and false negative responses (incorrect rejection of a grammatically correct sentence).

**Normal Data**

Normal data was obtained from a group of 18 normal elderly control subjects (mean age = 69.38, range 61 - 76). Of the 150 sentences, an average of 145.9 (range 142 - 149) were classified correctly by the normal subjects. Their errors were mainly false positive responses to feasible but unlikely sentences. They correctly identified a mean of 59.22 of 62 semantic anomalies (range 57 - 62) and a mean of 27.67 of 28 mapping anomalies (range 26 - 28).

### 4.3.2 Predictions

Subjects with central semantic deficits will perform poorly on this group of tests. Noun and verb retrieval may be impaired or either may be impaired selectively (as word class information is stored at a semantic level). Semantic paraphasias may be evident in production. In the word-picture matching tasks, semantic distracters may be selected instead of the target noun. In the comprehension of verbs, all verb types may be affected as all of the pairs of reverse role, reverse direction and reverse action verbs are semantically similar. Poor access to phonological information, both in input and output, may also impair performance on these tasks. Subjects with difficulties in accessing PAS information may have difficulty retrieving verbs if PAS information has to be accessed for single word production and comprehension. This will not affect their ability to retrieve nouns. Subjects with problems accessing lexical mapping information may also have difficulty retrieving verbs if it has to be accessed during single word use. This will again not affect noun retrieval or comprehension. If a subject has difficulty accessing lexical mapping information, the comprehension of reverse role verbs will be more impaired than the comprehension of reverse action and reverse direction verbs. The subject will also have difficulty identifying mapping anomalies in the grammaticality judgement task.

### 4.3.3 Results

The results from this set of tests are summarised in table 4.5.

**Table 4.5: Results of semantic tests**

| ACCESS TO SEMANTIC INFORMATION | n | Normal Mean | Normal Range | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|---|
| **Single Word Retrieval** | | | | | | | |
| VAN Noun Retrieval | **54** | **53** | **49 - 53** | **53** | **53** | **46*** | **45*** |
| VAN Verb Retrieval | **54** | **50** | **44 - 53** | **37*** | **40*** | **34*** | **31*** |
| CAT Noun Retrieval | **48** | **46.4** | **42 - 48** | **46** | **37*** | **34*** | **35*** |
| **Comprehension** | | | | | | | |
| CAT SWPM | **30** | **29.1** | **25 - 30** | **28** | **30** | **30** | **30** |
| CAT WWPM | **30** | **29.6** | **27 - 30** | **29** | **30** | **30** | **28** |
| Birkbeck Verb Video | **46** | **na** | **na** | **42** | **45** | **44** | **39** |
| Reverse Direction Verbs | **14** | **na** | **na** | **13** | **13** | **14** | **13** |
| Reverse Action Verbs | **16** | **na** | **na** | **15** | **16** | **14** | **14** |
| Reverse Role verbs | **16** | **na** | **na** | **14** | **16** | **16** | **12** |
| **Grammaticality Judgement** | | | | | | | |
| Appropriacy of Arguments | **150** | **145.83** | **142 - 149** | **126*** | **139*** | **145** | **146** |
| Correct Identification of Semantic Anomalies | **62** | **59.22** | **57 - 62** | **54*** | **55*** | **59** | **61** |
| Correct Identification of Mapping Anomalies | **28** | **27.67** | **26 - 28** | **22*** | **28** | **27** | **27** |

* Indicates performance significantly different from normal control subjects.

NA = Normal data not available.

**a) The Verb and Noun Test**

***Retrieval of Verbs***

On the VAN test, all of the subjects with aphasia differed significantly from the normal group in the retrieval of verbs. The results from the independent sample t tests are shown in table 4.6.

**Table 4.6: Verb retrieval on the VAN test**

| Subject | T | df | p value |
|---|---|---|---|
| **GW** | 5.13 | 16 | 0.000* |
| **JM** | 3.97 | 16 | 0.001* |
| **KD** | 6.29 | 16 | 0.000* |
| **TJ** | 7.44 | 16 | 0.000* |

***Retrieval of Nouns and Verbs***

In each case, there was a significant difference between the subjects' retrieval of nouns and verbs. The results from the chi square tests are reported in table 4.7. The nouns were always retrieved more accurately than the verbs.

**Table 4.7: Contrast between the retrieval of nouns and verbs on the VAN test**

| Subject | X | df | p value |
|---|---|---|---|
| **GW** | 15.00 | 1 | 0.000* |
| **JM** | 11.15 | 1 | 0.001* |
| **KD** | 8.93 | 1 | 0.007* |
| **TJ** | 5.83 | 1 | 0.016* |

***Retrieval of Nouns***

GW and JM's retrieval of nouns was within the normal range. KD and TJ, however, were impaired in their retrieval of nouns compared to the normal group. The results from the independent sample t tests are listed in table 4.8.

**Table 4.8: Noun retrieval on the VAN test**

| Subject | T | df | p value |
|---|---|---|---|
| **GW** | -1.07 | 16 | 0.299 |
| **JM** | -1.07 | 16 | 0.299 |
| **KD** | 4.25 | 16 | 0.001* |
| **TJ** | 5.01 | 16 | 0.000* |

***Error Patterns***

GW produced semantic paraphasias; many of these errors were the production of a noun semantically related to the target verb e.g. 'wedding' for 'marry'. JM produced a combination of semantic paraphasias e.g. 'painting' for 'colouring', and phonemic paraphasias on the longer words. KD's errors in noun retrieval were also a mixture of semantic and phonemic paraphasias. In the retrieval of verbs, he generally produced a semantically related noun e.g. 'syringe' for 'inject' and 'parcel' for 'deliver'; these items were often present in the action clip. TJ produced semantic paraphasias in the retrieval of both nouns and verbs e.g. 'pen' for 'pencil' and 'viewing' for 'watching'.

**b) CAT Naming Test**

In the naming section of the CAT, JM, KD and TJ scored outside the normal range. These results confirm KD and TJ's difficulty with noun retrieval. JM' s poorer performance on this task was a consequence of the high number of self corrections of phonological errors on the three syllable words.

**c) CAT Spoken Word (SWPM) and Written Word (WWPM) Picture Matching Tasks**

All of the subjects scored within the normal range on the CAT spoken and written word to picture matching sub-tests, indicating that they have access to basic semantic information about nouns.

**d) Birkbeck Verb Video (Byng 1988)**

The subjects with aphasia differed significantly from one another in their ability to understand verbs (Cochran Q test, Q = 12.60, df = 3, p = 0.0056). JM and KD made very few errors on this task. GW and TJ made errors in the comprehension of all three types of verbs. These errors were predominantly the selection of the related distracter. There was no significant difference between the comprehension of the three types of verbs in any of the subjects (chi square test, p always greater than 0.05). This suggests that poor performance on this task reflected poor access to semantic information, rather than poor access to lexical mapping information.

**e) Grammaticality Judgement Task: Semantic Appropriacy and Mapping**

The subjects with aphasia differed significantly from each other in their performance on this task (Cochran Q test, Q = 46.18, df = 3, p = 0.000) and in their ability to identify semantic anomalies correctly (Cochran Q test, Q = 15.72, df = 3, p = 0.0013). GW's and JM's overall performance differed from that of the normal control subjects (independent sample t tests, GW t = 10.41, df = 17, p = 0.000, JM t = 3.59, df = 17, p = 0.002). Their ability to detect semantic anomalies also differed from the normal control group (GW t = 3.44, df = 17, p = 0.003, JM t = 2.78, df = 17, p = 0.013). Analysis of GW's and JM's performance revealed an increased number of false positive responses (acceptance of semantically anomalous arguments). KD and TJ did not differ from the normal subjects in their performance on this task; they were able to identify semantic and mapping anomalies.

### 4.3.4 Summary of Results

The subjects all had a specific deficit in the retrieval of verbs, although of differing severity. All of the subjects were significantly impaired in their retrieval of verbs compared to nouns. These verb retrieval deficits may contribute to the sentence production difficulties seen in these subjects, accounting for the increased production of utterances with an undetermined thematic structure in the narrative sample. KD and TJ also experienced difficulty in the retrieval of nouns, whereas GW and JM were within normal limits on the noun section of the VAN. JM's performance on the CAT naming test was outside normal limits due to her self correction of phonemic

paraphasias. KD also produced some phonemic paraphasias, indicating that phonological difficulties may also have been contributing to his word retrieval deficit. It must be considered that these difficulties in single word retrieval may affect the subjects' ability to retrieve items within sentences. All of the subjects made some semantic paraphasias, suggesting that their difficulties may have been a consequence of impaired access to lexical semantic information. TJ and GW were also impaired in the comprehension of verbs in the Birkbeck Verb Video, with the selection of semantically related verbs. This may indicate that these two subjects have central difficulties accessing lexical semantic information.

GW and JM both experienced difficulty detecting semantic anomalies in the grammaticality judgement task. For GW, this may be an extension of his single word verb comprehension difficulties. If this is the case, however, it would be expected that TJ (who has an apparently more severe semantic impairment) would experience similar difficulty . In contrast, JM who did not appear to have difficulties in the comprehension of verbs experienced difficulty accessing semantic selection restriction information. It, therefore, seems that semantic selection restrictions are a specific sort of semantic information which can dissociate from other kinds of semantic knowledge.

## 4.4 Access to Predicate Argument Structure Information and the Creation of the Predicate Argument Structure

The tests in this section assessed access to predicate argument structure (PAS) information. Access to PAS information and the deficits identified in some subjects with aphasia were discussed in section 1.7.2. Like semantic information, PAS information is thought to be central to both comprehension and production, and was therefore, assessed using sentence production and grammaticality judgement tasks. The relationship of PAS and semantic information remains unclear. Difficulties in word retrieval and in mapping may prevent the realisation of an appropriate PAS, despite intact information about the arguments needed in conjunction with the verb.

### 4.4.1 Testing Materials

a) **Sentence Generation Task**

**Aim**

This test assessed the ability to construct an appropriate PAS for a verb, when given the phonological and orthographic form. By presenting the subject with the base form of the verb, it was hoped to eliminate the effects of verb retrieval deficits. An appropriate PAS involves the production of both the correct number of arguments and semantically appropriate arguments.

**Test Design**

75 verbs were selected, depending on the number and type of possible predicate argument structures associated with the verb. The verb classifications used were taken from the syntactic classifications found in the CELEX database (Center for Lexical Information 1993) and confirmed using the dictionary. Verbs were selected on the basis of argument structure and presumed pre-morbid familiarity. Items were not included if they could be used as a noun or adjective in the form to be presented. Due to the difficulty in finding verbs, groups of verbs were not matched for frequency or length. The groups of verbs varied quite significantly in mean frequency and length; this seemed to reflect the fact that the more possible verb argument arrangements, the greater frequency of use and the shorter the word. The mean frequency of the verbs in each group and their mean length in syllables and phonemes is recorded in table 4.9. It must be considered that these variables may affect the use of the target verb and its inclusion in a sentence. The verbs were divided into five groups as follows:-

FIXED ARGUMENT STRUCTURE

Two argument transitive (FT)

One argument intransitive (FI)

VARIABLE ARGUMENT STRUCTURE

Two argument transitive/one argument intransitive (VTI)

Two argument transitive/three argument ditransitive (VTD)

Two argument transitive/one argument intransitive/Three argument ditransitive or Transitive with complementation (VTID/TC)

A list of the verbs used can be found in appendix 9.

**Table 4.9: Mean frequency and length of verb types**

(frequency of the lemma in log frequency per million).

| Verb Type | F I | F T | V T D | V T I | V T I D/TC |
|---|---|---|---|---|---|
| **Mean Frequency** | **1.27** (0.72) | **1.60** (0.55) | **1.27** (0.46) | **1.76** (0.76) | **2.12** (0.77) |
| **Mean Length Syllables** | **2.33** (0.98) | **2.13** (0.64) | **1.93** (0.59) | **1.67** (0.72) | **1.27** (0.46) |
| **Mean Length Phonemes** | **5.40** (2.00) | **5.33** (1.23) | **5.13** (1.73) | **4.33** (1.91) | **3.60** (1.24) |

(Standard deviations in brackets)

**Presentation**

Verbs were presented randomly in written form and also read aloud by the researcher. The subjects were instructed to produce a sentence containing the 'action word' in any form. The test items were preceded by examples, to ensure the subject had understood the instructions. In some cases, the subjects were unable to complete the task in a single session, and thus the data was collected in two or three adjacent sessions. The sentences were recorded and then transcribed.

**Analysis**

The number of sentences including the target as a verb was recorded. Targets which produced no response or which did not contain the verb were excluded from the rest of the analysis. A thematic analysis of the main clause containing the target verb was then carried out. Sentences were labelled as 1,2,3 or 4 argument sentences depending on the number of phrasal components used in association with the verb. Sentences were then classified as optional (OPT), obligatory (OB), non-argument (NA) and inappropriate (INAPPROP).Utterances were coded as non-argument sentences if any of the phrasal components were non-arguments (see section 1.7.3). An example of non-argument utterances is 'the baby is crawling on the floor', where 'on the floor' is a prepositional non-argument; this would be coded as 2NA as the utterance contains two phrasal components, one of which is a non-argument. The example, ‘the teacher asked the boy the question yesterday' where 'yesterday' is an

adverbial non-argument would be coded as a 4NA utterance. Utterances were coded as obligatory if the number of arguments used was the compulsory number of arguments required by the verb and no non-arguments were present. For example 'the woman is sunbathing' or 'they enjoyed the film'. These utterances would be coded as 1OB and 2OB; the verbs ‘sunbathe’ and ‘enjoy’ each have only one PAS arrangement, with one and two obligatory arguments respectively. Utterances were coded as optional if the verb could be involved in utterances with varying numbers of arguments and no non-arguments were present. For example, the sentences, 'the woman is baking' or 'she baked the cake'; both constitute correct argument structure arrangements, and in each sentence, all of the components are arguments of the verb. These utterances would be coded as 1OPT and 2OPT respectively. Utterances were coded as inappropriate if the verb was being used in an inappropriate PAS (too few or too many arguments). For example, a transitive verb used in an intransitive sentence frame 'the boy deserved' or an intransitive verb used in a transitive sentence frame 'the boy vanished the rabbit'. These utterances would be coded as 1INAPPROP and 2INAPPROP respectively.

The following summary information was obtained:-

i) Percentage of sentences, including a verb, produced with an appropriate argument structure (with or without non-arguments)

ii) Percentage of sentences which include the production of non-arguments

This information was initially calculated for all the sentences containing a target verb and then for the five groups of verbs individually. For the verbs with variable argument structures, the form in which the verb was used was also recorded for each sentence and the percentage realisation of each possible form was calculated. This was only calculated for sentences which contained a verb in an appropriate argument structure.

**Normal Data**

Data was collected from 22 normal subjects, age range 24 - 71. Written questionnaires were used to obtain the normal data. The normal control subjects were asked to write a sentence containing the verb in any form. The data was analysed in exactly the same way as the spoken responses of the subjects with aphasia.

## Normal Results

Due to very poor agreement on its argument structure, the verb 'improvise' was removed from the analysis. This left only 14 verbs in the V T D group and a total of 74 verbs overall.

### *Target as Verb*

The normal subjects almost always produced a sentence containing the target verb. The mean score for the group was 73.0/74 (range 70 - 74). The four items which were most frequently not produced as verbs were allot (used as a lot), marry (used as get married), hide (used in hide and seek) and practise (used as practice). Table 4.10 shows the performance of the normal subjects on the different verb types. It can be seen that the normal performance was greater than 95% in using the verbs of all of the different types.

### *Argument Structure*

Normal subjects produced an average of 99.10% of verbs within an appropriate argument structure. When an appropriate argument structure was not used, it was generally a consequence of the verb being used in an idiomatic phrase or in its infinitival form. Table 4.10 shows the production of an appropriate argument structure for the different verb types. In each case, performance was greater than 95% accurate.

### *Production of Non-Arguments*

The mean percentage of utterances, produced by the normal subjects, containing non-arguments was 34.78%. Table 4.10 shows the rate of non-argument use with different verb types. The non-arguments were produced predominantly alongside verbs used in their intransitive form. Non-arguments were also used alongside transitive structures but never with verbs in their transitive with complementation or ditransitive form.

### *Performance on Different Verb Types*

Table 4.10 shows the performance on different verb types. It can be seen that the normal subjects had most difficulty in the correct use of the variable transitive/ditransitive verbs. Their performance, however, was always over 95% correct in the use of the verb in an appropriate argument structure.

***Realisation of Verb***

The verbs with variable argument structures were realised predominantly in their transitive form. The realisation of the various argument structure arrangements is shown in the table 4.11. Verbs were not often produced in their three argument form.

**Table 4.10: Normal performance on different verb types**

| Verb Type | Mean % Correct Target | Mean % Correct Argument Structure | Mean % Use of Non-Arguments |
|---|---|---|---|
| **FI** | 99.70 | 99.70 | 75.58 |
| **FT** | 99.70 | 99.09 | 14.19 |
| **VTD** | 96.36 | 97.05 | 23.96 |
| **VTI** | 97.40 | 99.70 | 40.64 |
| **VTID/TC** | 99.39 | 100 | 23.70 |

**Table 4.11: Realisation of verbs with variable argument structures**

| Verb Type | Mean % T | Mean % I | Mean % D or TC |
|---|---|---|---|
| **VTD** | 76.91 | | 23.09 |
| **VTI** | 68.93 | 30.62 | |
| **VTID/TC** | 62.27 | 24.61 | 13.12 |

**b) Grammaticality Judgement Task: Predicate Argument Structure**

**Aims**

This task assessed access to PAS information, without the need for the subject to produce the sentence. Using PAS information, sentences with an appropriate argument structure can be accepted as being correct and sentences with an inappropriate argument structure can be rejected.

**Test Design**

The same subset of verbs used in the grammaticality judgement task described in section 4.3.1 were used:- fixed intransitive, fixed transitive and variable intransitive

and transitive. Correct sentences were generated using each verb in all its appropriate classifications. The sentences typically took the form of pronoun and verb, with an accompanying noun phrase (if required). In some sentences an initial NP was used. As in the other task, the intransitive sentences were presented as a mixture of intransitive sentence with no accompanying non arguments, sentences with a non-argument prepositional phrase and sentences with a non-argument temporal phrase. In all the groups of sentences, the verbs were presented in a mixture of present and past tense. Incorrect sentences were generated using the verb in an argument structure which was inappropriate but trying to maintain the overall semantics of the sentence (i.e. not make the sentence obviously wrong due to semantic constraints). Fixed transitive verbs were used as intransitive and ditransitive, fixed intransitive were used as transitive, and variable intransitive and transitive were used as ditransitive. Ditransitive sentences were presented in a mixture of forms:- indirect object and direct object, direct object to indirect object. Overall this produced a total of 120 sentences:-

60 Correct Sentences

15 transitive sentences (fixed transitive verbs)

e.g. 'he donates blood'

15 transitive sentences (variable transitive/intransitive)

e.g. 'she collects stamps'

15 intransitive sentences (fixed intransitive verbs)

e.g. 'the volcano is erupting'

15 intransitive sentences (variable transitive/intransitive)

e.g. 'she is decorating'

60 Incorrect sentences

15 transitive sentences (fixed intransitive verbs)

e.g. 'he hibernated the winter'

15 intransitive sentences (fixed transitive verbs)

e.g. 'she announced'

15 ditransitive sentences (fixed transitive verbs)

e.g. 'he demolished the building to the council'

15 ditransitive sentences (variable transitive/intransitive)

e.g. 'they collected the stamps to the man'

**Presentation**

Sentences were presented in a random order. Subjects were asked to identify whether each sentence was a 'good' sentence (grammatically correct) or a 'bad' sentence (grammatically incorrect). Examples were given before the test items to ensure that the instructions had been understood. Sentences were repeated if requested. Testing was done over more than one session if the subjects became tired.

**Scoring**

The total number of correct responses was recorded (correct acceptance of a grammatical sentence, correct rejection of an ungrammatical sentence). Incorrect responses were divided into false positive responses (incorrect acceptance of an ungrammatical sentence) and false negative responses (incorrect rejection of a grammatically correct sentence).

**Normal Data**

Data was obtained from a group of 14 normal control subjects, mean age 67.43 (range 64 - 76). Their mean score was 113.36/120, range 108 - 117. Their errors were a mixture of false negative and false positive responses. In particular, the subjects had difficulty in correctly rejecting fixed transitive verbs appearing in intransitive form e.g. announce, achieve, and correctly accepting their variable transitive/ intransitive counterparts, e.g. mow, say.

**c) Sentence Anagram Task**

**Aims**

This task assessed the ability to select and order lexical items in order to create an appropriate PAS for a verb. It thus assessed the ability to construct the PAS, without retrieving the lexical items. Lexical items which were not appropriate, however, had to be identified and rejected.

**Test Design**

The same subset of verbs, used in the grammaticality judgement tests, was used in this task. The correct sentence in the grammaticality judgement task (PAS test) was split into its component phrases and a non-argument and an additional post-verb noun phrase was added if not present. For the variable transitive and intransitive verbs, the correct transitive sentence was selected, with the assumption that the subject could

produce either a transitive or intransitive sentence and it would be acceptable. Each of the 45 sentences, therefore, consisted of four components.

**Presentation**

Sentences were presented in a random order. In each case, the subject was given the verb component first and then the other components randomly. Each component was read aloud by the researcher. Subjects were asked to produce a sentence using the pieces provided. They were instructed that in some cases they may wish to use all the pieces, in others they may just want to use some of them. If a grammatically correct sentence was not produced, the researcher read the sentence and commented that it did not make sense and the subject was given an opportunity to produce another sentence.

**Scoring**

The total number of sentences produced correctly on the first attempt was taken as the final score on this task. It was, however, noted if the subject was able to correct the sentence following the researcher's prompt.

**Normal Data**

Normal data was not obtained for this task. It was assumed that normal subjects would make very few errors.

### 4.4.2 Predictions

Subjects with a semantic deficit may perform poorly on the sentence generation task due to poor understanding of the verb. It is hoped that giving the verb will eliminate verb retrieval deficits. Noun retrieval deficits may result in the omission of obligatory arguments from the PAS, despite intact access to PAS information. Inappropriate sentences involving the addition of arguments, however, should not occur. These subjects, when given a selection of appropriate arguments in the anagram task, should be able to produce an appropriate sentence and should perform well on the grammaticality judgement task. Subjects with difficulty accessing PAS information will perform poorly on the tests within this section. In the sentence generation task, poor access to PAS information may lead to both the omission of obligatory arguments and the addition of unnecessary arguments. In the same way, the subjects will be unable to correctly identify grammatical and ungrammatical sentences in the grammaticality judgement task. Giving the subjects a selection of arguments

may help to eliminate the deficit, by giving some clues to the PAS, but errors in producing an appropriate PAS may still be evident. Subjects with a deficit in accessing lexical mapping information and in the subsequent mapping of thematic and syntactic roles may experience difficulty in the sentence generation task, with apparent word retrieval problems in sentences (see discussion in section 1.7.4). The subjects, however, if they have access to PAS information will perform well on the grammaticality judgement task. The subjects should be able to produce appropriate sentences using the constituents provided in the anagram task. The sentences used in these tasks are generally non-reversible, and if they are reversible both sentences are acceptable; thematic role assignment can thus be achieved using non-linguistic information. It is acknowledged that the production of predicate argument structures in this way also relies on subsequent phrasal realisation. Deficits in accessing syntactic sub-categorisation information and in the understanding and production of function words (particularly prepositions) could result in poor performance on these tasks.

### 4.4.3 Results

**Table 4.12: Results of tests of predicate argument structure**

| ACCESS TO PAS INFORMATION | n | Normal Mean | Normal Range | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|---|
| **Production** | | | | | | | |
| Sentence Generation Task (Target as Verb) | **74** | **72.91** | **70 - 74** | **59*** | **72** | **56*** | **64*** |
| % Inappropriate PAS | | **0.90** | **0 - 4.11** | **18.64*** | **12.50*** | **19.64*** | **10.94*** |
| % Inappropriate Arguments | | **0** | **0** | **10.42*** | **0** | **0** | **0** |
| % Use of Non Arguments | | **35.81** | **21.92 - 52.05** | **33.33** | **44.44** | **7.14*** | **12.28*** |
| **Grammaticality Judgement** | | | | | | | |
| Number of Arguments | **120** | **113.36** | **108 - 117** | **93*** | **100*** | **111** | **110** |

* Indicates performance significantly different from normal control subjects.

The results from this group of tests are presented in table 4.12

**a) Sentence Generation Task**

***Production of Target Verb***

Three of the four subjects, GW, KD and TJ, differed significantly from the normal control group in their ability to produce the target as a verb in a sentence. JM's ability to use the target as a verb did not differ significantly from that of the normal controls. The results from the independent samples t tests are shown in table 4.13. Their performance on the different verb groups can be found in table 4.14. GW experienced most difficulty with the variable transitive/ditransitive verbs, TJ's errors were predominantly in the use of the fixed intransitive verbs and KD's errors were predominantly in the use of variable intransitive/transitive verbs. The reasons for this failure to use the target as verb within a sentence remains unclear. Poor performance may result from a poor understanding of the verb or an unwillingness to attempt sentences that they would be unable to complete. There appears to be no consistent pattern across verb types. The hierarchies of difficulties seen in the individual subjects cannot be explained by the effects of frequency or length.

**Table 4.13: Production of target verb**

| Subject | t | df | p value |
|---|---|---|---|
| **GW** | 12.27 | 21 | 0.000* |
| **JM** | 0.80 | 21 | 0.432 |
| **KD** | 14.91 | 21 | 0.000* |
| **TJ** | 7.86 | 21 | 0.000* |

**Table 4.14: Production of sentences containing the target verb**

(% Correct Use of Target)

| Verb Type | Mean of Normal Group | Normal Range (2 s.d.) | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|
| **FI** | 99.7 | 96.9 | 73.3* | 93.3* | 100 | 66.7* |
| **FT** | 99.7 | 96.9 | 86.7* | 100 | 93.3* | 93.3* |
| **VTD** | 96.4 | 88.1 | 50.0* | 92.9 | 78.6* | 92.9 |
| **VTI** | 97.4 | 88.5 | 100 | 100 | 66.7* | 93.3 |
| **VTID/TC** | 99.4 | 95.5 | 86.7* | 100 | 86.7* | 86.7* |

* = > 2 s.d. from normal mean

***Production of an Appropriate PAS***

All four subjects produced utterances in which the verb was used in an inappropriate PAS (see table 4.12); GW and KD produced a greater number of sentences with an inappropriate PAS than TJ and JM. The performance of the subjects also differed in the verb types which resulted in error and the types of arguments omitted. The production of an appropriate PAS for verbs of different types can be seen in table 4.15. Subjects KD and TJ sometimes produced arguments in which prepositions or determiners were realised, but the following noun was not produced. These subjects had, therefore, signalled the production of an non-argument/argument and were given credit for accessing PAS information even if they could not complete the sentence.

GW omitted predominantly external (agent) arguments, particularly in transitive and ditransitive structures (see table 4.15), for example 'build the bridge'. In some cases, however, particularly in the realisation of fixed transitive verbs internal (patient) arguments were omitted, e.g. 'we wish to announce'. Of the arguments omitted, 72.7% were external arguments and 27.3% were internal arguments. One of the intransitive verbs was produced with an additional inappropriate argument, 'he vanished the man'. He seemed unaware that the sentences he produced were not

appropriate. In addition, 10.4% of sentences which had an appropriate argument structure contained arguments that were semantically anomalous, for example, 'he preached me'.

**Table 4.15: Production of an appropriate predicate argument structure**

(% Correct)

| Verb Type | Mean of Normal Group | Normal Range (2 s.d.) | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|
| **FI** | 99.7 | 96.9 | 90.9* | 50.0* | 100 | 90.0* |
| **FT** | 99.1 | 92.9 | 53.9* | 86.7* | 57.1* | 92.9 |
| **VTD** | 97.1 | 85.7 | 28.6* | 100 | 45.5* | 76.9* |
| **VTI** | 99.7 | 96.7 | 93.3* | 100 | 88.9* | 92.9* |
| **VTID/TC** | 100 | 100 | 92.3* | 100 | 100 | 92.3* |

* = > 2 s.d. from normal mean

JM also occasionally omitted both internal and external arguments in two argument transitive structures, but the majority of her errors were the production of additional arguments with fixed one argument verbs (see table 4.15). In some cases it seemed that these errors were due to a missing preposition in an accompanying non-argument, for example, 'the baby is crawling the floor' and 'we disagree the fish tank', but this was not always the case.[1] JM, like GW, seemed unaware that the sentences produced were grammatically incorrect.

KD, like GW, omitted a mixture of internal and external arguments in the realisation of fixed transitive and variable transitive/ditransitive verbs (see table 4.15). In contrast to GW, however, KD omitted more internal arguments. Of the arguments omitted, 66.7% were internal arguments compared to 33.3% external arguments. KD often seemed aware that an additional phrase was necessary and would repeat the initial part of the sentence, for example 'I inform .... I inform ..... no no .. I inform'.

---

[1]Subsequent testing of JM showed that she was capable of producing prepositions in these contexts, although she did make some substitution errors. *It is, therefore, suggested that these sentences are a result of PAS difficulties, rather than difficulties producing prepositions.*

Following multiple repetitions and apparent difficulty in retrieving an appropriate word, he would give up and accept the one argument sentence he had produced. In an additional 40% of utterances KD produced the determiner but was unable to complete the noun phrase, for example 'I carry my ...'. In these cases, it was always the internal argument of the sentence which was incomplete.

TJ's errors in the production of an appropriate PAS were predominantly in the realisation of the PAS for variable transitive/ditransitive verbs. His other errors were quite evenly distributed across verb types (see table 4.15). TJ omitted predominantly the external argument of the PAS. Like KD, however, he also produced an additional 9.38% of sentences in which an argument consisted only of a determiner. There were also other sentences in which the noun phrase which was produced was not the most likely completion of the sentence, e.g. 'he blamed the chameleon' and 'he achieved the penultimate sentence'.

***Production of Non Arguments***

GW and JM produced a similar percentage of utterances with non-arguments as the normal group (see table 4.12) whereas KD and TJ both produced a lower percentage of utterances with additional non arguments. Table 4.16 summarises the subjects' production of non arguments in relation to verb type.

**Table 4.16: Production of sentences with non-arguments**

(% of Utterances)

| Verb Type | Mean of Normal Group | Normal Range (2 s.d.) | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|
| **FI** | 75.6 | 37.8 | 70.0 | 85.7 | 37.5* | 40.0* |
| **FT** | 14.2 | na | 0 | 46.2 | 0 | 0 |
| **VTD** | 24.0 | 4.06 | 0* | 30.8 | 0* | 0* |
| **VTI** | 40.6 | 13.76 | 42.9 | 80.0 | 0* | 23.1 |
| **VTID/TC** | 23.7 | 1.68 | 25.0 | 40 | 15.4 | 0* |

* = > 2 s.d. from normal mean

The distribution of the non-arguments produced by GW and JM was similar to that of the normal control subjects. They used non-arguments predominantly in conjunction with verbs in their intransitive form and sometimes with verbs in their transitive form. Non-arguments were never used with verbs in their three argument form. KD and TJ produced non-arguments exclusively with verbs in their intransitive form.

**b) Sentence Anagram Task**

The performance of the four subjects on this task is shown in table 4.17. The scores shown are the number correct on the initial attempt at the sentence.

**Table 4.17: Performance on the sentence anagram task**

| **Subject** | **GW** | **JM** | **KD** | **TJ** |
|---|---|---|---|---|
| **Number Correct /45** | 24 | 4 | 45 | 45 |

The performance of the four subjects differed significantly on this task (Cochran Q test, Q= 97.06, df = 3, p = 0.000). KD and TJ both performed without error, whereas GW and JM both found it difficult to construct a sentence. GW produced about half of the sentences with an appropriate argument structure on his first attempt. JM performed very poorly on this task, only 4/45 grammatical sentences were produced on her first attempt.

**c) Grammaticality Judgement Task: Possible PAS Arrangements (Number of Accompanying Arguments)**

There was a significant difference between the subjects' performance on this task (Cochran Q test, Q = 41.44, df = 3, p = 0.000). The performance of two subjects, GW and JM, differed significantly from that of the normal control subjects; KD's and TJ's performance was within the normal range. The results of the independent sample t tests are in table 4.18.

**Table 4.18: Performance on the grammaticality judgement task (PAS Arrangements)**

| Subject | t | df | p value |
|---|---|---|---|
| **GW** | 7.05 | 13 | 0.000* |
| **JM** | 4.62 | 13 | 0.000* |
| **KD** | 0.82 | 13 | 0.429 |
| **TJ** | 1.16 | 13 | 0.266 |

GW's and JM's poor performance reflected an increased number of false positive responses (acceptance of an inappropriate argument structure as correct). Both subjects made errors on a wide range of sentence types.

### 4.4.4 Summary of Results

All of the subjects had some difficulty with the sentence generation task. For the subjects, GW, KD and TJ, who often did not attempt to produce a sentence containing the target verb, the origin of their difficulty remains unclear. This inability could be related to poor access to semantic information, resulting in an unwillingness to attempt a sentence. It does not seem to be related to the relative frequency or length of verbs within different verb groups.

All of the subjects had difficulty producing verbs within an appropriate PAS. It is suggested that the production of an inappropriate PAS may be a consequence of different underlying impairments:-

Poor access to information about the PAS associated with a verb

Poor noun retrieval

Poor thematic role assignment

The qualitatively different performance and performance on other tasks may help to differentiate between these difficulties. The presence of mapping deficits and their effects on this task will be discussed in section 4.6.

GW experienced difficulty in producing an appropriate predicate-argument structure for the verb, both in terms of the number of arguments and the appropriacy of the arguments used alongside the verb. The majority of his errors involved the

omission of arguments. GW did not have difficulty with noun retrieval in single word tasks; his scores on the VAN and CAT noun retrieval were within normal limits. He was also able to produce a similar number of complete non-arguments as normal subjects. His word retrieval difficulties in sentences are, therefore likely to be due to difficulties in creating the PAS or in thematic role assignment. A deficit in accessing PAS information is suggested by GW's performance on the grammaticality judgement and anagram tasks. In the anagram task, GW was presented with possible arguments of the verb, but he was unable to select appropriate arguments to produce a grammatical sentence. When questioned about the sentence, he was always convinced the sentence he had produced was grammatically correct. These difficulties were mirrored in the grammaticality judgement tasks, where he was unable to reject sentences that were ungrammatical due to an inappropriate PAS. It is proposed that GW has a parallel difficulty in input and output tasks, related to PAS information. Whether this difficulty is in accessing central PAS information or in the processes that use the information in production and comprehension remains unclear. GW also produced semantically inappropriate arguments in the sentence generation task. This aspect of production is also mirrored in his inability to reject semantically inappropriate arguments in the grammaticality judgement task. GW had some difficulty accessing semantic information in the verb comprehension task and he produced semantic paraphasias during verb retrieval. These semantic difficulties did not appear to extend to the comprehension and production of nouns. It would appear, therefore, that GW's difficulties in accessing semantic selection restriction information are an extension of his difficulties with PAS rather than a difficulty retrieving the core meaning of the verb.

JM's difficulty in the production of an appropriate predicate-argument structure also seems to be a consequence of her reduced knowledge about what arguments are necessary accompaniments of the verb, particularly with fixed argument structure verbs. JM, like GW, did not have difficulty with noun retrieval in single word tasks at a semantic level. Word retrieval difficulties do not, therefore, seem to account for the omission of obligatory arguments. It must also be considered that the majority of her errors involved the production of additional arguments with fixed intransitive verbs. This may reflect a strategy of resorting to the most common transitive sentence form, when PAS information is difficult to access. In the majority of sentences produced

with an appropriate PAS, the verb could be used in a two argument, transitive form. This difficulty in accessing PAS information was also evident in her performance on the grammaticality judgement and sentence anagram task. She, like GW, appears to have difficulties in accessing or using PAS information in both comprehension and production tasks and this seems to account for her difficulties in the sentence generation task. It was proposed that GW's difficulties with semantic selection restrictions were a consequence of his difficulties accessing PAS information. JM's results seem to confirm the fact that semantic selection restrictions are included in PAS information. JM did not have significant semantic difficulties in the comprehension of nouns or verbs, and yet she was still unable to reject semantically inappropriate sentences in the grammaticality judgement task. Unlike GW, however, these difficulties did not extend to the production of semantically inappropriate arguments.

KD seemed aware that the argument structures he produced in the sentence generation task were inappropriate but seemed unable to realise all the required arguments. It appears that his problems in producing an appropriate argument structure may at least in part stem from word retrieval difficulties. KD differed significantly from the normal controls in his ability to produce nouns in isolation in the VAN and these difficulties may be resulting in omitted arguments. This is supported by the fact that often the arguments produced only consisted of a determiner and the main noun was omitted. When given a selection of arguments, KD had no difficulty in producing a grammatical sentence. In addition, he was able to identify inappropriate PAS arrangements and semantically inappropriate arguments. This would suggest that he has access to PAS information; he knows the number and type of arguments which are necessary accompaniments of the verb. His word retrieval difficulties, however, mean that in production he is not always able to fill the obligatory argument slots. His difficulties with word retrieval may also account for the low percentage of utterances containing non-arguments. Whether an impairment in the mapping of thematic and syntactic roles is also contributing to the omission of arguments will be investigated in section 4.6.

TJ, like KD, has impaired retrieval of nouns in the VAN and CAT tests, and these difficulties may account for his omission of obligatory arguments in the sentence generation task. He again seemed aware that the internal arguments were necessary

but he was unable to produce words to realise those arguments; his difficulties in producing the external arguments may reflect similar difficulties with word retrieval. Like KD, when given a selection of lexical items to fill the arguments slots, he was able to select and order them to produce an appropriate sentence. He was also able to identify grammatically correct and grammatically incorrect sentences in the grammaticality judgement task. He seems to have intact PAS information and it thus seems that his difficulties in producing the PAS of the verbs seem to be a consequence of his word retrieval difficulties. It must be considered, however, that despite similar scores on the VAN test, KD omitted more obligatory arguments than TJ in the sentence generation task (see section 4.6).

## 4.5 Access to Lexical Mapping Information

The tests in this section assessed access to lexical mapping information in single verb comprehension and in a grammaticality judgement task. Lexical mapping information was discussed in section 1.7.4.

### 4.5.1 Testing Materials

Two tests which were described in the semantics section also assessed access to lexical mapping information:- the Birkbeck Verb Video, specifically the comprehension of reverse role verbs, and the grammaticality judgement task involving the identification of mapping anomalies. The results from these parts of the tests will be discussed in this section.

### 4.5.2 Predictions

Subjects with semantic difficulties may be impaired in their ability to identify reverse role verbs, as they are semantically similar. These difficulties will, however, also be evident in their comprehension of reverse direction and reverse action verbs. Subjects with semantic difficulties may also be impaired in their ability to detect semantic anomalies. Subjects with difficulties in accessing PAS information should perform well on these tasks, unless access to PAS information is a pre-requisite for

the retrieval of verbs. They may, however, be impaired in their ability to detect semantic anomalies, if selection restriction information is part of the PAS, as it appears to be from the results of GW and JM. Subjects with difficulties in accessing lexical mapping information will have difficulty in the performance on both of these tasks. The comprehension of reverse role verbs will be more impaired than the comprehension of the reverse action and reverse direction verbs. Subjects will also have difficulty identifying mapping anomalies in the grammaticality judgement task.

### 4.5.3 Results

The results for the two tests are shown in table 4.19.

**Table 4.19: Results of tests assessing access to lexical mapping information**

| | n | Normal Mean | Normal Range | GW | JM | KD | TJ |
|---|---|---|---|---|---|---|---|
| **Access to Lexical Mapping Information** | | | | | | | |
| Birkbeck Verb Video | **46** | **na** | **na** | **42** | **45** | **44** | **39** |
| Reverse Direction Verbs | **14** | **na** | **na** | **13** | **13** | **14** | **13** |
| Reverse Action Verbs | **16** | **na** | **na** | **15** | **16** | **14** | **14** |
| Reverse Role verbs | **16** | **na** | **na** | **14** | **16** | **16** | **12** |
| Grammaticality Judgement (Appropriacy of Arguments) | **150** | **145.83** | **142 - 149** | **126*** | **139*** | **145** | **146** |
| Correct Identification of Mapping Anomalies | **28** | **22.67** | **26 - 28** | **22*** | **28** | **27** | **27** |

**a) Birkbeck Verb Comprehension Video: Comprehension of Reverse Role Verbs**

As mentioned previously, there was no significant difference between the comprehension of the three types of verbs in any of the subjects. (Chi square test, p greater than 0.05 in all cases). There is, therefore, no evidence to suggest that any of the subjects performed significantly worse with reverse role verbs than verbs of other

types. This would suggest that the poor performance on reverse role verbs by GW and TJ reflects a wider difficulty in accessing the semantics of the verbs, rather than a specific difficulty in retrieving lexical mapping information.

**b) Grammaticality Judgement: Appropriacy of Arguments and Mapping**

The subjects as a group differed significantly in their performance on this task (Cochran Q test, $Q = 46.18$, $df = 3$, $p = 0.000$) and in their ability to identify mapping anomalies (Cochran Q test, $Q = 14.67$, $df = 3$, $p = 0.0021$). GW and JM were significantly impaired on this task, as compared to the normal control group. KD and TJ's performance was within normal limits. Only GW, however, differed significantly in his ability to identify mapping anomalies (independent sample t test, $t = 9.28$, $df = 17$, $p = 0.000$). GW's impaired performance reflects a combination of difficulties accessing semantic selection restrictions and lexical mapping information. JM's difficulty appears to reside in a difficulty accessing semantic selection restrictions. Her identification of mapping anomalies did not differ significantly from normal performance.

### 4.5.4 Summary of Results

All of the subjects were able to comprehend reverse role verbs as accurately as verbs of other kinds. The results from the grammaticality judgement task, however, suggest that GW may have difficulty accessing lexical mapping information in comprehension tasks. These difficulties are accompanied by impaired access to general semantic information and semantic selection restrictions of verbs. The other subjects seem able to access sufficient mapping information to perform the grammaticality judgement task and understand reverse role verbs.

## 4.6 Thematic Role Assignment and Mapping in Sentence Production

The tests in this section investigated the retrieval of nouns and verbs when included in a sentence frame. When creating the sentence frame, the lexical items are assigned thematic roles which are then mapped onto syntactic roles. This mapping is investigated in sentences of different argument structure complexity (1, 2 and 3

arguments) and in non-reversible and reversible sentences. It is suggested that problems in thematic role assignment may manifest as word retrieval deficits at a sentence level, particularly as the complexity of the argument structure increases (Whitworth 1995b).

### 4.6.1 Testing Materials

#### a) Thematic Roles in Production (TRIP) (Whitworth 1995b)

**Aims**

The TRIP assessment contrasted the retrieval of nouns in isolation and in one, two and three argument structures. The retrieval in sentences involves the assignment of thematic roles and the mapping of those thematic roles onto syntactic roles. The test also assessed the retrieval of the verb in a sentence context.

**Test Design**

The test contrasted the retrieval of high frequency nouns, in isolation, and in one, two and three argument structures. The test consisted of 80 pictures (35 single nouns, 45 action pictures), divided into two sub-tests. The action pictures aimed to elicit the same high frequency nouns as those elicited in isolation, undertaking different thematic roles in one, two and three argument structures.

**Presentation**

The task was designed as a delayed repetition task. The researcher modelled all of the stimuli in a sub-test and then the subject described what was in the picture or what was happening in the picture.

**Scoring**

Sentences were scored for the successful retrieval of the component nouns and verbs, and the thematic completeness of the sentence.

**Normal Data**

The normal control subjects scored 95 - 100% correct on all measures.

#### b) Thematic Roles in Production: Anagram Task

**Aims**

This task assessed the ability to assign thematic roles and order the constituents in the sentence. The anagram task, however, excludes the effects of word retrieval

deficits on task performance and allows the ordering of constituents around the verb to be investigated.

**Test Design**

The 45 action pictures were used from the TRIP assessment. The one argument structures were included to ensure the subject's familiarity with the task. The target sentences were divided into their phrasal components. The three argument sentences, were presented in the direct object to indirect object form, with the 'to' given as a separate component.

**Presentation**

The pictures were presented alongside the components of the target sentence. The verb component was presented first with the other components presented randomly. On presentation, the researcher read each sentence component aloud. Subjects were asked to arrange the pieces to produce a sentence which described what was happening in the picture.

**Scoring**

Sentences were scored for the correct ordering of the components, and therefore, the correct expression of the thematic roles.

**Normal Data**

No normal data was obtained, it was assumed that normal subjects would be able to complete the task without error.

**c) Production of Reversible Sentences**

**Aims**

This test also assessed the ability to assign thematic roles to syntactic arguments within two and three argument structures but in sentences where two of the arguments were reversible. A contrast between the free production condition and the lexical items given condition may be used to distinguish mapping difficulties (evident in both conditions) and word retrieval difficulties (evident in the free production condition). Giving the subject the lexical items also alerts them to the number of the participants in the event (and thus the number of arguments in the PAS). In this way, both lexical retrieval difficulties and difficulties retrieving an appropriate PAS are bypassed.

## Test Design

Thirty pictures were selected to elicit twenty two argument and ten three argument reversible sentences. The pictures depicted fifteen scenarios. The two argument reversible sentences consisted of ten scenarios, in which each participant occurred in both the agent and the patient role, e.g. 'the man pushes the horse' 'the horse pushes the man'. The picture stimuli were taken predominantly from the PALPA Sentence Comprehension Test (Kay, Lesser and Coltheart 1992). The target verbs were:-pull, kick, push, frighten, approach, chase, hit, follow, watch, splash. Five scenarios were used to elicit the three argument structures, with the participants occurring in both the agent and benefactive role, e.g. 'the girl shows the letter to the boy' 'the boy shows the letter to the girl. The pictures were from an unpublished set from Saffran and colleagues; the verbs elicited were:- show, pass, give, hand, throw. The test was designed to be used in two ways:-

1. Free production
2. Lexical items given

It was thought that giving the lexical items would increase the chance of the target sentence being produced and reduce the effects of poor word retrieval.

## Presentation

Two and three argument sentences were presented separately, with sentences randomised within each group. Two practice items were given before the presentation of the test items. Different versions of the test were tested in different sessions.

### *Free Production*

The patient was asked to describe what was happening in the picture by producing a simple sentence.

### *Lexical Items Given*

The patient was asked to describe what was happening in the picture by producing a simple sentence, using the words given. Lexical items were presented in written form and also read aloud by the researcher. The verb was always presented first, and the position of the nouns was randomised across the sentences.

## Scoring

Patients were scored on the production of an appropriate sentence which retained the thematic roles which the participants were fulfilling. All of the participants had to

be included for a sentence to be scored as correct. In the free production task, subjects were not penalised for using alternative but appropriate vocabulary.

**Normal Data**

Normal data was not obtained. It was assumed that normal subjects would be able to produce an appropriate sentence for each of the pictures. Of interest to the study was the differential performance of the patients on the two conditions and the errors made.

**d) Production of Reversible Locative Sentences**

**Aims**

This test assessed the ability to assign locative relations onto syntactic positions around the preposition, and therefore, produce reversible locative sentences. This test was only used if the person showed adequate understanding of the semantics of the prepositions, in a single word production task.

**Test Design**

The picture stimuli were taken from Byng's (1988) test of the comprehension of reversible locative sentences. The test consisted of 24 sentences, 4 each of the prepositions:- on, under, behind, below, above and in. Twelve scenarios (2 for each preposition) were tested, with each of the items fulfilling each of the positions in the scene e.g. 'the bottle is on the book' and 'the book is on the bottle'.

**Presentation**

The pictures were presented in random order. As locative relations can generally be described in more than one way, the production of the target sentence was ensured by giving the subject the appropriate preposition. The preposition was given in written form and read aloud by the researcher. In each case, the subject was asked to describe the picture using the word provided.

**Scoring**

Sentences were scored correctly if they successfully portrayed the locative relations between the items.

**Normal Data**

No normal data was obtained for this task. It was thought that normal subjects would be able to complete the task without difficulty.

### 4.6.2 Predictions

Subjects with semantic or word retrieval deficits will experience difficulty in some of these tasks. Word retrieval difficulties, which are a consequence of semantic or phonological deficits, will be apparent both at single word and sentence level in the TRIP. The TRIP, however, does attempt to minimise these difficulties by using high frequency lexical items. The sentence production tasks (free production conditions) require the retrieval of verbs, a process known to be impaired in all of the subjects. Verb retrieval difficulties may, therefore, impair performance on these tasks. When given the lexical items, these subjects should be able to produce an appropriate sentence. Subjects with semantic difficulties involving the understanding of prepositions were not tested on the reversible locative sentences. Subjects with difficulties in accessing PAS information may perform better on these tasks than tasks with no picture stimuli. The picture stimuli highlight the participants involved in the event, and thus, give some clues to the argument structure of the verb. When given the lexical items, these subjects should experience no difficulty in correctly assigning the thematic roles to the lexical items and producing an appropriate sentence. Giving the subjects the lexical items essentially alerts them to the number of arguments in the PAS. Subjects with mapping difficulties will perform poorly on the tests in this section. These difficulties may be a consequence of poor access to lexical mapping information, impaired thematic role assignment or impaired mapping of thematic roles onto to appropriate syntactic positions. Poor access to lexical mapping information will affect performance on all of the tasks and will be associated with difficulties in comprehension. The processes which utilise that mapping information in production may differ from those used in comprehension, and deficits may, therefore, occur selectively in production (see section 1.11). Subjects with thematic role assignment and mapping deficits may omit obligatory arguments in sentences or order arguments around the verb incorrectly (reverse role errors). It is proposed that subjects will perform more poorly on reversible sentences, where they are unable to rely on pragmatic or real world information to assign thematic roles and order sentence components. It remains unclear whether the mapping mechanism involved in the production of reversible locatives (mapping of locative relations onto syntactic relations) is the same as reversible sentences involving verbs (mapping of thematic

roles onto syntactic relations). The results of this study should help to clarify this issue, depending on the subjects' performance on the two types of sentences.

### 4.6.3 Results

#### a) TRIP

The results for the TRIP assessment are shown in table 4.20.

**Table 4.20: Results of TRIP assessment**

| **Sentence Production:-** | **n** | **Normal Range** | **GW** | **JM** | **KD** | **TJ** |
|---|---|---|---|---|---|---|
| TRIP: Word Retrieval (Nouns) | | | | | | |
| Single Words: | **35** | **95 -100%** | **35** | **35** | **34** | **35** |
| 1 Argument Structures | **15** | **95 -100%** | **12*** | **15** | **11*** | **14*** |
| 2 Argument Structures | **40** | **95 -100%** | **37*** | **40** | **19*** | **28*** |
| 3 Argument Structures | **30** | **95 -100%** | **24*** | **30** | **14*** | **9*** |
| TRIP Word Retrieval (Verbs) | | | | | | |
| 1 Argument Structures | **15** | **95 -100%** | **13*** | **14*** | **12*** | **11*** |
| 2 Argument Structures | **20** | **95 -100%** | **16*** | **18*** | **8*** | **11*** |
| 3 Argument Structures | **10** | **95 -100%** | **8*** | **9*** | **6*** | **0*** |
| TRIP: Thematic Completeness | | | | | | |
| 1 Argument Structures | **15** | **95 -100%** | **12*** | **13*** | **10*** | **11*** |
| 2 Argument Structures | **20** | **95 -100%** | **18*** | **19** | **7*** | **8*** |
| 3 Argument Structures | **10** | **95 -100%** | **6*** | **9*** | **5*** | **0*** |
| TRIP: Anagram Task | **45** | **na** | **44** | **45** | **41** | **45** |

All of the subjects exhibited good retrieval of nouns in isolation; this is perhaps a consequence of the high frequency targets. Three of the subjects GW, KD and TJ showed a significantly different pattern of noun retrieval in isolation and in the one, two and three argument structures. Once the noun was included in a sentence frame, it was more difficult for these subjects to produce. JM successfully retrieved all of the

nouns in sentences. The results for the chi square tests are shown in table 4.21. Only for TJ, was there a significant difference in noun retrieval between one, two and three argument structures (chi square test, X = 19.86, df = 3, p = 0.000). As the complexity of the argument structure increased, TJ retrieved less of the items. Similarly, TJ's thematic completeness score deteriorated as the complexity of the argument structure increased (chi square test, X = 13.30, df = 2, p = 0.001). For none of the other subjects was there a significant difference between thematic completeness across the three sentence conditions. TJ also showed a significant difference between verb retrieval across the three conditions (chi square test, X = 9.82, df = 2, p = 0.007). The retrieval of verbs in the performance of the other three subjects did not differ between one, two and three argument structures.

**Table 4.21: Results for noun retrieval in TRIP assessment**

| Subject | X | df | p value |
|---|---|---|---|
| **GW** | 9.17 | 3 | 0.027* |
| **KD** | 44.84 | 3 | 0.000* |
| **TJ** | 43.01 | 3 | 0.000* |

* Significant difference

GW's errors in noun retrieval were a mixture of semantic paraphasias and omitted arguments. He also produced semantic paraphasias in the retrieval of verbs. The production of semantic paraphasias for verbs is consistent with his single word performance. The semantic paraphasias for the nouns all involved the production of 'boy', 'girl' 'man' and 'woman'. His sentences were generally well formed, although sometimes with a simplified argument structure, particularly in the production of three argument structures. He also produced two reverse role errors for reversible two argument structures, for example:-

Target:- 'the horse is pushing the man'

*'the horse is pushed by the man'*

GW also made one reverse role error in the TRIP anagram task, also for a reversible two argument sentence.

JM retrieved all of the nouns in isolation and in sentences correctly. She did, however, produce some semantic paraphasias instead of some of the target verbs. This is consistent with her performance on the verb retrieval section of the VAN. She generally produced well-formed thematically complete sentences. She did, however, produce additional, inappropriate arguments for two of the one argument structures, for example:-

Target:- 'the boy is swimming'

*'the boy swimming the sea'*

This is similar to her performance on the fixed intransitive verbs in the sentence generation task. JM performed without error in the anagram task. In these sentences, she was given only the participants of the sentence and thus had to make no choice about which were the appropriate arguments to include. Her difficulties in creating the PAS were thus bypassed.

KD's errors in the retrieval of nouns in sentences were a mixture of semantic paraphasias, omissions, production of the nouns in isolation and the use of pronouns. Sentences were often not well formed due to the omission of verbs and a failure to create an appropriate argument structure, for example:-

Target:- 'the children are showing the bread to the sheep'

*'the sheep .....bread ....bread ....the man .....the man ...given . the ..no ..girl'*

These difficulties were evident in the production of two and three argument structures. He, like GW, also made a reverse role error in the production of two argument reversible sentences, one in the production task and four in the anagram task.

TJ's difficulty in retrieving nouns in sentences seemed to stem from his failure to retrieve an appropriate verb. Sentences were often abandoned at the point of the verb. and thus, lexical items following the verb were omitted, for example, 'the snake is (5 sec) the snake is ..no'. The difference across one, two and three argument structures seems to be related to the increasing difficulty of verb retrieval and the increased number of post-verb noun phrases. When given the lexical items in a sentence anagram task, TJ was able to order the lexical items to produce the target sentences.

**b) Production of Reversible Two Argument Sentences**

The results for the free production and anagram tasks are recorded in table 4.22. TJ was unable to produce sentences in the free production condition. The three other

subjects differed significantly in their ability to produce two argument reversible sentences (Cochran Q test, Q = 8.40, df = 2, p = 0.0150). JM produced sentences which retained the thematic roles of the participants, but often they contained an inappropriate verb. This is consistent with her difficulties in verb retrieval in other tasks.

GW and KD, like JM also had difficulty in retrieving an appropriate verb to describe the event. GW and KD also had difficulty realising the thematic content of the sentence. KD's thematic errors were exclusively reverse role errors, for example:-

Target:- 'the horse is pulling the man'

*'the man is pulling the horse'*

GW's reverse role errors were attempts at passive sentences, for example:-

Target:- 'the car is splashing the boy'

*'the car is splashed by the boy'*

In addition to the reverse role errors, GW produced some sentences (3/20) in which one of the arguments was omitted; in these cases it was difficult to determine whether the thematic roles were realised correctly.

All four subjects completed the condition where the lexical items were given. The subjects again differed in their ability to produce the two argument sentences (Cochran Q test, Q = 13.96, df = 3, p = 0.0030). The provision of the lexical items did not improve GW's and KD's realisation of thematic roles and the production of an appropriate word order. GW again produced reverse role errors in passive sentences, KD produced active sentences in which the participants had been incorrectly ordered. JM performed this task without error. TJ still showed some difficulty in the retrieval of the words, despite oral and written cues. He often perseverated on previous items.

### c) Production of Reversible Three Argument Structures

The results for the free production and anagram tasks can be found in table 4.22. There was also a significant difference between the three subjects in their ability to produce reversible three argument sentences (Cochran Q test, Q = 8.00, df = 2, p = 0.0183). Both JM and KD described these pictures without error; this appeared to be a consequence of improved verb retrieval for these pictures. GW, on the other hand, often omitted one of the obligatory arguments (typically the patient argument), for example:-

Target:- 'the boy is throwing the ball to the girl'

*'the boy is throwing to the girl'*

The thematic roles of the arguments that were produced, were realised correctly. When given the lexical items, the subjects did not differ in their production of the three argument structures with all subjects producing the sentences without error. When given the lexical items, GW did not omit arguments.

**Table 4.22: Results of tests of reversible sentence production**

| | | GW | JM | KD | TJ |
|---|---|---|---|---|---|
| **Two Argument Reversible Sentences** | | | | | |
| Free Production: Thematic Role Realisation | **/20** | **14** | **19** | **15** | **na** |
| Free Production: Verb Retrieval | **/20** | **8** | **14** | **10** | **na** |
| Lexical Items Given: Thematic Role Realisation | **/20** | **13** | **20** | **16** | **18** |
| **Three Argument Reversible Sentences** | | | | | |
| Free Production: Thematic Role Realisation | **/10** | **6** | **10** | **10** | **na** |
| Free Production: Verb Retrieval | **/10** | **7** | **9** | **9** | **na** |
| Lexical Items Given: Thematic Role Realisation | **/10** | **10** | **10** | **10** | **10** |
| **Reversible Locatives** | | | | | |
| Preposition Given | **/24** | **na** | **24** | **na** | **na** |

**d) Production of Reversible Locatives**

Only JM completed the reversible locative test, as the other subjects all showed difficulties in the understanding and production of single prepositions. She completed the task without error, successfully mapping locative relations onto syntactic roles.

### 4.6.4 Summary of Results

All of the sentence production tasks in this section used picture stimuli in order to elicit the target sentence. The presence of the participants in the picture seemed to eliminate some of the difficulties that GW and JM had in the creation of the predicate argument structure. The presence of the participants in the picture was essentially alerting them to the need to include them in the sentence. With JM the picture stimulus was sufficient to eliminate the difficulties, with GW the lexical items were sometimes needed in addition to the picture. The omission of arguments, despite the presence of a picture stimulus, may be a consequence of his additional deficit in thematic role assignment and mapping.

GW's difficulties with verb retrieval were evident in all of the tasks in this section. He also seemed to have difficulties in creating the thematic structure, assigning thematic roles within the PAS and mapping thematic roles onto syntactic roles. Reverse role errors were present in the production of active sentences, both orally and in the anagram task. These errors may be a consequence of the deficit in accessing lexical mapping information to assign thematic roles or using the information to produce an appropriate word order. In addition to the reverse role errors, GW omitted obligatory noun phrases. GW, as previously discussed, did not have a marked deficit in the retrieval of nouns in isolation. In sentence production, GW's difficulties in creating the PAS and in mapping thematic and syntactic roles may both be contributing to his omission of arguments. JM's verb retrieval deficit was also evident on all of the tasks in this section. She did not, however, appear to have difficulties using lexical mapping information to map thematic roles to syntactic roles in the production of active sentences. She was able to realise the thematic roles of the participants correctly and did not produce reverse role errors. She was also able to map locative relations onto appropriate syntactic positions. KD, like GW, showed evidence of the omission of arguments and the production of reverse role errors. KD, however, did not have difficulty in identifying the mapping anomalies in the grammaticality judgement task. His difficulty may, therefore, be using the lexical mapping information to assign thematic roles rather than impaired access to that information. This difficulty arises in free production, when he is given the lexical items and in the anagram task. TJ, although he showed an increased difficulty with sentence production in the TRIP, does not appear to have a difficulty mapping

thematic roles onto syntactic positions. His word retrieval difficulties in the TRIP seemed to be a consequence of an inability to access the verb and thus a failure to retrieve post-verb noun phrases. He did not produce reverse role errors in the production of reversible sentences, either in the anagram task or the production task.

## 4.7 Thematic Role Assignment and Mapping in Sentence Comprehension

The aim of this section of tests was to assess the mapping of syntactic structure onto thematic roles within the predicate argument structure in comprehension. Mapping was investigated in a wide range of reversible sentences.

### 4.7.1 Testing Material

#### a) Birkbeck Reversible Sentence Comprehension Test (BRSCT) (described in Black, Nickels and Byng 1991)

**Aims**

This test assessed the ability to understand a variety of reversible sentences and thus match the sentence with a picture representation of the event described. In this way, it assessed access to semantic representations and the ability to assign the parsed lexical items to thematic roles within the PAS.

**Test Design**

The test was a sentence to picture matching task. Each sentence was presented alongside three pictures:- the target, a lexical distracter and a reverse role distracter. Seven types of reversible sentences were tested:- active agentive, active non-agentive, passive agentive, passive non-agentive, adjectival, deverbal adjectival and locatives.

**Presentation**

The spoken stimulus was presented and then the pictures were shown to the subject. The subject was asked to select the picture which best depicted the sentence.

**Scoring**

The number of correct responses for each verb type was recorded. Incorrect responses were coded either as lexical or reverse role, depending on the distracter picture which was selected.

**Normal Data**

Normal data was not available for the 70 sentence version of the test used in this study. Normal data (although not raw scores) was, however, discussed in Black et al (1991) for six of the sentence types. It was found that normal subjects produced more reverse role errors than lexical errors, that overall performance on passive sentences was comparable to performance on active sentences and that comprehension was affected by the semantic properties of the verbs; agentive sentences were understood more accurately than either non-agentive and adjective sentences. The comprehension of locative sentences did not differ significantly from action sentences. Of interest to this study was the comparative performance of the four subjects and their selection of lexical distracters relative to reverse role distracters.

**b) Comprehension of Reversible Two Argument Sentences**

**Aim**

This test assessed the comprehension of the sentences which were the targets of the production task. It assessed the ability to assign thematic roles to lexical items, and overtly identify the thematic role fulfilled by one of the participants.

**Test Design**

To allow a direct comparison with the production of two argument sentences, the target sentences from the picture description task were used.

**Presentation**

The sentences were presented randomly. In each case, the subject was given the two participants of the sentence in written form. Each sentence was presented auditorly by the researcher and the subject was asked to identify the agent - 'the person who is doing the action'. Sentences were repeated if requested.

**Scoring**

The number of correct responses was recorded for the active and passive sentences.

**Normal Data**

No normal data was obtained as it was thought that normal subjects would be able to perform this task without error.

### 4.7.2 Predictions

Subjects with semantic deficits will experience difficulty in some of these tasks. Poor access to semantic information may result in the selection of lexical distracters in the BRSCT, particularly with the more abstract non-agentive verbs and prepositions. Subjects with difficulties in accessing PAS information should perform well on the tests within this section. Subjects are essentially given the PAS information in the sentence. Subjects with mapping difficulties will perform poorly on the tests in this section. These mapping difficulties may be a consequence of poor access to lexical mapping information or poor use of that mapping information to map syntactic information onto thematic roles within the PAS. Thematic role assignment and mapping deficits will result in the selection of reverse role distracters in the BRSCT and a failure to correctly identify the agent in the two argument sentences. It remains unclear whether thematic role assignment in different sentence types involves the same mechanism. A comparison of the results for the different sentence types may help to clarify this issue.

### 4.7.3 Results

**Table 4.23: Results of tests of reversible sentence comprehension**

| | n | GW | JM | KD | TJ |
|---|---|---|---|---|---|
| **Sentence Comprehension** | | | | | |
| BRSCT | | | | | |
| Overall performance (number correct) | **70** | **42** | **63** | **57** | **60** |
| Active Sentences | **20** | **15** | **17** | **19** | **20** |
| Passive Sentences | **20** | **9** | **18** | **14** | **18** |
| Reversible Locatives | **10** | **7** | **10** | **6** | **5** |
| Adjective Sentences | **10** | **7** | **9** | **9** | **8** |
| Deverbal Adjective Sentences | **10** | **4** | **9** | **9** | **9** |
| Identification of Agent in Active Sentences | **20** | **16** | **18** | **16** | **19** |

The results of the tests which assessed the comprehension of sentences are recorded in the table 4.23.

**a) Birkbeck Reversible Sentence Comprehension Test (BRSCT)**

The performance of the four subjects differed significantly on this task (Cochran Q test, Q = 47.45, df = 3, p=0.000). The error patterns of the subjects can be seen in Table 4.24. All of the subjects selected both lexical and reverse role distracters, but in different proportions and in response to different sentence types. Binomial tests contrasting the selection of reverse role and lexical distracters revealed a significant difference in the performance of GW (p = 0.002) and KD (p = 0.025). Both of these subjects made more reverse role errors than lexical errors. GW selected a high number of reverse role distracters on both active and passive sentences. KD's selection of reverse role distracters was predominantly in the comprehension of passives, particularly, those with non-agentive verbs. GW and KD both made reverse role errors in the comprehension of the locative sentences. JM and TJ did not differ in the relative proportions of reverse role and lexical errors.

**Table 4.24: Error patterns in BRSCT**

| Error Patterns | n | GW | JM | KD | TJ |
|---|---|---|---|---|---|
| Reverse role distracters | 70 | 24 | 5 | 11 | 3 |
| Lexical distracters | 70 | 4 | 2 | 2 | 7 |

**b) Comprehension of Reversible Two Argument Sentences**

The performance of the four subjects on the active sentences did not differ significantly (Cochran Q test, Q = 7.36, df = 3, p = 0.0612). KD and GW, however, showed a trend towards producing more errors than JM and TJ on this task.

### 4.7.4 Summary of Results

GW experienced difficulty in the mapping between syntactic relations and thematic roles in the comprehension of reversible sentences. He selected reverse role distracters in the comprehension of all of the sentence types. These difficulties appeared to

mirror his difficulties in production. JM selected some reverse role distracters in the comprehension of passive sentences. Her comprehension of the other sentences was good. Her difficulties with the comprehension of passives may have been the result of reduced sensitivity to verb morphology and the presence of 'by' in the passive form. KD experienced difficulty in the mapping between syntactic and thematic structure. He selected reverse role distracters predominantly in reversible passive sentences, but also in reversible locatives. Unlike GW, and in contrast to his production, he did not have significant difficulties in the comprehension of reversible active sentences in the BRSCT. He did, however, make some errors in the identification of the agent in the comprehension of the reversible two argument sentences. TJ's difficulty in the comprehension of sentences, seemed to result predominantly from his impaired access to semantic information about the verbs and prepositions. He made very few reverse role errors in the BRSCT, but selected some lexical distracters. TJ did not appear to have a difficulty parsing sentences and mapping syntactic structure onto thematic structure.

## 4.8 Overall Summary of Results

The performance of the four subjects is summarised in table 4.25. The subjects with aphasia differed both quantitatively and qualitatively in their performance on these tasks. All of the subjects had verb retrieval deficits which may in part account for their difficulties, but each subject seemed to have additional deficits which were also contributing to their performance.

**Table 4.25: Performance of the four subjects on semantic, predicate argument structure and mapping tasks.**

| Subject | NOUN | | VERB | | | PAS | | | Thematic Role Assignment and Mapping | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Retrieval | Comprehension | Retrieval | Comprehension | Semantic Selection Restrictions | Production | Grammaticality Judgement | Anagrams | Production (Increasing number of arguments) | Production reversible sentences | Anagrams | Grammaticality Judgement | Comprehension of Reversible Sentences |
| **GW** | + | + | - | - | - | - | - | - | - | - | - | - | - |
| **JM** | + | + | - | + | - | - | - | - | + | + | + | + | + |
| **KD** | - | + | - | + | + | - | + | + | - | - | - | + | - |
| **TJ** | - | + | - | - | + | - | + | + | - | + | + | + | + |

Key: + = retained, - = impaired.

GW seemed to have two distinct difficulties which were contributing to his difficulties in producing the functional level of representation, alongside his verb retrieval deficit. First of all, he had difficulty accessing PAS information and using that information to create an appropriate argument structure. Secondly, he had difficulty assigning thematic roles and their subsequent mapping onto syntactic roles. These deficits were evident in both production and comprehension tasks. In production, GW's difficulties resulted in the omission of obligatory arguments, the production of semantically inappropriate arguments and the production of reverse role errors. The reverse role errors were only present in the production of reversible sentences, where he was unable to rely on pragmatic information to order the items. In grammaticality judgement tasks, his deficits resulted in an inability to identify sentences with an inappropriate PAS, semantically inappropriate arguments and inappropriate mapping. His comprehension performance was characterised by the selection of reverse role distracters, for all sentence types.

JM also seemed to have a difficulty in accessing information about the PAS arrangements which are associated with individual verbs, alongside verb retrieval deficits. This difficulty was most evident with verbs which have a fixed argument structure. Like GW, these difficulties were evident in both production and comprehension. In production, these difficulties resulted in the omission of obligatory arguments and the addition of inappropriate arguments with fixed intransitive verbs. She was unable to identify sentences with an inappropriate argument structure or semantically inappropriate arguments and was unable to produce correct sentences when given a choice of component arguments. When given picture stimuli which highlighted the participants, her difficulties in producing an appropriate PAS were reduced. JM did not appear to have difficulty with thematic role assignment. Reversible active sentences and reversible locative sentences were produced and understood correctly.

KD appeared to have two distinct deficits which were contributing to his difficulties in producing the functional level representation. KD had some single word retrieval difficulties both in the retrieval of nouns and verbs. It is suggested that these were, at least in part, due to a phonological impairment. In comprehension and when given the lexical items, KD seemed to have access to at least basic semantic information. These word retrieval deficits resulted in the omission of obligatory

arguments. It is proposed, however, that KD had access to PAS information and was aware that the arguments should be produced but was unable to realise those arguments. KD also had difficulty in thematic role assignment and the mapping between thematic and syntactic roles in both production and comprehension. In production, this difficulty resulted in reverse role errors in the production of reversible sentences. Impaired thematic role assignment may also account for the omission of arguments in some sentences. This would account for the fact that despite similar difficulties in single word retrieval, KD omitted more arguments than TJ. In comprehension, the mapping difficulty affected the comprehension of reversible locatives and reversible passive sentences; reverse role distracters were selected instead of the target.

TJ's difficulties did not seem to result from sentence level difficulties at all, but seemed to be a consequence of severe word retrieval difficulties, possibly with a semantic origin. This resulted in sentence generation difficulties due to problems with the verb and omission of obligatory arguments. When given the lexical items, however, he was able to produce an appropriate sentence and was aware of PAS information and thematic role assignment. His comprehension of single words and sentences seemed to reflect his difficulties accessing semantic information and resulted in the selection of lexical distracters.

## 4.9 General Discussion

The aim of this part of the study was to investigate the processes involved in the production of the functional level representation, via the analysis of four subjects with aphasia, thought to have difficulties in the production of thematic structure. The performance of the four subjects on a battery of tests was contrasted with a view to determining the nature of their underlying impairment. Tests were used which assessed access to and use of semantic information in word retrieval and comprehension, access to and use of PAS information in sentence production and comprehension, thematic role assignment and the association of thematic roles and syntactic roles. These three aspects correspond to the three sub-processes suggested by Schwartz (1987). The identification of differential deficits corresponding to these sub-processes would provide evidence of the contribution of these processes to the

production of thematic structure. The results of the four subjects are discussed in this section in relation to the suggested sub-processes and the role of lexically specified information. The patterns of performance observed in these subjects will also be discussed, with particular focus on the similarities and differences seen in subjects with different underlying deficits and their relationship to the subjects' production of narrative speech.

### 4.9.1 Evidence for the Proposed Sub-processes in the Production of the Functional Level Representation

It was suggested that different underlying impairments may be responsible for the functional level deficits seen in the narrative production of these four subjects. The results of the four subjects would seem to confirm the hypothesis that semantic deficits, poor production of the predicate argument structure and impaired thematic role assignment are differentially responsible for the performance of these subjects. All of the four subjects exhibited difficulty with verb retrieval which may have contributed to the impaired production of thematic structure at the functional level representation. Subjects, however, varied in the extent to which this difficulty was associated with other deficits. GW presented with poor access to PAS information and thematic role assignment difficulties. JM had a single additional deficit accessing and using PAS information. KD's performance appeared to result from a combination of word retrieval difficulties and impaired thematic role assignment and mapping. TJ's performance appeared to be a consequence of impaired access to semantic information, resulting in severe word retrieval difficulties in single word and sentence production. These dissociations provide some evidence of the distinct sub-processes suggested by Schwartz.

It could be argued that the identified dissociations reflect differential access to lexical information rather than damage to distinct processes in sentence production. The parallel deficits seen in production and comprehension provide some evidence that performance may be resulting from impaired access to lexical information. Parallel deficits in comprehension and production may also, however, be a consequence of shared processing mechanisms or simultaneous damage to distinct processes. It is impossible to determine between these possibilities from the

assessments used in this study. Further investigations of the nature of the relationship between the production and comprehension of thematic structure are needed.

The results of this study do, however, seem to confirm that aspects of verb information can be accessed and used differentially. The results also challenge Marshall's (1995) assertion that semantic selection restrictions are encoded within the verb's lexical semantic representation. Impaired access to semantic selection restrictions occurred alongside poor access to PAS information, rather than lexical semantic difficulties. It is, therefore, proposed that semantic selection restrictions form part of the PAS and thus are part of the information which governs the number and type of arguments associated with a verb. This suggestion, however, needs further investigation. The tasks used to assess access to semantic and PAS information used different verbs; the co-occurrence of PAS and semantic selection restriction deficits may be a consequence of specific deficits in accessing the verbs used in both tests. Further investigations are required assessing a broad range of verbs in each set of tasks.

### 4.9.2 Contrasting Manifestations of the Deficits

This section will consider the observed patterns of performance in relation to the underlying deficit and their relationship to the features identified in the narrative task. The subjects were chosen due to their low mean thematic complexity scores, which was considered to be indicative of a difficulty creating the functional level representation. The subjects did, however, differ in the extent to which their mean thematic complexity score differed from the normal group, their distribution of thematic structure and in the omission of obligatory arguments. It was suggested in section 2.8 that this may be a consequence of different degrees of severity or different underlying impairments.

All of the subjects presented with a significant deficit in the retrieval of verbs; this was evident in the production of single words and sentences. This provides additional evidence for the co-occurrence of verb deficits and sentence production difficulties. The nature of the verb retrieval deficit remains unclear. In all of the subjects, it seemed at least in part to reflect a difficulty in accessing semantic information. In two of the subjects, JM and KD there was a concurrent difficulty accessing phonological

information. There was, however, little evidence to suggest from the single word and constrained sentence tasks, that retrieval was affected by length or frequency. The deficits may, however, reflect the lower imageability of verbs or result from difficulties accessing lexical information if it is a pre-requisite for lexical retrieval. In sentence tasks, for example the TRIP, the verb deficit resulted in the production of semantic paraphasias and the omission of verbs. In some cases, particularly in the performance of TJ, failure to retrieve the verb resulted in the abandonment of the sentence. These verb retrieval deficits can account for some aspects of the observed performance in the narrative task. There is a perfect correspondence between the severity of the verb retrieval deficit (as indicated by performance on the VAN) and the mean thematic complexity scores. TJ presented with the most obvious verb retrieval deficit and had the lowest mean thematic complexity scores; subject JM showed the reverse pattern. By definition, the omission of the verb resulted in utterances with an undetermined thematic structure (UTS) and verb retrieval deficits may result in the predominance of single phrases. The presence of UTS utterances was the main contributor to the low mean thematic complexity scores in at least two of the subjects (KD and TJ). It is more difficult to explain the use of less complex thematic structures and the omission of obligatory arguments in terms of a verb retrieval deficit.

The additional presence of noun retrieval deficits in subjects TJ and KD may explain other aspects of their performance. TJ's word retrieval deficit was prevalent in the retrieval of even high frequency nouns. This additional noun retrieval deficit may also account for the very high percentage of UTS utterances in his narrative; TJ was unable to retrieve sufficient sentence components to create determinable sentence structure. His speech consisted of single phrases, separated by large pauses. KD's noun retrieval deficit may account for the omission of main nouns within phrases and the omission of obligatory arguments. These were certainly patterns of performance which were evident in the constrained sentence tasks.

Thematic role assignment difficulties in the sentence production tasks, characteristic of the performance of GW and KD, resulted in the production of reverse role errors and the omission of verb arguments, in two and three argument sentences. Thematic role assignment difficulties may, therefore, also be responsible for the omission of arguments in the narrative task. This was a prominent feature in the narratives of GW. These difficulties may also explain the limited production of three

argument structures by these subjects; these structures were difficult for these subjects in the TRIP assessment. Reverse role errors were not identified in the narrative task. This would seem to be the result of the non-reversible nature of the verbs and the events described in the narrative. The order of the participants in the events was governed by non-linguistic and pragmatic information.

The presence of PAS difficulties was also hard to identify from the narrative performance of these subjects. Difficulties accessing PAS information may account for the omission of some arguments in the narratives of GW and JM. If the subjects were unaware of the PAS, then a reliance on the transitive form may result in the apparent omission of arguments in the production of three argument structures. Problems producing the PAS may also result in the production of some structures with an UTS. PAS difficulties may, however, be masked by the requirements of the narrative task. The number of arguments is generally determined by the non-linguistic information coded within the event and most of the verbs used in the narrative could occur in more than one PAS arrangement; this provides the subjects with a greater opportunity to select an appropriate PAS. From the performance of JM in the sentence generation task, it was apparent that verbs with fixed argument structures, were more difficult than verbs with variable PAS arrangements. This in contrast to the increased complexity of verbs with multiple PAS arrangements identified in sentence comprehension tasks (Shapiro et al 1987).

These results suggest that the different manifestations of a functional level deficit may be a consequence of different underlying impairments. The precise nature of the relationship between the underlying impairment and the observed patterns of performance, however, remains difficult to determine; there is some overlap in the features which result from different impairments, for example, the omission of verb arguments may be a consequence of a semantic, PAS or thematic role assignment deficit. In these cases the relative contribution of the underlying impairments to the observed features of the narrative needs to be determined. Only if subjects presented with discrete deficits to only one aspect of processing could the link be established more clearly.

# CHAPTER 5: Discussion

The aim of this study was to investigate sentence production deficits in subjects with aphasia, with a view to improving the description of the observed features of performance and determining the nature of the underlying impairment. This chapter will draw together the findings of the sections of the study described in chapters two to four. The chapter is divided into three sections. Initially, the implications of the findings for the characterisation of sentence production deficits will be discussed. Secondly, models of sentence production will be considered alongside suggestions for additional research. Finally the implications for clinical assessment and treatment are evaluated.

## 5.1 Characterisation of Sentence Production Deficits in Aphasia

The distinction between agrammatism and paragrammatism has dominated the description of sentence production deficits in aphasia. Previous analyses which have been used to describe agrammatic and paragrammatic speech have been restricted to particular aspects of linguistic structure, and thus, have not enabled a complete profile of a subject's ability to produce thematic, phrasal and morphological structure to be obtained. The narrative analysis described in chapter two aimed to address this limitation. The analysis, in its description of more than one level of linguistic structure, allowed more accurate comparisons of normal and aphasic performance to be made. In this way, the extent to which the two aphasic groups and individual subjects within those groups resembled each other could be determined.

The results of the narrative analysis questioned the validity of grouping subjects via the fluency of their speech. Subjects in the non-fluent and fluent group did not exclusively demonstrate the features traditionally associated with agrammatism and paragrammatism respectively. There was marked variability in the performance of individual subjects within each group and extensive overlap between the two groups. Sentence production deficits were of a greater variety than would be suggested by a simple division into two syndromes and the deficits seen in non-fluent and fluent subjects were not differentiable. No relationship between rate of speech and parameters of thematic and phrasal production was found. Fluency provided no clues to the patterns of performance which would be evident in any individual subject.

Subjects who differed significantly in their rate of speech showed very similar patterns of deficit and vice versa. The characterisation of aphasic sentence production deficits as a continuum was thus rejected. The factors which determine the fluency of someone's speech therefore remain unclear. The same deficits seem to affect spontaneous speech production in different ways in different subjects; this may be a consequence of the differential use of adaptive strategies.

With the failure of fluency as an adequate means of grouping subjects, alternative ways of considering sentence production deficits were sought. The rejection of functional syndromes suggested that the performance of subjects should be considered with no prior assumptions that the presence of one feature would necessarily imply the co-occurrence of other features. The search for unitary explanations of multiple deficits could also be abandoned. The description of individual subjects in terms of a model of normal sentence production provided a way of characterising individual variability in performance. Subjects were analysed individually with a view to describing the precise contribution of specific deficits to their performance. This did not mean that certain patterns of deficit would not occur with increased frequency than others, but models of production provided a framework for describing these patterns of deficit, but also very selective deficits and unusual patterns of symptoms.

The narrative analysis was designed to capture the information specified at the two levels of representation thought to be of most importance in the description of aphasic sentence production, the functional and positional levels. It was, therefore, possible to relate the observed deficits with damage to the processes responsible for the production of thematic and/or phrasal structure. At the broadest level of distinction, the contribution of impaired functional and positional level processes could be determined. Within those levels of processing, there was also the potential for dissociations which resulted from damage to discrete sub-processes. These descriptions could provide a more accurate way of describing the performance of an individual and perhaps for grouping subjects with similar deficits. For the purpose of the study in chapter three, it was considered important to investigate the performance of subjects who would have traditionally been described as agrammatic. It was considered that there was sufficient consistency within the non-fluent group to warrant this grouping. The majority of subjects presented with a combination of thematic and phrasal difficulties. It was, however, acknowledged that all of the subjects within the

group did not show the same patterns of deficit. In the investigation of the processing and adaptation accounts of agrammatism, it was not considered appropriate to include fluent subjects. With the overall rejection of grouping subjects on the basis of fluency, however, the analysis of narrative speech in relation to a normal model may provide a system of classification of increased value. The analysis presents researchers with a means of grouping subjects who present with functional or positional level deficits, similar dissociations within those levels of processing and similar severities of impairment, depending on the parameter of interest. Subjects can be selected on the basis of their performance on particular parameters. For example, the investigation in chapter three could have been carried out only with subjects who presented with concurrent thematic and phrasal difficulties, with the exclusion of non-fluent subjects who did not present with these difficulties and the inclusion of fluent subjects. The narrative analysis will also provide the researcher with an awareness of other co-occurring deficits whose contribution on performance can be contrasted.

## 5.2 Models of Normal Sentence Production

It was proposed in section 1.5 that the study of sentence production deficits in aphasia provides an opportunity to evaluate current models of sentence production. The narrative analysis and the subsequent studies of the interaction between thematic and phrasal production provide some insight into the processes responsible for producing thematic and phrasal structure. The notion of independent processes involved in the production of thematic and phrasal structure was supported by the dissociations evident in the production of narrative speech. Double dissociations in the production of thematic structure and phrasal structure were identified. Additional evidence regarding the relationship between these aspects of processing was provided by the results of the interaction study reported in chapter three. The processing of thematic structure did not appear to compete with phrasal processing. This would suggest there is some validity in the two independent levels of representation suggested in Garrett's model. Functional and positional level processing were, however, both affected by the information coded within the message. The number of arguments in the PAS and the complexity of the phrases used to realise those arguments reflected the information to be conveyed and its relationship to previous

discourse. From the results of the study, however, it is not clear how other information, coded non-linguistically at the message level representation, for example, definiteness, tense, perspective, is transmitted for linguistic coding at the positional level.

With regard to functional level processing, the narrative analysis suggested dissociations between the ability to produce complex thematic structure and the omission of verb arguments. The results of the study reported in chapter four suggested that these dissociations may be, at least in part, the consequence of damage to discrete sub-processes. The comprehensive testing of four subjects who presented with functional level deficits provided evidence for the three sub-processes suggested by Schwartz (1987). The production of thematic structure at the functional level representation was shown to be dependent on the retrieval of semantic information, the retrieval of the PAS and the assignment of lexical items to thematic roles within the PAS. Only with a consideration of the comparative performance of these subjects on a number of different assessments could the true nature of their impairments be determined, as damage resulted in a similar pattern of observable performance.

There was evidence from the results of the studies reported in chapters three and four that similar mechanisms are involved in the production of verb arguments and non-arguments. Normal and aphasic subjects produced non-arguments alongside verbs in their intransitive (one argument) and transitive (two argument) forms. There was no apparent difference for the aphasic subjects in the ease with which they produced arguments and non-arguments. The presence of non-arguments, like PAS information, reflected the information to be conveyed in the message. Often, non-arguments seemed to have similar semantic roles as verb arguments in other sentences; in this way, they seemed to be fulfilling a thematic role. In contrast to verb arguments, however, this thematic role was not determined by the lexical verb and had greater flexibility in its position within the sentence. Non-arguments thus seemed to encode semantic information in a similar way to verb arguments; those subjects who presented with noun retrieval difficulties, KD and TJ, had equivalent difficulties in non-arguments and arguments. At a positional level, non-argument phrases seemed to be produced by the same mechanism as those phrases realising verb arguments. There was no difference in the complexity of utterances containing non-arguments and those containing only verb arguments. There was also no difference in the

complexity of individual phrases realising non-arguments and arguments. A further study of the distribution of function word and inflection errors would provide additional support that the same mechanisms are involved in argument and non-argument production at the positional level.

With regard to the production of the positional level representation, dissociations were observed in the ability to produce phrases of comparable complexity to normal subjects and the production of function word and inflectional errors. The observed dissociations in the production of function words and inflectional morphemes provided additional evidence that different mechanisms are responsible for their retrieval and/or subsequent insertion within phrasal frames. The majority of subjects retained the ability to produce some complex phrases and to insert and order function words, adjectives etc. on some occasions. This perhaps suggests that phrasal fragments are in some sense stored and subjects had access to these frames even if the grammatical content was not always inserted. Although, Lapointe and Dell's characterisation of these syntactic processes is capable of explaining the observed deficits, their model requires further investigation with the production of a wider range of function words and inflections in more constrained tasks. In addition, there needs to be consideration of the ordering of the phrases in response to thematic role assignment and access to syntactic sub-categorisation information. In this study, thematic role assignment and the mapping of thematic roles onto syntactic roles was only considered in relation to the production of canonical word order. It was proposed that the production of reverse role errors was a consequence of difficulties in thematic role assignment or mapping and that the two could not be distinguished. Future research, however, needs to determine whether there is the potential for discrete difficulties in thematic role assignment and mapping. This dissociation would provide evidence for the presence of a functional level representation which is independent of surface form and which can be translated into different surface syntactic structures. This in contrast to Bock and Levelt's (1994) proposal that it is syntactic functions which are assigned at the functional level. This would seem to require the study of the differential production of canonical and non-canonical word order, in terms of the processing demands of production and the errors produced. A contrastive study of sentences with the same underlying thematic structure (and thus the same thematic

complexity) but different surface syntactic structures would also help to disambiguate the relative contributions of thematic and syntactic complexity in sentence production.

In the evaluation of current models of sentence production, two main areas need to be investigated:- the role of general procedures and the relationship between sentence production and sentence comprehension. From the study described in chapter four, it was difficult to determine the extent to which the results were a consequence of damage to different sub-processes or differential access to lexical information. The role of general procedures which use the information specified in the verb and operate in the production of sentence components that are not determined by the lexical verb, remains unclear. It is proposed that if these procedures do exist, they must be specific to the processing of certain sentence types. This study did not contrast the production of different sentence types in any controlled way and thus differential impairments could not be identified. There was, however, some evidence from the sentence generation task described in chapter four, that sentences containing certain types of verbs may be more difficult than others. The role of general procedures in the construction of the PAS, thematic role assignment and construction of the syntactic sub-categorisation frame needs more systematic investigations contrasting the production of different sentence structures with the same verbs and different verbs and with verbs which do and do not differ from the general rules of English.

The major limitation of the present study was its restricted focus on production. In the understanding of sentence processing deficits in aphasia, it seems vital to clarify the relationship between the processes involved in comprehension and production. Although the study of functional level processing in chapter four involved some use of comprehension and grammaticality judgement tasks, a systematic study of comprehension was not carried out for either single words or sentences. Similar sub-processes, as identified in the production of the functional level representation, may exist in the comprehension of thematic structure. If they do, however, they will occur in a different order and are likely to be more interactive with the previous encoding of phrasal information. The relationship between the peripheral processing of phrasal structure is likely to be more disparate due to the very different demands or production and comprehension.

The results of chapter four highlighted the limitation of the present study in determining the nature of the relationship between associated deficits. The limited

joint assessment of the production and comprehension of thematic structure revealed parallel deficits in the performance of the tasks. The assessments could not, however, determine the relationship between the identified deficits. Associations between aspects of performance may result from impaired access to a central source of lexical information, impairment to a central process, a causal effect of one process on another or parallel impairment to distinct processes. Monitoring the effects of controlled treatment can help to distinguish between these possibilities. If the deficits are the result of a central impairment, then treatment of one aspect will result in parallel gains in the untreated aspect. If the associations are the consequence of simultaneous deficits to discrete aspects of processing, then no generalisation will be observed. It was described in section 1.7.4 how studies of mapping therapy had clarified the centrality of mapping to comprehension and production. Similar studies could be carried out to clarify the centrality of PAS processing and phrasal processing and the role of general procedures in the processing of different sentence types.

## 5.3 Clinical Implications

The narrative analysis provides a clinically relevant way of characterising sentence production deficits in subjects with aphasia; the analysis provides comprehensive information about the retention of and impairment to thematic, phrasal and morphological processing. In this way, the extent of a subject's difficulties across these parameters and their relative contribution to the person's spontaneous speech can be determined. A major advantage of this analysis, compared to previous descriptions of aphasic speech, is the collection of more adequate normal data. The availability of normal data provides a means of determining the validity of the procedure in eliciting aspects of performance. Additional tasks may be required for the sampling of certain parameters, for example, complex verb phrases with varied auxiliaries and morphology. Normal data also ensures that clinically important deficits can be distinguished from normal variability.

The relationship of the narrative analysis to the structures specified at the functional and positional levels of representation allows the location of the impairment to be determined. The narrative analysis is not, however, sufficiently detailed to allow the identification of the impaired sub-processes, particularly the sub-

processes responsible for the production of the functional level of representation. The narrative analysis thus serves as a guide to a clinician enabling appropriate further assessments to be selected. The study described in chapter four highlighted that different underlying impairments can result in similar features of performance in the production of narrative speech. The four subjects presented with quite similar patterns of narrative speech and yet this observed performance was a consequence of different underlying impairments. Only in the use of a variety of assessments, which isolate aspects of performance and prevent the use of non-linguistic strategies, could the true nature of the impairment be determined. In therapy, if the aim is to treat the underlying impairment and not just focus on the observable symptoms, then this additional assessment is essential. The treatment of the underlying deficit should result in more effective treatment for subjects with aphasia. This assessment and treatment is, however, limited by the current under-specification of the processes involved in normal production.

The wide scope of the narrative analysis and its focus on spontaneous speech makes it an appropriate means of monitoring change in sentence production in response to recovery or treatment. In spontaneous recovery, it would be expected that there would be widespread changes across functional and positional level processing resulting in an overall improvement in sentence production. It would be expected that targeted treatment would result in more specific gains at one level of processing. The narrative analysis thus monitors the influence of treatment on spontaneous speech and acts as a control for non-treated parameters.

# References


Ahrens, K., & Swinney, D. (1995). Participant roles and the processing of verbs during sentence comprehension. *Journal of Psycholinguistic Research, 24*, 533 - 547.

Allport, D. A., & Funnell, E. (1981). Components of the mental lexicon. *Philosophical Transactions of the Royal Society*, 295, 397 - 410.

Badecker, W., & Caramazza, A. (1986). A final brief in the case against agrammatism: The role of theory in the selection of data. *Cognition, 24*, 277 - 282.

Bastiaanse, R. (1995). Broca's aphasia: A syntactic and/or a morphological disorder? Case study. *Brain and Language, 48*, 1 - 32.

Bastiaanse, R., Edwards, S., & Kiss, K. (1996). Fluent aphasia in three languages: Aspects of spontaneous speech. *Aphasiology, 10*, 561 - 575.

Bates, E., Chen, S., Tzeng, O., Li, P., & Opie, M. (1991). The noun-verb problem in Chinese. *Brain and Language, 41*, 203-233.

Berndt, R. S. (1991). Sentence processing in aphasia. In M. T. Sarno (Ed.), *Acquired Aphasia* (Second Edition). New York: Academic Press.

Berndt, R. S., & Caramazza, A. (1980). A redefinition of the syndrome of Broca's aphasia: Implications for a neuropsychological model of language. *Applied Psycholinguistics, 1*, 225 - 278.

Berndt, R. S., & Caramazza, A. (1981). Syntactic aspects of aphasia. In M. T. Sarno (Ed.), *Acquired Aphasia* (First edition). New York: Academic Press.

Berndt, R. S., Mitchum, C. C., Haendiges, A. N., & Sandson, J. (1997a). Verb retrieval in aphasia: I. Characterising single word impairments. *Brain and Language, 56*, 68-106.

Berndt, R. S., Haendiges, A. N., Mitchum, C. C., & Sandson, J. (1997b). Verb retrieval in aphasia: II. Relationship to sentences processing. *Brain and Language, 56*, 107 - 137.

Berndt, R.S., Haendiges, A., & Wozniak, M. (1997c). Verb retrieval and sentence processing: Dissociation of an established symptom pattern. *Cortex, 33*, 99 - 114.

Bird, H., & Franklin, S. (1996). Cinderella revisited: A comparison of fluent and non-fluent aphasia. *Journal of Neurolinguistics, 9*, 187 - 206.

Bird, H. & Webster, J. (1997). The Verb and Noun Test (VAN). Unpublished.

Black, M., Nickels, L., & Byng, S. (1991). Patterns of sentence processing deficit: Sentences can be a complex matter. *Journal of Neurolinguistics*.

Blumstein, S. (1973). A Phonological Investigation of Aphasic Speech. The Hague: Mouton.

Bock, J. K. (1987). Co-ordinating words and syntax in speech plans. In A. W. Ellis (Ed.), *Progress in the Psychology of Language.* (Vol. 3,). London: Lawrence Erlbaum Associates.

Bock, J. K., & Levelt, W. J. M. (1994). Language production: Grammatical encoding, *Handbook of Psycholinguistics volume 29* . New York: Academic Press.

Bradley, D., Garrett, M. F., & Zurif, E. B. (1980). Syntactic deficits in Broca's aphasia. In D. Caplan (Ed.), *Biological Studies of mental Processes*. Cambridge: MIT Press.

Breedin, S. D., & Martin, R. C. (1996). Patterns of verb impairment in aphasia: An analysis of four cases. *Cognitive Neuropsychology, 13*, 51 - 91.

Breedin, S. D., Saffran, E. M., & Schwartz, M. F. (1998). Semantic factors in verb retrieval: An effect of complexity. *Brain and Language, 63*, 1 - 31.

Butterworth, B., & Howard, D. (1987). Paragrammatisms. *Cognition, 26*, 1 - 37.

Butterworth, B., Panzeri, M., Semenza, C., & Ferreri, T. (1990). Paragrammatism: A longitudinal study on an Italian patient. *Language and Cognitive Processes, 5*, 115 - 140.

Byng, S. & Coltheart, M. (1986). Aphasia therapy research: Methodological requirements and illustrative results. In E. Hjelmquist & L.G. Nilsson (Eds.). *Communication and Handicap: Aspects of Psychological Compensation and Technical Aids*. North Holland: Elsevier Science Publications.

Byng, S. (1988). Sentence processing deficits: Theory and therapy. *Cognitive Neuropsychology, 5*, 629 - 676.

Byng, S., & Black, M. (1989). Some aspects of sentence production in aphasia. *Aphasiology, 3*, 241 - 263.

Byng, S., Nickels, L., & Black, M. (1994). Replicating therapy for mapping deficits in agrammatism: Remapping the deficit? *Aphasiology, 8*, 315 - 341.

Caplan, D. (1985). Syntactic and semantic structures in agrammatism. In M. L. Kean (Ed.), *Agrammatism.* Orlando: Academic Press.

Caplan, D. (1986). In defense of agrammatism. *Cognition, 24*, 263 - 276.

Caplan, D. (1991). Agrammatism is a theoretically coherent aphasic category. *Brain and Language, 40*, 274 - 281.

Caramazza, A., & Berndt, R. S. (1978). Semantic and syntactic processes in aphasia: A review of the literature. *Psychological Bulletin, 85*, 898-918.

Caramazza, A., Berndt, R. S., Basili, A. G., & Koller, J. J. (1981). Syntactic processing deficits in aphasia. *Cortex, 17*, 333 -348.

Caramazza, A., & Hillis, A. E. (1989). The disruption of sentence production: Some dissociations. *Brain and Language, 36*, 625 - 650.

Caramazza, A., & Hillis, A. E. (1991). Lexical organization of nouns and verbs in the brain. *Nature, 349*, 788 - 790.

Caramazza, A., & Miceli, G. (1991). Selective impairment of thematic role assignment in sentence processing. *Brain and Language, 41*, 402 - 436.

Caramazza, A., & Zurif, E. B. (1976). Dissociation of algorithmic and heuristic processes in language comprehension: Evidence from aphasia. *Brain and Language, 3*, 572 - 582.

Center for lexical information (1993*). Celex Lexical Database*. Nijmegen: University of Nijmegen.

Chomsky, N. (1981). *Lectures on Government and Binding*. Dordrecht: Foris Publications.

Crystal, D., Fletcher, P., & Garman, M. (1989). *Grammatical Analysis of Language Disability*. (Second Edition). London: Whurr Publishers Ltd.

De Villiers, J. (1974). Quantitative aspects of agrammatism in aphasia. *Cortex, 1*, 36 - 54.

De Villiers, J. G. (1978). Fourteen grammatical morphemes in acquisition and aphasia. In A. Caramazza & E. B. Zurif (Eds.), *Language Acquisition and Language Breakdown: Parallels and Divergences.* Baltimore: John Hopkins University Press.

Edwards, S. (1995). Aphasic spontaneous speech. *European Journal of Disorders of Communication, 30*, 333 - 345.

Edwards, S., & Bastiaanse, R. (1998). Diversity in the lexical and syntactic abilities of fluent aphasic speakers. *Aphasiology, 12*, 99 - 117.

Ellis, A. W., Miller, D., & Sin, G. (1983). Wernicke's aphasia and normal language processing: A case study in cognitive neuropsychology. *Cognition, 15*, 111-144.

Friederici, A. D. (1981). Production and comprehension of prepositions in aphasia. *Neuropsychologia, 19*, 191 - 199.

Friederici, A. D. (1982). Syntactic and semantic processes in aphasic deficits: The availability of prepositions. *Brain and Language, 15*, 249 - 258.

Friederici, A. D. (1985). Levels of processing and vocabulary types: Evidence from on-line comprehension in normals and agrammatics. *Cognition, 19*, 133 - 166.

Friederici, A. D., Schole, P. W., & Garrett, M. F. (1982). Syntactically and semantically based computations: Processing of prepositions in agrammatism. *Cortex, 18*, 525 - 534.

Garrett, M. F. (1980). Levels of processing in sentence production. In B. Butterworth (Ed.), *Language Production I* . New York: Academic Press.

Garrett, M. F. (1982). Production of speech: Observation from normal and pathological language use. In A. W. Ellis (Ed.), *Normality and pathology in cognitive functions.* . London: Academic Press.

Gleason, J., Goodglass, H., Obler, L., Green, E., Hyde, M., & Weintraub, S. (1980). Narrative strategies of aphasic and normal speaking subjects. *Journal of Speech and Hearing Research, 23*, 370-383.

Gleason, J. B., Goodglass, H., Green, E., Ackerman, N., & Hyde, M. (1975). The retrieval of syntax in Broca's aphasia. *Brain and Language, 2*, 451 - 471.

Goodenough, C., Zurif, E. B., & Weintraub, S. (1977). Aphasics' attention to grammatical morphemes. *Language and Speech, 20*, 11 -19.

Goodglass, H. (1962). *Redefining the concept of agrammatism.* Paper presented at the XIIth Congress International Association of Logopedics and Phoniatrics, Padua.

Goodglass, H. (1968). Studies on the grammar of aphasics. In S. Rosenberg & J. Joplin (Eds.), *Developments in Applied Psycholinguistics Research.* . New York: Macmillan Co.

Goodglass, H., & Berko, J. (1960). Aphasia and inflectional morphology in English. *Journal of Speech and Hearing Research, 3*, 257 - 267.

Goodglass, H., Blumstein, S. E., Gleason, J. B., Hyde, M. R., Green, E., & Statlender, S. (1979). The effect of syntactic encoding on sentence comprehension in aphasia. *Brain and Language, 7*, 201 - 209.

Goodglass, H., Christiansen, J. A., & Gallagher, R. (1993). Comparison of morphology and syntax in free narrative and structured tests: Fluent vs non-fluent aphasics. *Cortex, 29*, 377 - 407.

Goodglass, H., Fodor, I. G., & Schulhoff, C. (1967). Prosodic factors in grammar - evidence from aphasia. *Journal of Speech and Hearing Research, 10*, 5 - 20.

Goodglass, H., Gleason, J. B., Bernholtz, N., & Hyde, M. R. (1972). Some linguistic structures in the speech of a Broca's aphasic. *Cortex, 8*, 191 - 212.

Goodglass, H., & Kaplan, E. (1983). *The Assessment of Aphasia and Related Disorders.* (Second Edition ed.). Philadelphia: Lea and Febiger.

Goodglass, H., & Mayer, J. (1958). Agrammatism in aphasia. *Journal of Speech and Hearing Disorders, 23*, 99 - 111.

Goodglass, H., & Menn, L. (1985). Is agrammatism a unitary phenomenon? In M. L. Kean (Ed.), *Agrammatism* . Orlando: Academic Press.

Grimshaw, J. (1979). Complement selection and the lexicon. *Linguistic Inquiry, 10*, 279 - 326.

Grodzinsky, Y. (1984). The syntactic characterisation of agrammatism. *Cognition, 16*, 99 - 120.

Grodzinsky, Y. (1986). Language deficits and the theory of syntax. *Brain and Language, 27*, 135 - 159.

Grodzinsky, Y. (1990). *Theoretical perspectives on language deficits.* Cambridge, MA: MIT Press.

Grodzinsky, Y. (1991). There is an entity called agrammatic aphasia. *Brain and Language, 41*, 555 - 564.

Grodzinsky, Y. (1995). A restrictive theory of agrammatic comprehension. *Brain and Language, 50*, 27 - 51.

Grodzinsky, Y., & Finkel, L. (1996). Severe grammaticality deficits in agrammatism and Wernicke's aphasia. *Brain and Language, 55*, 50 - 53.

Haendiges, A. N., Berndt, R. S., & Mitchum, C. C. (1996). Assessing the elements contributing to a 'mapping' deficit: A targeted treatment study. *Brain and Language, 52*, 276 - 302.

Heeschen, C. (1980). Strategies for decoding actor-object relations by aphasic patients. *Cortex, 16*, 5 - 19.

Heeschen, C. (1985). Agrammatism and paragrammatism: A fictitious opposition. In M. L. Kean, *Agrammatism*. New York: Academic Press.

Heeschen, G., & Kolk, H. (1988). Agrammatism and paragrammatism. *Aphasiology, 2*, 299-302.

Howard, D. (1985). Agrammatism. In S. Newman & R. Epstein (Eds.), *Current Perspectives in Dysphasia* . London: Longman Group Limited.

Howard, D., & Franklin, S. (1987). Three ways for understanding written words and their use in two contrasting cases of surface dyslexia. In D. A. Allport, D. Mackay, W. Prinz, & E. Scheere (Eds.), *Language perception and production: relationships between listening, speaking, reading and writing.* . London: Academic Press.

Isserlin, M. (1922). Ueber agrammatismus. Zeitschrift fur des gesamte Neurologie and Psychiatrie, 75, 332 - 416.

Jakobson, R. (1956). Two aspects of language and two types of aphasic disturbances. In R. Jakobson & M. Halle (Eds.), *Fundamentals of Language* . The Hague: Mouton.

Jones, E. V. (1984). Word order processing in aphasia: Effects of verb semantics. In F. C. Rose (Ed.). *Advances in Neurology, 42: Progress in Aphasiology.* . New York: Raven.

Jones, E. V. (1986). Building the foundations for sentence production in a non-fluent aphasic. *British Journal of Disorders of Communication, 21*, 63 - 82.

Kay, J., Lesser, R., & Coltheart, M. (1992). *PALPA: Psycholinguistic Assessments of Language Processing in Aphasia.* Hove: Lawrence Erlbaum Associates.

Kean, M. (1977). The linguistic interpretation of aphasic syndromes: Agrammatism in Broca's aphasia, an example. *Cognition, 5*, 9 - 46.

Kean, M. L. (1995). The elusive character of agrammatism. *Brain and Language, 50*, 369 - 394.

Kempen, G., & Hoenkamp, E. (1987). An incremental procedural grammar for sentence formulation. *Cognitive Science, 11*, 201-258.

Kleist, K. (1916). Ueber leitungsaphasie und die grammatischen storungen. *Monatsschrift fur Psychatrie und Neurologie, 40*, 118 - 199.

Kolk, H., & Heeschen, C. (1990). Adaptation symptoms and impairment symptoms in Broca's aphasia. *Aphasiology, 4*, 221-232.

Kolk, H., & Heeschen, C. (1992). Agrammatism, paragrammatism and the management of language. *Language and Cognitive Processes, 7*, 89 - 129.

Kolk, H. H. J., & Van Grunsven, M. M. F. (1985). Agrammatism as a variable phenomenon. *Cognitive Neuropsychology, 2*, 347 - 384.

Kolk, H. H. J., Van Grunsven, J. F., & Keyser, A. (1985). On parallelism between production and comprehension in agrammatism. In M. L. Kean (Ed.), *Agrammatism* . New York: Academic Press.

Kolk, H., & Weijts, M. (1996). Judgments of semantic anomaly in agrammatic patients: Argument movement, syntactic complexity and the use of heuristics. *Brain and Language, 54*, 86 - 135.

Lapointe, S. G. (1985). A theory of verb form use in the speech of agrammatic aphasics. *Brain and Language, 24*, 100 - 155.

Lapointe, S. G., & Dell, G. S. (1989). A synthesis of some recent work in sentence production. In G. N. Carlson & M. K. Tanenhaus (Eds.), *Linguistic Structure in Language Processing* . Dordrecht: Kluwer.

Le Dorze, G., Jacob, A., & Coderre, L. (1991). Aphasia rehabilitation with a case of agrammatism: a partial replication. *Aphasiology, 5*, 63 - 85.

Levelt, W.J.M. (1989). *Speaking: From intention to articulation*. London: MIT Press.

Levelt, W. J. M. (1992). Accessing words in speech production: Stages, processes and representations. *Cognition, 42*, 1-22.

Linebarger, M. C., Schwartz, M. F., & Saffran, E. M. (1983). Sensitivity to grammatical structure in so-called agrammatic aphasics. *Cognition, 13*, 361 - 392.

Luria, A. R. (1970). *Traumatic aphasia: Its syndromes, psychology and treatment*. Translated by D. Bowden. The Hague: Mouton.

Maher, L. M., Chatterjee, A., Rothi, L. J., Gonzalez, & Heilman, K. M. (1995). Agrammatic sentence production: The use a temporal-spatial strategy. *Brain and Language, 49*, 105 - 124.

Marshall, J. (1995). The mapping hypothesis and aphasia therapy. *Aphasiology, 9*, 517 - 539.

Marshall, J., Chiat, S., & Pring, T. (1997). An impairment in processing verbs' thematic roles: a therapy study. *Aphasiology, 11*, 855 - 876.

Marshall, J., Pring, T., & Chiat, S. (1993). Sentence processing therapy: Working at the level of the event. *Aphasiology, 7*, 177 - 199.

Marshall, J., Pring, T., & Chiat, S. (1998). Verb retrieval and sentence production in aphasia. *Brain and Language, 63*, 159 - 183.

Martin, R. C., & Blossom-Stach, C. (1986). Evidence of syntactic deficits in a fluent aphasic. *Brain and Language, 28*, 196 - 234.

McCarthy, R., & Warrington, E. K. (1985). Category specificity in an agrammatic patient: The relative impairment of verb retrieval and comprehension. *Neuropsychologia, 23*, 709 - 727.

Menn, L., & Obler, L. (Eds.). (1990). *Agrammatic aphasia: A cross language narrative source book.* Amsterdam: John Benjamins.

Menn, L., Powelson, J., Miceli, G., Williams, E., & Zurif, E. (1982). *A psycholinguistic model for paragrammatic speech.* Paper presented at the Body for the Advancement of Brain Behaviour and Language Enterprise, Niagara Falls, Ontario.

Miceli, G., & Caramazza, A. (1988). Dissociation of inflectional and derivational morphology. *Brain and Language, 35*, 24 - 65.

Miceli, G., Mazzuchi, A., Menn, L., & Goodglass, H. (1983). Contrasting cases of Italian agrammatic aphasia without comprehension disorder. *Brain and Language, 19*, 65 - 97.

Miceli, G., Silveri, M. C., Romani, C., & Caramazza, A. (1989). Variation in the pattern of omissions and substitutions of grammatical morphemes in the spontaneous speech of so-called agrammatic patients. *Brain and Language, 36*, 447 - 492.

Miceli, G., Silveri, M. C., Villa, G., & Caramazza, A. (1984). On the basis for the agrammatic's difficulty in producing main verbs. *Cortex, 20*, 207 - 220.

Mitchum, C.C., & Berndt, R.S. (1989). Aphasia rehabilitation: An approach to diagnosis and treatment of disorders of language production. In M. G. Eisenberg (Ed.). *Advances in Clinical Rehabilitation*. New York: Academic Press.

Mitchum, C. C., & Berndt, R. S. (1994). Verb retrieval and sentence construction: Effects of targeted intervention. In M. J. Riddoch & G. W. Humphreys (Eds.), *Cognitive Neuropsychology and Cognitive Rehabilitation.* . East Sussex: Lawrence Erlbaum Associates Inc.

Mitchum, C. C., Haendiges, A. N., & Berndt, R. S. (1993). Model-guided treatment to improve written sentence production: A case study. *Aphasiology, 7*, 71 - 109.

Mitchum, C. C., Haendiges, A. N., & Berndt, R. S. (1995). Treatment of thematic mapping in sentence comprehension; Implications for normal processing. *Cognitive Neuropsychology, 12*, 503 -547.

Monsell, S. (1985). Repetition and the lexicon. In A. W. Ellis (Ed.), *Progress in the Psychology of Language* Volume 2. London: Lawrence Erlbaum Associates.

Nickels, L., Byng, S., & Black, M. (1991). Sentence processing deficits: A replication of therapy. *British Journal of Disorders of Communication, 26*, 175 - 199.

Parisi, D., & Pizzamiglio, L. (1970). Syntactic comprehension in aphasia. *Cortex, 6*, 204 - 215.

Penn, C., & Behrmann, M. (1986). Towards a classification scheme for aphasic syntax. *British Journal of Disorders of Communication, 21*, 21 - 38.

Pick, A. (1913). *Die agrammatischen sprachstorungen*. (Vol. 1). Berlin: Springer.

Pick, A. (1931). *Aphasia* (J. W. Brown, Trans.). Springfield: Charles Thomas.

Pinker, S. (1989). Learnability and cognition: The acquisition of argument structure. Cambridge: MIT Press.

Saffran, E. M. (1982). Neuropsychological approaches to the study of language. *British Journal of Psychology, 73*, 317 - 337.

Saffran, E. M., Berndt, R. S., & Schwartz, M. F. (1989). The quantitative analysis of agrammatic production; Procedure and data. *Brain and Language, 37*, 440 - 479.

Saffran, E. and Schwartz, M. F. (1989). Agrammatic comprehension it's not: alternatives and implications. *Aphasiology*, 2, 389 - 394.

Saffran, E. M., Schwartz, M. F., & Marin, O. S. M. (1980a). The word order problem in agrammatism II: Production. *Brain and Language, 10*, 263 - 280.

Saffran, E. M., Schwartz, M. F., & Marin, O. S. (1980b). Evidence from aphasia: Isolating the components of a production model. In B. Butterworth (Ed.), *Language Production* . London: Academic Press.

Schmauder, A. R. (1991). Argument structure frames: A lexical complexity metric? *Journal of Experimental Psychology: Learning, Memory and Cognition, 17*, 49 - 65.

Schwartz, M. F. (1987). Patterns of speech production deficit within and across aphasia syndromes: Application of a psycholinguistic model. In M. Coltheart, G. Sartori, & R. Job (Eds.), *The Cognitive Neuropsychology of Language* . London: Lawrence Erlbaum Associates.

Schwartz, M. F., Fink, F. B., & Saffran, E. M. (1995). The modular treatment of agrammatism. *Neuropsychological Rehabilitation, 5*, 93 - 127.

Schwartz, M. F., Linebarger, M. C., Saffran, E. M., & Pate, D. S. (1987). Syntactic transparency and sentence interpretation in aphasia. *Language and Cognitive Processes, 2*, 85 - 113.

Schwartz, M. F., Linebarger, M. L., & Saffran, E. M. (1985). The status of the syntactic theory of agrammatism. In M. L. Kean (Ed.), *Agrammatism.* . New York: Academic Press.

Schwartz, M. F., Saffran, E. M., Fink, R. B., Myers, J. L., & Martin, N. (1994). Mapping therapy: A treatment programme for agrammatism. *Aphasiology, 8*, 19 - 54.

Schwartz, M. F., Saffran, E. M., & Marin, O. S. M. (1980). The word order problem in agrammatism: I. Comprehension. *Brain and Language, 10*, 249 - 262.

Shapiro, L., Zurif, E., & Grimshaw, J. (1987). Sentence processing and the mental representation of verbs. *Cognition, 27*, 219-246.

Shapiro, L. P., Brookins, B., Gordon, B., & Nagel, H. N. (1991). Verb effects during sentence processing. *Journal of Experimental Psychology: Learning, Memory and Cognition., 27*, 219 - 246.

Shapiro, L. P., Gordon, B., Hack, N., & Killackey, J. (1993). Verb-argument structure processing in complex sentences in Broca's and Wernicke's aphasia. *Brain and Language, 45*, 423 - 447.

Shapiro, L. P., & Levine, B. A. (1990). Verb processing during sentence comprehension in aphasia. *Brain and Language, 38*, 21 - 47.

Shapiro, L. P., McNamara, P., Zurif, E., Lanzoni, S., & Cermak, L. (1992). Processing complexity and sentence memory: Evidence from amnesia. *Brain and Language, 42*, 431 - 453.

Shapiro, L. P., Zurif, E. B., & Grimshaw, J. (1989). Verb processing during sentence comprehension: Context impenetrability. *Journal of Psycholinguistic Research, 18*, 223 - 243.

Shewan, C. M., & Canter, G. J. (1971). Effects of vocabulary, syntax and sentence length on auditory comprehension of aphasic patients. *Cortex, 7*, 209 - 226.

Stemberger, J. P. (1985). Bound morpheme loss errors in normal and agrammatic speech: One mechanism or two? *Brain and Language, 25*, 246 - 256.

Swinburn, K., Baker, G. & Howard, D. (1997). The Comprehensive Aphasia Test. Unpublished.

Thompson, C., Shapiro, L., Li, L., & Schendel, L. (1995). Analysis of verbs and verb-argument structure: A method for quantification of aphasic language production. *Clinical Aphasiology, 23*, 121 - 140.

Thompson, C. K., Lange, K. L., Schneider, S. L., & Shapiro, L. P. (1997). Agrammatic and non-brain damaged subjects' verb and verb argument structure production. *Aphasiology, 11*, 473 - 490.

Tissot, R. J., Mounin, G., & Lhermitte, F. (1973). *L'agrammatisme*. Brussels: Dessart.

Wells, G. (1985). *Language in the Pre-school Years*. Cambridge: Cambridge University Press.

Whitworth, A. (1994). *Thematic role assignment in word retrieval deficits in aphasia.* Unpublished PhD Thesis, Newcastle-upon-Tyne.

Whitworth, A. (1995a). Characterising thematic role assignment in aphasic sentence production: Procedures for elicited and spontaneous output. *European Journal of Disorders of Communication, 30*, 384 - 399.

Whitworth, A. (1995b). *Thematic Roles in Production (TRIP): An Assessment of Word Retrieval at the Sentence Level*. London: Whurr Publishers.

Williams, E. (1981). Argument structure and morphology. *The Linguistic Review, 1*, 81 - 114.

Williams, S. E., & Canter, G. J. (1987). Action naming performance in four syndromes of aphasia. *Brain and Language, 32*, 124-136.

Wulfeck, B. B. (1988). Grammaticality judgments and sentence comprehension in agrammatic aphasia. *Journal of Speech and Hearing Research, 31*, 72 - 81.

Zingeser, L., & Berndt, R. S. (1990). Retrieval of nouns and verbs in agrammatism and anomia. *Brain and Language, 39*, 14 - 32.

Zurif, E. B., & Caramazza, A. (1976). Psycholinguistic structures in aphasia: Studies in syntax and semantics. In H. Whitaker & H. A. Whitaker (Eds.). *Studies in Neurolinguistics* . New York: Academic Press.

Zurif, E. B., Caramazza, A., & Myerson, R. (1972). Grammatical judgments of agrammatic aphasics. *Neuropsychologia, 10*, 405 - 417.

Zurif, E. B., Green, E., Caramazza, A., & Goodenough, C. (1976). Grammatical intuitions of aphasic patients: Sensitivity to functors. *Cortex, 12*, 183 - 186.

Zurif, E. B., Swinney, D., Prather, P., Solomon, J., & Bushell, C. (1993). An on-line analysis of syntactic processing in Broca's and Wernicke's aphasia. *Brain and Language, 45*, 448 - 464.

# APPENDIX

## APPENDIX 1: Definitions of Thematic Roles

### Definitions from Wells (1985)

**Agent** - an animate being who causes a change of state in another participant or carries out a function

**Patient** - a physical object, animate or inanimate, an event or a mental or verbal representation of any of these which is in a particular state or changes state or location.

**Experiencer** - an animate being who experiences internal states or changes of state.

**Instrument** - a physical object, natural force, event or mental representation of any one of these, which serves as the immediate cause of a change of the state or location of another participant.

**Locative** - location of a patient in space either at rest or in movement, or the source or goal of a change of location.

**Possessor** - location of a patient when the location is an animate being with ownership or temporary control of the patient.

**Benefactive** - the animate being for whose benefit an object or event is intended.

**Temporal** - the location of a patient in time.

## APPENDIX 2: Summary of Mapping Therapy Studies

| Study | Byng and Coltheart (1986) | Byng et al (1994) | Byng et al (1994) | Byng et al (1994) | Haendiges et al (1996) |
|---|---|---|---|---|---|
| **Patient** | BRB | AER | EM | LC | EA |
| **Type of Patient** | Non fluent agrammatic | Agrammatic | Agrammatic | Agrammatic | Non fluent agrammatic |
| **Focus of Therapy** | Written locatives | Written rev/non-rev active agentive sentences | Written rev/non rev active agentive sentences | Written rev/non rev active agentive sentences | Auditory active /passive sentences SWPM |
| **Improved on Therapy Materials** | + | + | + | + | + |
| **Improvement in Comprehension: Actives** | + | + | - | - | + |
| **Passives** | + | - | + | - | + (not truncated) |
| **Locatives** | + | - | - | - | + |
| **Improvement in Production: Actives** | ns | ns | ns | ns | ns |
| **Passives** | ns | ns | ns | ns | ns |
| **Locatives** | ns | ns | ns | ns | ns |
| **Improvement in Verb Retrieval** | ns | treated V | treated V | treated and untreated | ns |
| **Improvement in Spontaneous Speech** | + | + | limited | limited | ns |
| **Generalisation Comp/Production** | + | + | some | some | ns |
| **Generalisation Across Modality** | + | + | - | - | some |
| **Generalisation Verb/Locatives** | + | ns | ns | ns | + |
| **Generalisation Different Verbs** | na | - | - | + | some |

**KEY: + improvement, - no improvement, ns not stated, na not applicable.**

| Study | Jones (1986) | Le Dorze et al (1991) | Marshall et al (1993) | Marshall (1994) (Marshall 1995) | Mitchum et al (1993) |
|---|---|---|---|---|---|
| **Patient** | BB | MG | MM | PB | EA |
| **Type of Patient** | Non fluent agrammatic | Non fluent agrammatic | Non fluent dyspraxic | Fluent | Non fluent |
| **Focus of Therapy** | Written intransitive, non rev/rev transitive sentences | Intransitive, transitive and prepositional sentences: pictorial representations | Identify participant roles - video stimuli | Written sentences 3 argument verbs | Written verb retrieval/production of sentence frame |
| **Improved on Therapy Materials** | + | + | + | + | + |
| **Improvement in Comprehension: Actives** | + | ns | some | only 3 argument | ns |
| **Passives** | + | ns | ns | ns | ns |
| **Locatives** | + | ns | ns | ns | ns |
| **Improvement in Production: Actives** | ns | + | improved production of PAS | only 3 argument | + |
| **Passives** | ns | ns | ns | ns | ns |
| **Locatives** | ns | ns | ns | ns | ns |
| **Improvement in Verb Retrieval** | some | ns | treated and untreated | ns | only treated |
| **Improvement in Spontaneous Speech** | + | some | - | improved 3 argument structures | some (increased gain in written) |
| **Generalisation Comp/Production** | + | + | some | + | ns |
| **Generalisation Across Modality** | + | + | - | + | + |
| **Generalisation Verb/Locatives** | + | ns | na | ns | ns |
| **Generalisation Different Verbs** | ns | some | + | - | - |

**KEY: + improvement, - no improvement, ns not stated, na not applicable.**

| Study | Mitchum et al (1995) | Whitworth (1994) | Whitworth (1994) |
|---|---|---|---|
| **Patient** | ML | EW | PH |
| **Type of Patient** | Fluent | Fluent | ? Fluent |
| **Focus of Therapy** | Auditory active/passive rev sentences | Auditory and written sentences - hierarchy of difficulty | Auditory and written sentences - hierarchy of difficulty |
| **Improved on Therapy Materials** | + | + | + |
| **Improvement in Comprehension: Actives** | + | + (improved in auditory, trend in written) | + (improved written, trend for auditory) |
| **Passives** | + aud:full and truncated, written - full | ns | ns |
| **Locatives** | ns | - | - |
| **Improvement in Production: Actives** | - | ns | ns |
| **Passives** | ns | ns | ns |
| **Locatives** | ns | ns | ns |
| **Improvement in Verb Retrieval** | na | - | + |
| **Improvement in Spontaneous Speech** | - | + | + |
| **Generalisation Comp/Production** | - | + | + |
| **Generalisation Across Modality** | + | na | na |
| **Generalisation Verb/Locatives** | na | - | - |
| **Generalisation Different Verbs** | + | + | + |

**KEY: + improvement, - no improvement, ns not stated, na not applicable.**

# APPENDIX 3: Details of Individual Subjects in the Aphasic Group

| Subject | Sex | Date of Birth | Age | Time Post-Onset |
|---|---|---|---|---|
| **AL** | M | 28.12.31 | 66 | 10 mths |
| **AM** | F | 21.10.45 | 51 | 10 mths |
| **BG** | M | 26.6.32 | 65 | 18 mths |
| **BM** | M | 30.5.30 | 67 | 4 yrs |
| **CG** | F | 14.7.50 | 47 | 2 yrs |
| **DM** | M | 2.7.26 | 72 | 2 yrs |
| **GW** | M | 29.1.57 | 40 | 8 yrs |
| **HW** | F | 18.2.46 | 52 | 6 yrs |
| **IB** | F | 26.6.48 | 49 | 8 yrs |
| **JM** | F | 29.7.36 | 61 | 18 mths |
| **JS** | F | 2.2.34 | 64 | 6 yrs |
| **KD** | M | 22.10.49 | 48 | 6 mths |
| **MK** | F | 26.1.31 | 67 | 2 yrs |
| **ML** | F | 16.6.31 | 66 | 18 mths |
| **NB** | F | 20.3.18 | 80 | 3 yrs |
| **PW** | F | 9.7.26 | 72 | 12 mths |
| **RN** | M | 9.4.29 | 69 | 2 yrs |
| **RS** | M | 7.3.37 | 61 | 9 yrs |
| **SS** | F | 12.1.26 | 72 | 18 mths |
| **TF** | M | 20.5.49 | 49 | 2 yrs |
| **TJ** | M | 14.6.41 | 56 | 2 yrs |
| **VC** | F | 4.12.16 | 61 | 6 yrs |

# APPENDIX 4: Results of Comprehensive Aphasia Test (Swinburn,Baker and Howard 1997)

| CAT Subtest | n | AL | AM | BG | BM | CG | DM | GW | IB | JM | JS | KD | HW | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COMPREHENSION** | | | | | | | | | | | | | | | | | | | | | | | |
| Auditory Single Word | 30 | 30 | 27 | 28 | 25 | 30 | 20 | 28 | 27 | 30 | 26 | 30 | 22 | 30 | 26 | 30 | 17 | 30 | 30 | 30 | 30 | 30 | 30 |
| Written Single Word | 30 | 28 | 23 | 30 | 20 | 30 | 29 | 29 | 30 | 30 | 28 | 30 | 5 | 30 | 26 | 30 | 10 | 30 | 30 | 30 | 30 | 28 | 28 |
| Auditory Sentence | 32 | 29 | 19 | 30 | 19 | 29 | 11 | 26 | 16 | 28 | 14 | 27 | 16 | 31 | 21 | 29 | 16 | 25 | 29 | 16 | 27 | 22 | 19 |
| Written Sentence | 32 | 23 | 16 | 22 | 10 | 26 | 15 | 29 | 17 | 25 | 20 | 19 | 0 | 22 | 0 | 29 | 11 | 26 | 32 | 17 | 25 | 26 | 15 |
| Auditory Paragraphs | 4 | 3 | 2 | 4 | 1 | 4 | 0 | 4 | 4 | 3 | 0 | 3 | 4 | 3 | 4 | 2 | 0 | 4 | 4 | 4 | 3 | 4 | 0 |
| **REPETITION** | | | | | | | | | | | | | | | | | | | | | | | |
| Single Word | 32 | 31 | 12 | 24 | 30 | 32 | 12 | 30 | 22 | 31 | 32 | 32 | 32 | 32 | 32 | 29 | 17 | 32 | 32 | 32 | 29 | 30 | 3 |
| Non-Word | 10 | 4 | 2 | 6 | 10 | 6 | 0 | 6 | 6 | 6 | 0 | 2 | 10 | 6 | 10 | 9 | 4 | 10 | 10 | 0 | 8 | 6 | 0 |
| Complex Word | 6 | 6 | 3 | 3 | 6 | 6 | 3 | 6 | 0 | 1 | 6 | 6 | 6 | 5 | 6 | 6 | 0 | 6 | 6 | 6 | 5 | 4 | 0 |
| Digit Span | | 4 | 2 | 4 | 5 | 5 | 5 | 7 | 4 | 4 | 3 | 5 | 4 | 4 | 7 | 6 | 2 | 3 | 7 | 7 | 7 | 5 | 3 |
| Sentences (content words) | | 4 | 3 | 3 | 5 | 5 | 3 | 6 | 3 | 4 | 3 | 5 | 4 | 6 | 6 | 6 | 0 | 4 | 6 | 6 | 6 | 3 | 2 |
| **NAMING** | | | | | | | | | | | | | | | | | | | | | | | |
| Nouns | 48 | 43 | 25 | 35 | 34 | 48 | 39 | 46 | 27 | 37 | 48 | 34 | 28 | 44 | 26 | 45 | 13 | 47 | 48 | 37 | 43 | 35 | 22 |
| Verbs | 10 | 10 | 8 | 2 | 3 | 10 | 4 | 7 | 2 | 7 | 8 | 8 | 0 | 10 | 8 | 10 | 2 | 7 | 8 | 4 | 8 | 4 | 4 |
| **READING** | | | | | | | | | | | | | | | | | | | | | | | |
| Single Word | 48 | 42 | 36 | 46 | 33 | 46 | 44 | 46 | 19 | 40 | 48 | 42 | 0 | 40 | 12 | 45 | 35 | 48 | 43 | 35 | 44 | 45 | 22 |
| Non-Word | 10 | 0 | 3 | 10 | 0 | 6 | 2 | 0 | 0 | 2 | 8 | 0 | 0 | 2 | 0 | 10 | 6 | 10 | 4 | 0 | 0 | 6 | 0 |
| Complex Word | 6 | 6 | 4 | 4 | 0 | 4 | 0 | 6 | 0 | 0 | 6 | 5 | 0 | 0 | 0 | 5 | 0 | 6 | 6 | 0 | 3 | 2 | 0 |
| Function Word | 6 | 6 | 6 | 4 | 4 | 6 | 3 | 6 | 2 | 6 | 5 | 6 | 0 | 6 | 2 | 6 | 6 | 6 | 6 | 2 | 6 | 4 | 2 |
| **WRITING** | | | | | | | | | | | | | | | | | | | | | | | |
| Copying | 27 | 27 | 5 | 27 | 26 | 27 | 27 | 27 | 26 | 26 | 27 | 27 | 0 | 27 | 27 | 27 | 17 | 27 | 27 | 26 | 27 | 27 | 27 |
| Written Naming | 21 | 16 | 9 | 20 | 12 | 18 | 15 | 20 | 5 | 13 | 21 | 13 | 0 | 20 | 13 | 21 | 0 | 21 | 19 | 14 | 19 | 20 | 20 |
| Words to Dictation | 28 | 26 | 21 | 16 | 10 | 21 | 18 | 26 | 6 | 24 | 25 | 15 | 0 | 21 | 21 | 27 | 0 | 28 | 25 | 11 | 24 | 27 | 18 |

| | n | AL | AM | BG | BM | CG | DM | GW | IB | JM | JS | KD | HW | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COGNITION** | | | | | | | | | | | | | | | | | | | | | | | |
| Line Bissection | | 0 | -0.5 | 0 | 1 | -0.5 | 0 | 0 | -1.5 | 0 | -2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0.5 |
| Coloured RM | 12 | 11 | 5 | 12 | 10 | 12 | 11 | 11.2 | 12 | 11.7 | 8 | 10.2 | 8 | 11 | 6 | 12 | 8 | 12 | 12 | 11 | 11 | 12 | 8 |
| Pyramids and Palmtrees | 10 | 9 | 8 | 10 | 9 | 10 | 9 | 10 | 10 | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 9 | 10 | 10 | 8 | 10 | 10 | 9 |
| Verbal Fluency:- | | | | | | | | | | | | | | | | | | | | | | | |
| Animals | | 22 | 8 | 8 | 4 | 9 | 10 | 14 | 7 | 19 | 11 | 6 | 8 | 11 | 9 | 7 | 3 | 7 | 11 | 4 | 12 | 2 | 4 |
| /s/ | | 2 | 4 | 0 | 0 | 5 | 3 | 4 | 2 | 6 | 6 | 2 | 0 | 4 | 5 | 8 | 0 | 2 | 3 | 2 | 2 | 2 | 1 |
| Recognition Memory | 10 | 10 | 8 | 10 | 10 | 10 | 8 | 10 | 10 | 10 | 9 | 10 | 9 | 10 | 10 | 10 | 7 | 10 | 9 | 8 | 10 | 10 | 9 |
| Ideomotor Apraxia | 12 | 12 | 9 | 9 | 4 | 12 | 8 | 12 | 12 | 12 | 12 | 12 | 8 | 12 | 12 | 12 | 10 | 12 | 12 | 8 | 11 | 12 | 12 |
| Visual Agnosia | 10 | 10 | 10 | 9 | 8 | 10 | 10 | 10 | 7 | 10 | 8 | 10 | 7 | 10 | 9 | 10 | 9 | 10 | 9 | 8 | 10 | | 8 |
| Arithmetic | 6 | 2 | 2 | 6 | 3 | 6 | 6 | 6 | 4 | 6 | 6 | 3 | 0 | 5 | 5 | 3 | 4 | 6 | 6 | 5 | 5 | 6 | 4 |

# APPENDIX 5: Methodology for Narrative Analysis

## A) Obtaining the Sample

Saffran et al (1989) provide guidelines for the elicitation and transcription of a narrative sample, for the extraction of narrative words and for the segmentation of narrative words into utterances. These guidelines were followed with the following amendments:-

i) Samples were obtained only using the story of Cinderella, to ensure the consistency of the obtained narrative.

ii) The whole sample produced by the subject was used as the basis for the analysis (not just the first 150 words).

iii) Utterances like "when she arrived at the ball she danced with the prince", which are coded as a single utterance in the Saffran et al. analysis, were divided into the two component sentences and the presence of the discourse marker coded.

iv) With examples of direct speech, for example, 'she said I want to go to the ball', which are excluded from the Saffran et al. analysis, only the discourse marker 'she said' was eliminated. The utterance itself was retained in the narrative analysis. This was done as there are not many very stereotypical phrases in the Cinderella story which would distort the sample and the discourse is a rich source of verb tense changes.

## B) The Analysis

The analysis was divided into four distinct components:-

1) General Information

2) Thematic Structure

3) Phrasal Structure

4) Morphological Structure

The thematic, phrasal and morphological structure of each utterance were coded individually and then averaged across the narrative sample.

## 1) General Information

### *a) Rate of Speech*

Rate (words per minute) = Total number of words in sample

Time taken in minutes.

The criteria for word counts was as Saffran et al (1989), for example, lexical compounds scored as one word, contractions scored as two words.

### *b) Percentage Narrative*

Percentage Narrative = % of Number of words in the extracted narrative

Total number of words in the sample.

The percentage narrative was used as a measure of the amount of repair, repetition and the production of unrelated material in the sample.

### *c) Percentage Complex Sentences*

Percentage Complex Sentences = % of Number of complex sentences

Total number of utterances

Complex sentences were considered to include the production of subordinate sentences, the production of co-ordinate sentences and the production of sentences containing postmodifying clauses. The percentage of complex sentences was used as a measure of the overall complexity of the sample obtained.

### *d) Percentage Discourse Markers*

Percentage Discourse Markers = % of Number of utterances with discourse markers

Total number of utterances

Utterances with discourse markers were considered to be those introduced by words such as then, when, after etc. which were not used habitually. The percentage discourse markers was used as a measure of the overall cohesion of the sample produced.

## 2) Thematic Structure

Each utterance was analysed for its thematic structure. The analysis of thematic structure was based on The Thematic Role Analysis of Spontaneous Output designed by Whitworth (1995a). Co-ordinate sentences were coded as two individual

utterances; if phrasal components of the second sentence were missing due to ellipsis, the recovered thematic structure was coded.

***a) Undetermined Thematic Structure (UTS)***

Utterances were coded as having an undetermined thematic structure if:-

- They contained no verb
- They contained a verb but in an argument structure that could not be determined
- They consisted of a single verb phrase

The utterances were labelled as single, dual and triple, depending on the number of phrasal components, (one, two, and three respectively). The constituent phrases were coded in terms of their type but not the order in which they occurred.

***b) Argument Structures***

The structures, with a determinable argument structure, were divided into one, two and three argument structures depending on the number of phrasal components used in association with the verb. The number of phrases used was taken as an indicator of the complexity of the utterance. The phrasal components were analysed in terms of the thematic role being undertaken by that component. Definitions of the common thematic roles can be found in appendix 1.

Sentences were coded at this level for their underlying form, as in Thompson et al (1995). For example, questions and commands were coded as their corresponding declarative sentence, passives were coded as their corresponding active sentence. This was done with a view to capturing the underlying representation of the sentence, which then may undergo transformation to a different surface form. The one, two and three argument structures were then sub-divided into non-argument utterances, optional argument structure utterances and obligatory argument structure utterances. Definitions of the argument structure classifications can be found below.

***Non-Argument***

Utterances were coded under the non-argument column if the utterance included a non argument. Non-arguments are defined 'not arguments of predicates; they place

restrictions or qualifications on the predicate and its arguments, or give additional information about the participants in the situation and the speaker's perspective on it' Byng and Black (1989). Non-arguments were identified by two main criteria:-

- Optional components
- Mobility within the utterance

***Obligatory Argument Structure***

Utterances were coded under the obligatory column if the number of arguments used (i.e. one, two or three respectively) was the compulsory number of arguments required by the verb.

***Optional Argument Structure***

Utterances were coded under the optional column if the verb can be involved in utterances with varying numbers of arguments (i.e. can be in utterances with both one and two arguments). The optional nature of arguments in the particular context of the utterance coded was not considered. Possible verb sub-classifications were taken from the CELEX lexical database (Center for Lexical Information 1993).

***c) Thematic Embedding***

This category was used for 'those utterances where thematic roles are embedded in more complex syntactic and thematic structures' (p390 Whitworth 1995a). In these cases due to the complex nature of the sentences, it was often difficult to identify the thematic roles which individual participants were fulfilling. This category encompassed mostly subordinate sentences. This category was not used for sentences like 'she decided that she was going to the ball'. In this case, the thematic roles can be identified, it is just that one of the thematic roles is being realised by a clausal component.

***d) Omission of Obligatory Arguments***

The omission of obligatory arguments was coded. Obligatory arguments were defined as 'an argument that must be realised syntactically if the sentence is to be grammatical' (Byng and Black 1989). The context in which the utterance occurred was taken into consideration, when evaluating whether an argument was an obligatory part of the sentence. Utterances were coded in the above section, as if the complete argument structure was realised, and then the omission of the argument coded. Omitted

arguments were coded for the thematic role the argument should have fulfilled and whether it was an internal or external argument of the verb. Utterances with an omitted argument were not included in the calculation of overall thematic complexity or in the analysis of the interaction of thematic/phrasal complexity.

### *Summary of Thematic Structure*

The following measures were used in order to summarise the subjects' performance:-

**a) Percentage distribution of thematic structure**

% Undetermined thematic structure

% 1 argument structures

% 2 arguments structures

% 3 argument structures

% Thematic embedding

This was used as a measure of the ability to produce the functional level of representation for a wide range of sentences.

**b) Mean thematic complexity score**

This was computed using a weighted system to give extra weight to the more complex utterances. UTS, 1, 2, 3, and TE utterances were given a value of 1 to 5 respectively and a total complexity score thus obtained.

$$\text{Mean thematic complexity} = \frac{\text{Total complexity score}}{\text{Total number of utterances}}$$

This was again used as a measure of the ability to produce the functional level of representation and as a measure of the complexity of the sentences used.

**c) Percentage argument omission**

Percentage Argument Omission =

$$\%\text{ of } \frac{\text{Number of 2 and 3 argument structures with omitted arguments}}{\text{Total number of 2 and 3 argument strutcures}}$$

This was used as a measure of the ability to create/retrieve and realise a complete predicate argument structure at the functional level of representation.

## 3. Phrasal Structure

### *a) Phrasal Complexity*

The phrasal structure of four types of phrases were investigated, noun phrases(NP), verb phrases (VP), adjectival phrases (AP) and prepositional phrases (PP).

Each phrase was broken down into its constituent parts. The categories were based on the LARSP analysis (Crystal, Fletcher and Garman 1989) and were grouped into those involving one, two or three phrasal components. An additional 'complex' category was added to code the use of post-modifying phrases and clauses, the use of co-ordinated phrases and the use of phrases with four or more components. The internal structure of postmodifying phrases/clauses and co-ordinate phrases was not analysed.

### *b) Phrasal Errors*

Errors involving the use of prepositions, determiners, pronoun, auxiliaries and the main verb were coded. As with the identification of argument omissions, the surrounding context was used to identify phrasal errors, particularly those involving pronouns and auxiliaries. The phrasal errors were divided into two main types:- omissions and inappropriate (generally substitutions, but sometimes additions). When nouns occurred in isolation in UTS, the lack of a determiner was not considered to be an error due to difficulties in identifying the target utterance. In utterances with an identifiable argument structure, phrasal errors were much more readily identifiable. Phrases involving the omission of items were coded as if the item was present, and then the omission noted in the error section. Phrases with an omitted component were not included in the calculation of overall phrasal complexity or in the analysis of the interaction of thematic/phrasal complexity.

(NB: The omission of the main verb was used to code utterances where an auxiliary was present but no main verb. Utterances with no verb at all were coded as UTS).

### *Summary of Phrasal Structure*

The following measures were used in order to summarise the subjects' performance:-

### a) Percentage distribution of phrasal structure

The distribution was calculated separately for noun phrases, verb phrases, adjectival phrases and prepositional phrases.

% phrases with a single component

% phrases with two components

% phrases with three components

% complex phrases

This was used as a measure of the ability to produce the positional level of representation, in particular create the syntactic frame and produce the function words, for the four maximal phrase categories.

**b) Mean phrasal complexity score**

This was computed using a weighted system to give extra weight to the more complex phrases. Phrases with 1, 2 and 3 components were given a value of 1 to 3 respectively, complex phrases were given a value of 4. A total complexity score was thus obtained and the mean complexity score was then calculated for noun phrases, verb phrases, adjectival phrases and prepositional phrases.

$$\text{Mean phrasal complexity} = \frac{\text{Total complexity score}}{\text{Total number of phrases}}$$

This was again used a measure of the ability to produce the positional level of representation for noun phrases, verb phrases, adjectival phrases and prepositional phrases. It was also used as a measure of the complexity of the phrases produced.

**c) Percentage phrasal error**

This was calculated for the use of determiners, pronouns, prepositions, auxiliaries, main noun and main verb. Omission and inappropriate errors were combined.

$$\text{Percentage phrasal error} = \% \text{ of } \frac{\text{Number of errors}}{\text{Number of times correctly used}}$$

## 4. Morphological Structure

### *a) Range of Morphology Used*

The morphology present within noun and verb phrases was coded.

***Noun Phrase Morphology*** - Regular plurals, irregular plurals, and possessive 's'.

***Verb Phrase Morphology*** - Regular past tense, irregular past tense, progressive '-ing', perfect '-en' and the third person singular 's'. Verb phrase morphology was only coded for the main verb of the sentence; the morphology of the auxiliary verbs was not coded.

***b) Morphological Errors***

As with the other error categories, the immediate context of the utterance was used to identify morphological errors. The morphological errors were divided into two main types:- omissions and inappropriate (generally substitutions, but sometimes additions).

***Summary of Morphological Structure***

The following measures were used to summarise the subjects' performance:-

**a) Frequency of use of each morpheme**

This was the number of times the morphme was used correctly in the narrative sample.

**b) Percentage morphological error**

This was calculated for each of the morphemes. Omission and inappropriate errors were combined.

$$\text{Percentage morphological error} = \% \text{ of } \frac{\text{Number of errors}}{\text{Number of times correctly used}}$$

# APPENDIX 6: Upper and Lower Limits of Normal Performance

| | Mean of Normal Group | Normal Lower Limit (2 s.d.) | Normal Upper Limit (2 s.d.) |
|---|---|---|---|
| **GENERAL INFORMATION** | | | |
| **Rate of Speech** | 137.02 | 71.34 | 202.71 |
| **Percentage Narrative** | 88.38 | 77.30 | 99.46 |
| **Percentage Complex Sentences** | 33.40 | 4.23 | 62.58 |
| **Percentage Discourse Markers** | 21.40 | 1.81 | 41.00 |
| **THEMATIC STRUCTURE** | | | |
| **Mean Thematic Complexity** | 3.15 | 2.74 | 3.56 |
| **Percentage Distribution** | | | |
| 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 |
| Percentage Argument Omission | 0.15 | NA | 1.09 |
| **PHRASAL STRUCTURE** | | | |
| **Mean NP Complexity** | 1.83 | 1.51 | 2.15 |
| **Percentage Distribution NP** | | | |
| 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 |
| **Mean VP Complexity** | 1.37 | 1.19 | 1.55 |
| **Percentage Distribution VP** | | | |
| 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 |
| **Mean AP Complexity** | 2.07 | 1.15 | 2.99 |
| **Percentage Distribution AP** | | | |
| 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 |
| **Mean PP Complexity** | 2.95 | 2.53 | 3.37 |
| **Percentage Distribution PP** | | | |
| 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)

| | Mean of Normal Group | Normal Lower Limit (2 s.d.) | Normal Upper Limit (2 s.d.) |
|---|---|---|---|
| **Percentage Phrasal Errors** | | | |
| a) Percentage Main Verb Error | 0.00 | NA | 0.00 |
| b) Percentage Main Noun Error | 0.03 | NA | 0.30 |
| c) Percentage Determiner Error | 0.00 | NA | 0.00 |
| d) Percentage Pronoun Error | 0.42 | NA | 4.14 |
| e) Percentage Preposition Error | 0.12 | NA | 1.18 |
| f) Percentage Auxiliary Error | 0.00 | NA | 0.00 |
| **MORPHOLOGICAL STRUCTURE** | | | |
| **Percentage Morphological Errors** | | | |
| a) Percentage Regular Plural Error | 0.00 | NA | 0.00 |
| b) Percentage Irregular Plural Error | 0.00 | NA | 0.00 |
| c) Percentage Possessive 's' Error | 0.00 | NA | 0.00 |
| d) Percentage Regular Past Error | 0.00 | NA | 0.00 |
| e) Percentage Irregular Past Error | 0.19 | NA | 1.91 |
| f) Percentage Progressive 'ing' Error | 0.63 | NA | 6.21 |
| g) Percentage Perfect 'en' Error | 0.00 | NA | 0.00 |
| h) Percentage 3rd Person 's' Error | 0.00 | NA | 0.00 |

NA = Not Applicable (value less than zero)

# PAGE NUMBERING AS ORIGINAL

# APPENDIX 7: Results of Individual Aphasic Subjects on Narrative Task

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GENERAL INFORMATION** | | | | | | | | | | | |
| **Rate of Speech (wpm)** | 44.60* | 40.28* | 27.14* | 35.37* | 19.39* | 37.06* | 17.90* | 68.00* | 21.09* | 56.56* | 136.73 |
| **Percentage Narrative** | 78.79 | 80.00 | 59.87* | 35.60* | 67.79* | 51.59* | 57.30* | 59.41* | 47.71* | 81.22 | 64.23* |
| **Percentage Complex Sentences** | 2.94* | 4.55 | 3.57* | 18.18 | 5.00 | 0.00* | 14.71 | 4.35 | 0.00* | 12.50 | 20.55 |
| **Percentage Discourse Markers** | 17.65 | 18.18 | 7.14 | 13.64 | 0.00* | 0.28* | 0.00* | 4.35 | 0.00* | 0.00* | 9.59 |

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GENERAL INFORMATION** | | | | | | | | | | | |
| **Rate of Speech** | 29.20* | 23.13* | 115.44 | 71.75 | 88.97 | 74.38 | 50.48* | 60.98* | 52.00* | 20.46* | 113.85 |
| **Percentage Narrative** | 70.73* | 90.09 | 66.24* | 74.82* | 47.84* | 52.66* | 74.53* | 56.99* | 86.54 | 39.47* | 24.66* |
| **Percentage Complex Sentences** | 5.13 | 11.76 | 18.29 | 6.67 | 3.85* | 6.06 | 15.63 | 7.32 | 35.29 | 0.00* | 4.17* |
| **Percentage Discourse Markers** | 5.13 | 5.88 | 4.88 | 15.00 | 15.38 | 21.21 | 6.25 | 4.88 | 0.00* | 0.00* | 4.17 |

* = > 2 Standard Deviations from the Normal Mean

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **THEMATIC STRUCTURE** | | | | | | | | | | | |
| **Mean Thematic Complexity** | 2.08* | 2.73* | 1.86* | 1.91* | 2.30* | 1.53* | 2.47* | 2.17* | 1.17* | 2.56* | 2.89 |
| **Percentage Distribution** | | | | | | | | | | | |
| a) Percentage Undetermined Thematic Structure | 41.18* | 18.18* | 53.57* | 50.00* | 30.00* | 63.16* | 2.35 | 39.13* | 91.43* | 12.50* | 13.70 |
| b) Percentage 1 Argument | 8.82 | 13.64 | 7.14 | 9.09 | 10.00 | 21.05 | 14.71 | 8.70 | 0.00 | 21.88 | 10.96 |
| c) Percentage 2 Argument | 50.00 | 45.45 | 39.28* | 40.91* | 60.00 | 15.79* | 52.94 | 47.83 | 8.57* | 62.50 | 52.5 |
| d) Percentage 3 Argument | 0.00* | 22.73 | 0.00* | 0.00* | 0.00* | 0.00* | 8.82 | 4.35* | 0.00* | 3.13* | 19.18 |
| e) Percentage Thematic Embedding | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.11 |
| Percentage Argument Omission | 11.76* | 13.33* | 36.36* | 22.22* | 0.00 | 0.00 | 14.29* | 8.33* | 66.67* | 0.00 | 5.77* |

* = > 2 Standard Deviations from the Normal Mean

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **THEMATIC STRUCTURE** | | | | | | | | | | | |
| **Mean Thematic Complexity** | 2.00* | 2.82 | 3.18 | 2.32* | 2.50* | 2.79 | 2.88 | 1.90* | 2.94 | 1.17* | 1.17* |
| **Percentage Distribution** | | | | | | | | | | | |
| a) Percentage Undetermined Thematic Structure | 46.15* | 11.76 | 0.00 | 11.67* | 30.77* | 18.18 | 9.38 | 9.76* | 11.76 | 91.30* | 91.67* |
| b) Percentage 1 Argument | 10.26 | 5.88 | 8.54 | 16.67 | 11.51 | 6.06 | 9.38 | 7.32 | 11.76 | 0.00 | 0.00 |
| c) Percentage 2 Argument | 41.03* | 70.59 | 65.85 | 51.67 | 38.46* | 54.55 | 65.63 | 82.93* | 47.06 | 8.70* | 8.33* |
| d) Percentage 3 Argument | 0.03* | 11.76 | 24.39 | 18.33 | 15.38 | 21.21 | 15.63 | 0.00* | 29.41 | 0.00* | 0.00* |
| e) Percentage Thematic Embedding | 0.00 | 0.00 | 1.22 | 1.67 | 3.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Percentage Argument Omission | 0.00 | 7.14* | 1.35* | 4.76* | 7.14* | 0.00 | 0.00 | 2.94* | 7.69* | 0.00 | 0.00 |

* = > 2 Standard Deviations from the Normal Mean

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean NP Complexity** | 1.54 | 1.65 | 1.58 | 1.92 | 1.89 | 1.81 | 1.93 | 1.72 | 1.45* | 1.81 | 1.75 |
| **Percentage Distrbution NP** | | | | | | | | | | | |
| a) Percentage 1 Component NP | 56.76 | 51.61 | 61.29 | 44.00 | 39.29 | 47.62 | 37.78 | 55.17 | 65.96 | 51.06 | 63.64 |
| b) Percentage 2 Component NP | 35.14 | 38.71 | 25.81 | 36.00 | 35.71 | 38.10 | 42.22 | 31.03 | 27.66 | 29.79 | 13.64 |
| c) Percentage 3 Component NP | 5.41 | 3.22 | 6.45 | 4.00 | 21.43 | 0.00 | 8.89 | 0.00 | 2.13 | 6.38 | 7.27 |
| d) Percentage Complex NP | 2.70 | 6.45 | 6.45 | 16.00 | 3.57 | 14.29 | 11.11 | 13.79 | 4.26* | 12.77 | 15.45 |

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean NP Complexity** | 2.04 | 2.20 | 1.69 | 1.67 | 1.49* | 1.80 | 1.74 | 1.66 | 1.81 | 2.32 | 1.68 |
| **Percentage Distrbution NP** | | | | | | | | | | | |
| a) Percentage 1 Component NP | 39.58 | 32.00 | 64.84 | 59.14 | 71.79* | 48.98 | 59.52 | 62.71 | 61.54 | 15.79 | 45.16 |
| b) Percentage 2 Component NP | 31.25 | 32.00 | 15.63 | 23.66 | 17.95 | 30.61 | 14.29 | 18.64 | 11.54 | 57.89 | 48.39 |
| c) Percentage 3 Component NP | 14.58 | 20.00 | 5.47 | 7.53 | 0.00* | 12.24 | 19.04 | 8.47 | 11.54 | 5.26 | 0.00 |
| d) Percentage Complex NP | 14.58 | 16.00 | 14.06 | 9.68 | 10.26 | 8.16 | 7.14 | 10.17 | 15.38 | 21.05 | 6.45 |

* = > 2 Standard Deviations from the Normal Mean

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean VP Complexity** | 1.30 | 1.32 | 1.20 | 1.00* | 1.44 | 1.00* | 1.25 | 2.00 | 1.20 | 1.20 | 1.74 |
| **Percentage Distrbution VP** | | | | | | | | | | | |
| a) Percentage 1 Component VP | 78.26 | 73.68 | 85.00 | 100.00* | 62.50 | 100.00* | 78.57 | 33.33 | 93.33 | 80.00 | 51.39 |
| b) Percentage 2 Component VP | 17.39 | 21.05 | 10.00 | 0.00* | 31.25 | 0.00* | 17.86 | 40.00 | 0.00 | 20.00 | 30.56 |
| c) Percentage 3 Component VP | 0.00 | 5.26 | 5.00 | 0.00 | 6.25 | 0.00 | 3.57 | 20.00 | 0.00 | 0.00 | 11.11 |
| d) Percentage Complex VP | 4.35 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.67 | 6.67 | 0.00 | 6.94 |

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean VP Complexity** | 1.43 | 1.25 | 1.27 | 1.38 | 2.04 | 1.41 | 1.41 | 1.54 | 1.19 | 1.00* | 2.00 |
| **Percentage Distrbution VP** | | | | | | | | | | | |
| a) Percentage 1 Component VP | 57.14 | 81.25 | 78.57 | 67.27 | 25.00 | 70.37 | 62.07 | 54.05 | 81.25 | 100.00* | 33.33 |
| b) Percentage 2 Component VP | 42.86 | 12.5 | 16.67 | 27.27 | 54.17 | 18.52 | 24.48 | 40.54 | 18.75 | 0.00* | 33.33 |
| c) Percentage 3 Component VP | 0.00 | 6.25 | 3.57 | 5.45 | 12.50 | 11.11 | 3.45 | 2.70 | 0.00 | 0.00 | 33.33 |
| d) Percentage Complex VP | 0.00 | 0.00 | 1.19 | 0.00 | 8.33 | 0.00 | 0.00 | 2.70 | 0.00 | 0.00 | 0.00 |

* = > 2 Standard Deviations from the Normal Mean

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean AP Complexity** | 1.67 | 2.00 | 2.00 | 1.50 | 3.00* | 1.00* | 1.00* | 1.33 | 1.00* | 1.17 | 2.22 |
| **Percentage Distrbution AP** | | | | | | | | | | | |
| a) Percentage 1 Component AP | 66.67 | 0.00 | 50.00 | 50.00 | 0.00 | 100.00* | 100.00* | 66.67 | 100.00* | 83.33 | 33.33 |
| b) Percentage 2 Component AP | 0.00 | 100.00 | 0.00 | 50.00 | 0.00 | 0.00 | 0.00 | 33.33 | 0.00 | 16.67 | 33.33 |
| c) Percentage 3 Component AP | 33.33 | 0.00 | 50.00 | 0.00 | 100.00* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.11 |
| d) Percentage Complex AP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 22.22 |

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean AP Complexity** | 2.50 | 3.50* | 1.91 | 1.22 | 1.00* | 1.00* | 1.00* | 1.88 | NA | 1.33 | NA |
| **Percentage Distrbution AP** | | | | | | | | | | | |
| a) Percentage 1 Component AP | 50.00 | 0.00 | 59.09 | 77.78 | 100.00* | 100.00* | 100.00* | 25.00 | NA | 66.67 | NA |
| b) Percentage 2 Component AP | 0.00 | 0.00 | 13.64 | 22.22 | 0.00 | 0.00 | 0.00 | 62.50 | NA | 33.33 | NA |
| c) Percentage 3 Component AP | 0.00 | 50.00 | 4.55 | 000 | 0.00 | 0.00 | 0.00 | 12.50 | NA | 0.00 | NA |
| d) Percentage Complex AP | 50.00 | 50.00* | 22.73 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | NA | 0.00 | NA |

* = > 2 Standard Deviations from the Normal Mean
NA = Not Applicable (not present in sample)

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean PP Complexity** | 3.00 | 3.00 | 2.60 | 3.50 | 2.50* | 2.50* | 3.10 | 3.00 | 1.00* | 3.25 | 3.09 |
| **Percentage Distrbution PP** | | | | | | | | | | | |
| a) Percentage 1 Component PP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00* | 0.00 | 0.00 |
| b) Percentage 2 Component PP | 12.50 | 16.67 | 40.00 | 0.00 | 50.00* | 50.00* | 0.00 | 0.00 | 0.00 | 0.00 | 12.50 |
| c) Percentage 3 Component PP | 75.00 | 66.67 | 60.00 | 50.00 | 50.00 | 50.00 | 90.00 | 100.00 | 0.00* | 75.00 | 65.63 |
| d) Percentage Complex PP | 12.50 | 16.67 | 0.000 | 50.00 | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 | 25.00 | 21.86 |

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean PP Complexity** | 3.20 | 3.00 | 2.92 | 3.00 | 2.82 | 2.94 | 3.00 | 3.14 | 2.60 | 2.31* | 3.33 |
| **Percentage Distrbution PP** | | | | | | | | | | | |
| a) Percentage 1 Component PP | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.79* | 0.00 |
| b) Percentage 2 Component PP | 0.00 | 20.00 | 34.62 | 28.57 | 36.36 | 6.25 | 18.18 | 0.00 | 40.00 | 57.89* | 0.00 |
| c) Percentage 3 Component PP | 80.00 | 60.00 | 38.46 | 42.86 | 45.45 | 93.75 | 63.64 | 85.71 | 60.00 | 5.26* | 66.67 |
| d) Percentage Complex PP | 20.00 | 20.00 | 26.92 | 28.57 | 18.18 | 0.00 | 18.18 | 14.29 | 0.00 | 21.05 | 33.33 |

* = > 2 Standard Deviations from the Normal Mean

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Percentage Phrasal Errors** | | | | | | | | | | | |
| a) Percentage Main Verb Error | 4.55* | 0.00 | 0.00 | 0.00 | 0.00 | 22.22* | 3.57* | 0.00 | 0.00 | 0.00 | 7.04* |
| b) Percentage Main Noun Error | 7.14* | 4.17* | 33.33* | 11.76* | 0.00 | 5.88* | 0.00 | 5.88* | 0.00 | 0.00 | 1.92* |
| c) Percentage Determiner Error | 10.00* | 0.00 | 15.38* | 0.00 | 15.38* | 37.50* | 3.33* | 16.67* | 50.00* | 15.79* | 5.41* |
| d) Percentage Pronoun Error | 12.50* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.69* | 0.00 | 0.00 | 25.37* |
| e) Percentage Preposition Error | 0.00 | 0.00 | 0.00 | 50.00* | 0.00 | 50.00* | 0.00 | 0.00 | 0.00 | 33.33* | 10.34* |
| f) Percentage Auxiliary Error | 25.00* | 0.00 | 16.67* | NA | 16.67* | NA | 16.67* | 0.00 | NA | 0.00 | 16.67* |

* = > 2 Standard Deviations from the Normal Mean
NA = Not Applicable (not present in sample)

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Percentage Phrasal Errors** | | | | | | | | | | | |
| a) Percentage Main Verb Error | 7.14* | 6.25* | 0.00 | 0.00 | 18.18* | 3.70* | 0.00 | 2.78* | 0.00 | 0.00 | 33.33* |
| b) Percentage Main Noun Error | 8.57* | 9.52* | 1.96* | 10.00* | 50.00* | 10.81* | 0.00 | 0.00 | 0.00 | 0.00 | 4.17* |
| c) Percentage Determiner Error | 0.00 | 20.00* | 0.00 | 10.71* | 16.67* | 0.00 | 38.89* | 9.52* | 42.86* | 0.00 | 0.00 |
| d) Percentage Pronoun Error | 0.00 | 0.00 | 0.00 | 4.17* | 23.33* | 8.33* | 0.00 | 18.52* | 0.00 | 0.00 | 0.00 |
| e) Percentage Preposition Error | 0.00 | 25.00* | 4.76* | 15.38* | 11.11* | 13.33* | 11.11* | 0.00 | 0.00 | 0.00 | 0.00 |
| f) Percentage Auxiliary Error | 9.09* | 0.00 | 7.14* | 18.18* | 0.00 | 12.50* | 55.56* | 0.00 | 66.67* | NA | 0.00 |

* = > 2 Standard Deviations from the Normal Mean
NA = Not Applicable (not present in sample)

| | AL | AM | BG | BM | CG | DM | GW | HW | IB | JM | JS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Percentage Morphological Errors** | | | | | | | | | | | |
| a) Percentage Regular Plural Error | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | NA | 0.00 | 0.00 | 54.55* | 0.00 | 0.00 |
| b) Percentage Irregular Plural Error | 0.00 | NA | NA | 0.00 | 0.00 | NA | 0.00 | NA | NA | NA | 0.00 |
| c) Percentage Possessive 's' Error | NA | NA | NA | 0.00 | NA | NA | NA | NA | NA | NA | NA |
| d) Percentage Regular Past Error | 42.86* | 0.00 | 0.00 | 0.00 | NA | NA | 0.00 | NA | NA | 0.00 | 0.00 |
| e) Percentage Irregular Past Error | 0.00 | 0.00 | 0.00 | 0.00 | 33.33* | NA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| f) Percentage Progressive 'ing' Error | 0.00 | NA | 0.00 | 0.00 | 0.00 | NA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| g) Percentage Perfect 'en' Error | 0.00 | NA | NA | 0.00 | NA | NA | NA | NA | NA | 0.00 | 0.00 |
| h) Pecentage 3rd Person 's' Error | 100.00* | NA | NA | 0.00 | 0.00 | 100.00* | 0.00 | 0.00 | NA | 0.00 | 1.67* |

* = > 2 Standard Deviations from the Normal Mean
NA = Not Applicable (not present in sample)

| | KD | MK | ML | NB | PW | RN | RS | SS | TF | TJ | VC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Percentage Morphological Errors** | | | | | | | | | | | |
| a) Percentage Regular Plural Error | 18.18* | 25.00* | 0.00 | 0.00 | 50.00* | 33.33* | 0.00 | 0.00 | 0.00 | 0.00 | 50.00* |
| b) Percentage Irregular Plural Error | 0.00 | NA | 0.00 | 0.00 | NA | NA | 0.00 | 0.00 | NA | NA | NA |
| c) Percentage Possessive 's' Error | NA | NA | 0.00 | NA | NA | NA | NA | NA | NA | NA | NA |
| d) Percentage Regular Past Error | NA | 50.00* | 0.00 | 0.00 | NA | 0.00 | 0.00 | 0.00 | NA | NA | NA |
| e) Percentage Irregular Past Error | 12.50* | 28.87* | 0.00 | 6.67* | 16.67* | 0.00 | 0.00 | 0.00 | NA | 0.00 | 0.00 |
| f) Percentage Progressive 'ing' Error | 0.00 | 0.00 | 0.00 | 0.00 | 40.00* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| g) Percentage Perfect 'en' Error | 0.00 | NA | NA | NA | NA | 0.00 | NA | NA | NA | NA | NA |
| h) Pecentage 3rd Person 's' Error | 0.00 | NA | 2.94* | NA | 100.00* | 7.69* | NA | NA | 10.00* | 0.00 | NA |

* = > 2 Standard Deviations from the Normal Mean
NA = Not Applicable (not present in sample)

**APPENDIX 8: The Verb and Noun Test Manual**

**(Bird and Webster 1997)**

# Verb And Noun Test

by

**Helen Bird**

&

**Janet Webster**

# About the VAN test

The video comprises two parts: a test of verb retrieval and a test of noun retrieval. Each part lasts for 11 minutes. Verbs are presented before nouns, but it is not necessary that verbs are tested before nouns. It is advised however that both parts are completed in the same session.

The test is designed to identify specific verb retrieval deficits and noun retrieval deficits, independent of the effects of word frequency and length. It will also highlight deficits for low frequency words both within and across word class. Similarly effects of word length can be shown.

As this test uses video, all items are necessarily of high imageability, but nouns are by nature considered more imageable than verbs. Therefore imageability can be investigated only within word class.

Within the verb test a wide variety of verb types, divided into high and low frequency, are included. Verbs are classified by the type and number of their possible argument structures.

## Instructions

Before administering the test, the following instructions should be given.

For verbs: "You will see some actions. Watch each one until the screen goes blank. Then you will be asked what is happening. Tell me what is happening in one word."

For nouns: "You will see some objects. Watch each one until the screen goes blank. Then you will be asked what it is. Tell me what it is in one word."

Each clip is shown for 5 seconds, followed by a 3 second pause for the item to be named. It is very important that the whole clip is watched before naming takes place, as some of the verbs involve a whole scene to get across the required meaning (e.g. *surrender*). When the screen goes blank, the appropriate question should be asked.

For verbs: "Tell me what is happening in one word."
For nouns: "Tell me what it is in one word."

Some of the verb items have accompanying sound. Sound is used only when it is part of the meaning of the verb, and so most of the verbs (and all the nouns) are silent, but the volume control can be set at a moderate level and then left. Each part of the test is preceded by four practice items. These are included to ensure that the instructions have been understood, particularly watching the whole clip before responding, and giving a one word response. One practice item has sound (*cheer*), so that a level can be set. When you are happy that the instructions have been fully understood, the questions can be shortened to "What is happening?" and "What is it?" Should a multi-word response be given, such as *kneel down* or *colour, or crayon* use the prompt "Can you tell me in one word?"
Obviously the video can be paused at any time.

## Scoring

The final response is the response to be scored. If a multi-word response has been given, the answer following the prompt is the item scored. The score sheets include a column in which to transcribe responses and a column to record whether the item is correct or incorrect.

Criteria

1. Phonemic paraphasias scored as correct if recognisable as target.
2. Semantic paraphasias scored as incorrect.
3. Inflected forms are accepted as correct. For example *fly*, *flying*, *flew*, *flied* are all acceptable as they contain the target stem and are all verbs. *Flight* however is not acceptable, as it is a noun, even though it contains the target stem. Therefore in the case of the target 'marry', correct responses include *marry*, *marries*, *married*, *marrying*, but not *marriage*.

## Analysis

The right hand side of the score sheet gives a breakdown of word class, imageability, frequency and length. In order to analyse the effect of these word variables, put a mark for the correct responses in each corresponding box. Add up the number of items correct in each column and write the totals in the spaces provided. Place the verb classification score sheet alongside the original verb response sheet repeat the above procedure.

The totals can be transferred to the overall score sheet to give a complete profile of performance.

## Patient Information

Name: d.o.b:

Testing date: Tested by:

## Overall Scores

normal scores:

| | noun | verb |
|---|---|---|
| mean: | 51.33 | 49.50 |
| range: | 48 - 53 | 43 - 54 |

| NOUN/VERB | NOUN /54 | VERB /54 |
|---|---|---|

| LENGTH | LONG | SHORT |
|---|---|---|
| NOUN | /15 | /15 |
| VERB | /15 | /15 |
| NOUN + VERB | /30 | /30 |

| FREQUENCY | HIGH | LOW |
|---|---|---|
| NOUN | /20 | /20 |
| VERB | /20 | /20 |
| NOUN + VERB | /40 | /40 |

| IMAGEABILITY | HIGH | LOW |
|---|---|---|
| NOUN | /20 | /20 |
| IMAGEABILITY VERB | /20 | /20 |

| VERB | ARGUMENT | | | |
|---|---|---|---|---|
| 1 /7 | 2 /15 | 3 /12 | 4 /15 | 5 /15 |

## Other Information

## CLASSIFICATION OF VERBS

Verbs are classified in this test by the number and type of possible argument structures that they can take.
There are five major groups:-

**Group 1**

These are verbs with obligatory classifications, either transitive or intransitive.

**Group 2-5**

These are verbs with two to five optional classifications respectively.
These verbs are sub-divided by their possible sub-classifications (see below for definitions and examples).

For each type of verb, verbs are divided into high and low frequency words.

## SUB-CLASSIFICATIONS OF VERBS

***TRANSITIVE (T)***

Verbs which can take a direct object.

e.g. the policeman arrested the thief
she is knitting a scarf

***TRANSITIVE PLUS COMPLEMENTATION (TC)***

Verbs which can take a direct object and an object complement.
Object complements can be a NP, AP, PP or clause.

e.g. they threw him into jail
they signed the card from Bill

***INTRANSITIVE (I)***

Verbs which can occur without a direct object.

e.g. the man is sneezing
the baby crawled

***DITRANSITIVE (D)***

Verbs which can take two objects, one direct object and one indirect object

e.g. he wrote Jane a letter
she read the book to David

***LINKING VERB (L)***

Verbs which occur with subject complements. Most common linking verb is 'be'.
Subject complements can be a NP, AP, PP or clause.

e.g. she grew tall
Max stood for parliament

Definitions from Celex Lexical Database (Centre for Lexical Information, Nijmegen University 1993)

# Nouns

| | PRACTICE | | |
|---|---|---|---|
| | biscuit | | |
| | caravan | | |
| | flag | | |
| | brush | | |
| | | | |
| | ITEM | transcription | |
| | | | |
| 1 | strawberry | | |
| 2 | computer | | |
| 3 | ear | | |
| 4 | scissors | | |
| 5 | battery | | |
| 6 | fish | | |
| 7 | clock | | |
| 8 | apple | | |
| 9 | comb | | |
| 10 | bath | | |
| 11 | shirt | | |
| 12 | ring | | |
| 13 | newspaper | | |
| 14 | piano | | |
| 15 | pencil | | |
| 16 | pocket | | |
| 17 | stairs | | |
| 18 | bowl | | |
| 19 | finger | | |
| 20 | gate | | |
| 21 | towel | | |
| 22 | watch | | |
| 23 | cat | | |
| 24 | dress | | |
| 25 | ladder | | |
| 26 | zip | | |
| 27 | bird | | |
| 28 | car | | |
| 29 | bean | | |
| 30 | angel | | |
| 31 | dog | | |
| 32 | bus | | |
| 33 | gun | | |
| 34 | fence | | |
| 35 | duck | | |
| 36 | bell | | |
| 37 | moon | | |
| 38 | tie | | |
| 39 | chair | | |
| 40 | blanket | | |
| 41 | rope | | |
| 42 | pineapple | | |
| 43 | desk | | |
| 44 | saw | | |
| 45 | bed | | |

| | verb/noun | | imageability | | frequency | | length | |
|---|---|---|---|---|---|---|---|---|
| | verb | noun | HiIm | LoIm | HiFr | LoFr | Long | Short |
| 1 | ■ | | | ■ | ■ | ■ | ■ | ■ |
| 2 | ■ | | ■ | | | ■ | | ■ |
| 3 | ■ | | | ■ | ■ | ■ | ■ | ■ |
| 4 | ■ | | ■ | | ■ | | ■ | ■ |
| 5 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 6 | ■ | | | ■ | | ■ | ■ | ■ |
| 7 | ■ | | ■ | | ■ | | ■ | ■ |
| 8 | ■ | ■ | ■ | ■ | | | | ■ |
| 9 | ■ | ■ | ■ | ■ | | | ■ | |
| 10 | ■ | | ■ | | ■ | ■ | ■ | |
| 11 | ■ | | ■ | ■ | ■ | ■ | ■ | |
| 12 | ■ | | ■ | | ■ | ■ | ■ | |
| 13 | ■ | ■ | ■ | ■ | | | ■ | ■ |
| 14 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 15 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 16 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 17 | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 18 | ■ | ■ | ■ | ■ | ■ | | ■ | ■ |
| 19 | ■ | | ■ | ■ | | ■ | ■ | ■ |
| 20 | ■ | | ■ | ■ | | ■ | ■ | ■ |
| 21 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 22 | ■ | | ■ | ■ | ■ | ■ | | ■ |
| 23 | ■ | | ■ | ■ | ■ | ■ | | ■ |
| 24 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 25 | ■ | ■ | ■ | ■ | ■ | | ■ | ■ |
| 26 | ■ | ■ | ■ | ■ | ■ | | ■ | |
| 27 | ■ | | ■ | ■ | | ■ | ■ | ■ |
| 28 | ■ | | ■ | ■ | | ■ | ■ | ■ |
| 29 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 30 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 31 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 32 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 33 | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 34 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 35 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 36 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 37 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 38 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 39 | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 40 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 41 | ■ | | ■ | | ■ | ■ | ■ | ■ |
| 42 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 43 | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| 44 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 45 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

# Nouns

| | ITEM | transcription | | verb/noun | | imageability | | frequency | | length | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | verb | noun | HiIm | LoIm | HiFr | LoFr | Long | Short |
| 46 | bag | | | | | | | | | | |
| 47 | egg | | | | | | | | | | |
| 48 | rabbit | | | | | | | | | | |
| 49 | radio | | | | | | | | | | |
| 50 | brick | | | | | | | | | | |
| 51 | whistle | | | | | | | | | | |
| 52 | onion | | | | | | | | | | |
| 53 | hat | | | | | | | | | | |
| 54 | helicopter | | | | | | | | | | |
| 55 | anchor | | | | | | | | | | |
| 56 | knife | | | | | | | | | | |
| 57 | abacus | | | | | | | | | | |
| 58 | castle | | | | | | | | | | |
| 59 | sponge | | | | | | | | | | |
| 60 | fork | | | | | | | | | | |
| 61 | train | | | | | | | | | | |
| 62 | coat | | | | | | | | | | |
| 63 | cake | | | | | | | | | | |
| 64 | razor | | | | | | | | | | |
| 65 | nose | | | | | | | | | | |
| 66 | cap | | | | | | | | | | |
| 67 | plate | | | | | | | | | | |
| 68 | belt | | | | | | | | | | |
| 69 | shoe | | | | | | | | | | |
| 70 | cup | | | | | | | | | | |
| | | TOTAL | | | | | | | | | |
| | | out of | 70 | | 54 | 20 | 20 | 20 | 20 | 15 | 15 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

# Verbs

| | PRACTICE | | |
|---|---|---|---|
| | light | | |
| | tie | | |
| | propose | | |
| | cheer | | |
| | | | |
| | ITEM | transcription | |
| | | | |
| 1 | fly | | |
| 2 | grate | | |
| 3 | bark | | |
| 4 | drink | | |
| 5 | carry | | |
| 6 | toss | | |
| 7 | land | | |
| 8 | choose | | |
| 9 | spread | | |
| 10 | inject | | |
| 11 | surrender | | |
| 12 | cover | | |
| 13 | watch | | |
| 14 | hold | | |
| 15 | throw | | |
| 16 | grow | | |
| 17 | lock | | |
| 18 | decorate | | |
| 19 | arrive | | |
| 20 | snore | | |
| 21 | play | | |
| 22 | climb | | |
| 23 | hypnotise | | |
| 24 | clap | | |
| 25 | burn | | |
| 26 | blow | | |
| 27 | beg | | |
| 28 | read | | |
| 29 | fill | | |
| 30 | serve | | |
| 31 | crawl | | |
| 32 | shoot | | |
| 33 | marry | | |
| 34 | win | | |
| 35 | hide | | |
| 36 | swim | | |
| 37 | cut | | |
| 38 | laugh | | |
| 39 | sit | | |
| 40 | kneel | | |
| 41 | leave | | |
| 42 | cry | | |
| 43 | mow | | |
| 44 | dry | | |
| 45 | arrest | | |

| | | verb/noun | | imageability | | frequency | | length | |
|---|---|---|---|---|---|---|---|---|---|
| | | verb | noun | HiIm | LoIm | HiFr | LoFr | Long | Short |
| 1 | fly | | | | | | | | |
| 2 | grate | | | | | | | | |
| 3 | bark | | | | | | | | |
| 4 | drink | | | | | | | | |
| 5 | carry | | | | | | | | |
| 6 | toss | | | | | | | | |
| 7 | land | | | | | | | | |
| 8 | choose | | | | | | | | |
| 9 | spread | | | | | | | | |
| 10 | inject | | | | | | | | |
| 11 | surrender | | | | | | | | |
| 12 | cover | | | | | | | | |
| 13 | watch | | | | | | | | |
| 14 | hold | | | | | | | | |
| 15 | throw | | | | | | | | |
| 16 | grow | | | | | | | | |
| 17 | lock | | | | | | | | |
| 18 | decorate | | | | | | | | |
| 19 | arrive | | | | | | | | |
| 20 | snore | | | | | | | | |
| 21 | play | | | | | | | | |
| 22 | climb | | | | | | | | |
| 23 | hypnotise | | | | | | | | |
| 24 | clap | | | | | | | | |
| 25 | burn | | | | | | | | |
| 26 | blow | | | | | | | | |
| 27 | beg | | | | | | | | |
| 28 | read | | | | | | | | |
| 29 | fill | | | | | | | | |
| 30 | serve | | | | | | | | |
| 31 | crawl | | | | | | | | |
| 32 | shoot | | | | | | | | |
| 33 | marry | | | | | | | | |
| 34 | win | | | | | | | | |
| 35 | hide | | | | | | | | |
| 36 | swim | | | | | | | | |
| 37 | cut | | | | | | | | |
| 38 | laugh | | | | | | | | |
| 39 | sit | | | | | | | | |
| 40 | kneel | | | | | | | | |
| 41 | leave | | | | | | | | |
| 42 | cry | | | | | | | | |
| 43 | mow | | | | | | | | |
| 44 | dry | | | | | | | | |
| 45 | arrest | | | | | | | | |

# Verbs

| | ITEM | transcription | | verb/noun | | imageability | | frequency | | length | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | verb | noun | HiIm | LoIm | HiFr | LoFr | Long | Short |
| 46 | knit | | | | | | | | | | |
| 47 | scratch | | | | | | | | | | |
| 48 | colour | | | | | | | | | | |
| 49 | hiccup | | | | | | | | | | |
| 50 | open | | | | | | | | | | |
| 51 | limp | | | | | | | | | | |
| 52 | deliver | | | | | | | | | | |
| 53 | salute | | | | | | | | | | |
| 54 | examine | | | | | | | | | | |
| 55 | kiss | | | | | | | | | | |
| 56 | camp | | | | | | | | | | |
| 57 | stand | | | | | | | | | | |
| 58 | write | | | | | | | | | | |
| 59 | sigh | | | | | | | | | | |
| 60 | run | | | | | | | | | | |
| 61 | whistle | | | | | | | | | | |
| 62 | trace | | | | | | | | | | |
| 63 | walk | | | | | | | | | | |
| 64 | whisper | | | | | | | | | | |
| 65 | jump | | | | | | | | | | |
| 66 | sneeze | | | | | | | | | | |
| 67 | rub | | | | | | | | | | |
| 68 | nod | | | | | | | | | | |
| 69 | sign | | | | | | | | | | |
| 70 | pull | | | | | | | | | | |
| | | TOTAL | | | | | | | | | |
| | | out of | 70 | 54 | | 20 | 20 | 20 | 20 | 15 | 15 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

| | PRACTICE | | | | | | |
|---|---|---|---|---|---|---|---|
| | light | | | | | | |
| | tie | | | | | | |
| | propose | | | | | | |
| | cheer | | | | | | |
| | | | | | | | |
| | ITEM | 1 | 2 | 3 | 4 | 5 | |
| | | | | | | | |
| 1 | fly | | | | | | T I D |
| 2 | grate | | | | | | T I |
| 3 | bark | | | | | | T I |
| 4 | drink | | | | | | T TC I |
| 5 | carry | | | | | | T TC I |
| 6 | toss | | | | | | T TC I D |
| 7 | land | | | | | | T TC I D L |
| 8 | choose | | | | | | T TC I D |
| 9 | spread | | | | | | T I D L |
| 10 | inject | | | | | | T D |
| 11 | surrender | | | | | | |
| 12 | cover | | | | | | T I |
| 13 | watch | | | | | | T TC I |
| 14 | hold | | | | | | T TC I |
| 15 | throw | | | | | | T TC I D |
| 16 | grow | | | | | | |
| 17 | lock | | | | | | |
| 18 | decorate | | | | | | T I |
| 19 | arrive | | | | | | |
| 20 | snore | | | | | | |
| 21 | play | | | | | | |
| 22 | climb | | | | | | T I |
| 23 | hypnotise | | | | | | |
| 24 | clap | | | | | | T TC I |
| 25 | burn | | | | | | T TC I L |
| 26 | blow | | | | | | T TC I D L |
| 27 | beg | | | | | | T TC I L |
| 28 | read | | | | | | T I D L |
| 29 | fill | | | | | | |
| 30 | serve | | | | | | |
| 31 | crawl | | | | | | I |
| 32 | shoot | | | | | | |
| 33 | marry | | | | | | T I |
| 34 | win | | | | | | T I D |
| 35 | hide | | | | | | T I |
| 36 | swim | | | | | | T TC I |
| 37 | cut | | | | | | T TC I D L |
| 38 | laugh | | | | | | T TC I L |
| 39 | sit | | | | | | |
| 40 | kneel | | | | | | I |
| 41 | leave | | | | | | |
| 42 | cry | | | | | | T I |
| 43 | mow | | | | | | T I |
| 44 | dry | | | | | | T I |
| 45 | arrest | | | | | | T |

| | ITEM | 1A | 2A | 3A | 4A | 5A | |
|---|---|---|---|---|---|---|---|
| 46 | knit | ■ | ■ | ■ | | ■ | T I D L |
| 47 | scratch | ■ | ■ | | ■ | ■ | T TC I |
| 48 | colour | ■ | ■ | | ■ | ■ | T TC I |
| 49 | hiccup | | ■ | ■ | ■ | ■ | I |
| 50 | open | ■ | | ■ | ■ | ■ | T I |
| 51 | limp | ■ | ■ | ■ | ■ | ■ | |
| 52 | deliver | ■ | ■ | ■ | | ■ | T TC I D |
| 53 | salute | ■ | | ■ | ■ | ■ | T I |
| 54 | examine | ■ | ■ | ■ | ■ | ■ | |
| 55 | kiss | ■ | ■ | ■ | | ■ | T TC I D |
| 56 | camp | ■ | ■ | ■ | ■ | ■ | |
| 57 | stand | ■ | ■ | ■ | | ■ | T I D L |
| 58 | write | ■ | ■ | | ■ | ■ | T I D |
| 59 | sigh | | ■ | ■ | ■ | ■ | I |
| 60 | run | ■ | ■ | ■ | ■ | | T TC I D L |
| 61 | whistle | ■ | ■ | ■ | | ■ | T TC I L |
| 62 | trace | | ■ | ■ | ■ | ■ | T |
| 63 | walk | ■ | ■ | ■ | | ■ | T TC I L |
| 64 | whisper | ■ | ■ | | ■ | ■ | T TC I |
| 65 | jump | ■ | | ■ | ■ | ■ | T I |
| 66 | sneeze | | ■ | ■ | ■ | ■ | I |
| 67 | rub | ■ | ■ | ■ | ■ | ■ | |
| 68 | nod | ■ | | ■ | ■ | ■ | T I |
| 69 | sign | ■ | ■ | ■ | | ■ | T TC I L |
| 70 | pull | ■ | ■ | ■ | ■ | | T TC I D L |
| | | | | | | | |
| | TOTALS | | | | | | |
| | out of | 7 | 15 | 12 | 15 | 5 | |

# APPENDIX 9: Verbs used in Sentence Generation Task

**Variable T/I**
agree
bake
collect
decorate
donate
heal
hide
interrupt
marry
meet
mow
obey
practise
say
spend

**Variable T/D**
afford
allocate
allot
assure
blame
cleanse
convince
earn
ensure
forbid
impress
improvise
inform
inject
instruct

**Variable T/I/D**
ask
build
forgive
knit
preach
teach
write

**Variable T/I/TC**
carry
confess
hear
leave
lose
propose
see
toss

**Fixed I**
apologise
arrive
crawl
die
hibernate
interfere
kneel
participate
sunbathe
vanish
disagree
collide
erupt
appear
sympathise

**Fixed T**
achieve
admire
announce
demolish
deserve
discuss
enjoy
fetch
identify
invent
kidnap
punish
suggest
unlock
describe