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Syntactic Deficits in Aphasic Comprehension

by

Leone Sveinson

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled, "Syntactic Deficits in Aphasic Comprehension" submitted by Leone Sveinson in partial fulfillment of the requirements for the degree of Master of Arts.

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ABSTRACT

This thesis involves an empirical study which examines the nature of sentence comprehension and how it is impaired in aphasia. The study employs Government and Binding Theory (Chomsky, 1981, 1982) to assist in the creation of a picture-pointing task which investigates aphasic patients' interpretation of a group of test sentences that contain either a pronominal (e.g., The boy sprayed him.) or an anaphor (e.g., The boy sprayed himself.). It is found that aphasic patients experience more difficulty interpreting a sentence which contains a pronominal than they do interpreting a sentence which contains an anaphor. Of particular interest is the observation that often patients interpret a pronominal as if it were the corresponding anaphor. These findings are used to make suggestions about the processing of pronominals and anaphors which has a bridge to normal comprehension. The results indicate that a relationship exists between aphasic language and normal language, and that linguistic theory and empirical methodology play important roles in demonstrating what the nature of that relationship is.

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For three very special people

PETE

whose patience and support is unyielding

DAD

whose character is so much a part of me

GRAMMPA M

who never left

The idea, which constitutes the actual being of the human mind, is not simple, but compounded of a great number of ideas.

By idea, I mean the mental conception which is formed by the mind as a thinking thing.

By an adequate idea, I mean an idea which, in so far as it is considered in itself, without relation to the object, has all the properties or intrinsic marks of a true idea.

(Benedict De Spinoza, 1883)

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Chapter 1

Introduction

1.0.0 Introduction and overview to the current investigation

This thesis reports on a neurolinguistic investigation of language loss in aphasia. The term aphasia refers to an impairment of language as a result of brain damage (usually stroke or trauma), and generally is used to describe a variety of acquired language disorders that can occur in any one or more of the modalities of speech comprehension or production , reading, or writing (Eisenson, 1973; Halpern, 1972). The thesis adopts a neurolinguistic perspective which has the following general goals: 1) to characterize language breakdown in aphasia in terms of the specific linguistic elements and/or principles of language , and 2) to characterize the relationship between patterns of language loss in aphasia and theories of normal language .

These two goals have not always been recognized as central to neurolinguistics. As will be discussed in this chapter, the history of neurolinguistics has been characterized by a movement towards increasing the involvement of linguistic theory and models of normal language processing in the characterization of language loss in aphasia.

In relation to the goals of neurolinguistics stated above, the current study is motivated by the following two general questions: How can theories of normal linguistic competence assist in characterizing the impairment of sentence

comprehension in aphasia? How can information from language breakdown in aphasia shed light on how normal individuals comprehend sentences?

The assumption which underlies these two questions is that aphasic language and normal language are somehow related to one another, and that information from one can provide insight into the nature of the other. This thesis investigates whether we can learn something of value about normal sentence comprehension by examining aphasic performance.

In this thesis the above questions have been investigated in the following manner. First, a specific syntactic phenomenon was selected for investigation. The phenomenon chosen was a particular aspect of pronoun interpretation, specifically, the relationships which pronominals (e.g., him) and anaphors (e.g., himself) have with their antecedents.

The relationships between pronominals and anaphors, and their antecedents are illustrated in (1). In (1a), the noun phrase (NP) Sally and the pronominal her cannot refer to the same person. In (1b), the NP Sally and the anaphor herself must refer to the same person .

(1) (a) Sally washed her.
(b) Sally washed herself.

In both of the sentences given in (1) syntactic structure is not crucial to the correct interpretation of the sentence. In (1b) for example, one does not need

hierarchical information to determine that herself must refer to the NP Sally . This is because Sally is the only NP in the sentence and thus is the only possible antecedent. Similarly in (1a) , structure is not necessary to determine that her and Sally cannot be coreferential. Sally is the only NP in the sentence and thus cannot be the antecedent of her.

Syntactic structure becomes important, however, when interpreting the following pair of sentences in (2).

(2) (a) Sally's friend washed her.

(b) Sally's friend washed herself.

In (2a) one needs syntactic structure to determine that her cannot refer to friend but can possibly refer to Sally's. In (2b) one needs syntactic information to determine that friend and herself must be coreferential whereas Sally's and herself cannot be .

So, as demonstrated in (1) and (2), pronominals and anaphors differ in the sense that they 'obey different syntactic constraints on the choice of antecedents' (Caplan & Hildebrandt, 1988, p. 17). Government and Binding Theory (Chomsky, 1981, 1982) offers one interpretation for the type of 'syntactic constraints' referred to above. This theory describes a set of principles that govern the interpretation of pronominals and anaphors. Because of this, Caplan and Hildebrandt provide the following summary .

> Among the major current theories, it [Government and Binding Theory] specifies the largest typology of referentially dependent elements. Therefore, it leads to the prediction of the greatest number of specific impairments affecting these categories. A database resulting from the investigation of a large number of hypothesized types of referentially dependent elements has the potential to reveal impairments involving these categories. (p. 23)

The interpretation of sentences containing pronominals and anaphors will be discussed in greater detail in Chapter 2. At this point it is important to note that the correct interpretation of sentences which contain these elements requires syntactic information.

The second step in the investigation of aphasic sentence comprehension involved the creation of a paradigm of test sentences containing pronominals and anaphors. A set of 13 monoclausal test sentences was constructed to investigate the reference relationships described above. Then, as the third step, each of these sentences was combined with four pictures and incorporated into a picture-pointing task.

In every set of four pictures, one picture corresponded to the correct interpretation of the test sentence (the target picture), and the other three pictures were distractors. For each sentence the aphasic patient was required to point to the picture that best illustrated the meaning of the sentence (i.e., the target). The significant feature about the distractors was that each one

corresponded to a possible misinterpretation of the test sentence. If an aphasic patient choose one of the three distractors, important information could be gained concerning the possible nature of the interpretation error.

The steps described above outline the general construction of the investigation and permit a revision of the general questions presented at the outset. Specifically, this investigation focuses on the following three research questions.

1) Are there differences in aphasics' interpretation of pronominals and anaphors ?

2) If there are differences in aphasics' interpretations of pronominals and anaphors, what is the appropriate characterization of these differences?

3) What is the relationship between aphasics' interpretation of sentences containing a pronominal or anaphor, and normals' interpretation of sentences containing a pronominal or anaphor ?

These questions capture the fundamental issues which the current study seeks to investigate. Details of the construction of the empirical task are contained in the chapters that follow. Before considering that information, however, it is important to review the historical context in which investigations of this sort take place. Linguistic theory and scientific research methods did not always play the vital role which they currently do in neurolinguistic investigations into the nature of language loss in aphasia. It is essential that one understand how, in early research, lack of these two elements restricted

the characterization of the subtlties of language loss in aphasia and, in addition, limited the types of generalizations that investigators could make.

1.1.0 Neurolinguistics

1.1.1 Early and Recent

Modern neurolinguistic research had its beginnings in the sixteenth century. During this time there was an accumulation of evidence which suggested that the language faculty was distinct from other cognitive faculties (e.g., memory), and that the language faculty could be broken down into subcomponents which could be selectively impaired . As a result of a number of clinical observations that were made on aphasic patients, there were indications that the subcomponents which were subject to loss or damage consisted of auditory language comprehension , verbal production, reading and writing (e.g., Gesner, 1770; Grafenberg, 1585; Schmidt, 1676).

Gesner (1770) was perhaps the first to attempt to systematically summarize and interpret previous studies relating to the selective loss of various cerebral faculties. Information from this summary , in addition to his own work, lead him to make the following observation:

> Just as some verbal powers can become weakened without injury to others, memory also can be specifically impaired to a greater or lesser degree with respect to only certain classes of ideas.....The vessels of the brain are surely not arranged in accordance with categories of

> ideas and therefore it is incomprehensible that these categories should correspond to areas of destruction. (p. 125-126)

In the first statement , it is clear that Gesner acknowledges the selective loss of memory. In the second statement, however, it is apparent that Gesner was not yet prepared to consider the notion that perhaps the loss of certain cognitive faculties were somehow linked to specific areas of the brain.

It was not until the publishing of a series of papers by Paul Broca (Broca, 1861, 1863, 1866), that the notion of cerebral 'localization', as it is now known, was seriously considered. The term 'localizationist' was, as still is, used to describe a group of individuals who maintained that certain cognitive faculties were controlled by brain mechanisms which were 'localized' in specific circumscribed areas of the cerebral cortex.

Broca's contribution to the theory of 'localization' came primarily through his discovery that a link existed between an area of the brain at the foot of the third frontal convolution (now called Broca's Area), and the faculty of articulate speech (Broca, 1861, 1863, 1866). Broca, who was a French anatomist, formed the basis of his hypothesis on two famous cases studies involving aphasic patients. During a postmortem examination he observed that in both instances the lesion was in the posterior part of the third frontal convolution. In both cases the lesion was in the left hemisphere.

Initially, Broca did not attempt to explain the coincidence that existed between the left hemisphere and the resulting production deficit that was apparent in both subjects prior to their deaths. Later , however, after several other similar cases were reported , Broca hypothesized that the left hemisphere must serve an important role in the speech of right-handed individuals.

It should be noted that Broca did not speculate upon the localization of any function other than that pertaining to articulate speech. His findings , however, created a context in which other individuals attempted to investigate the possible anatomical basis of language. The most significant of these individuals was the German psychiatrist Carl Wernicke.

As noted by Arbib, Caplan and Marshal (1982), Wernicke was primarily interested in creating a theory which would " show how language abilities are organized into functional subsystems whose structure and pattern of interconnection could be interpreted, and in part even motivated anatomically" (p. 10) . Wernicke claimed to have located an area of the brain (now called Wernicke's Area) that was responsible for speech comprehension (1874, 1906). In light of both clinical and anatomical observation, Wernicke attributed the loss of language comprehension which he had observed in a number of patients to a lesion in the first temporal convolution .

The most significant outcome of Broca's and Wernicke's findings was the suggestion that there is an anatomical basis for language and that the faculty of language is composed of at least two subcomponents, articulation and

comprehension, which are localized in the brain. As a result of the findings of Broca and Wernicke, during the century that followed, aphasiology research was devoted primarily to the task of trying to establish correspondences between language defects and specific lesion sites in the brain (e.g., Flechsig, 1901; Meynert, 1867). Great attention and enthusiasm were given to the possibility that specific types of mental activity could be regarded as the function of a specific area of the brain.

The main emphasis of the era seemed to be placed on the need to develop a clinical taxonomy of aphasia types which were primarily anatomically based. This was the age of the so-called 'diagram makers' , who thought that they should be able to draw functional maps of the cerebral cortex. Lichtheim (1885), as one of the more famous examples, claimed that the 'symptom complexes' of aphasia could be explained in terms of lesions to one of three main regions or five main pathways.

Problems soon arose, however, when it became apparent that all aphasic performance could not be accounted for strictly by the localizationist approach and not all symptoms of language loss could be correlated with specific lesions sites (Freud, 1891; Head, 1926; Jackson, 1878; Kleist , 1934; Moutier, 1908). Clinical observation revealed an overwhelming number of language disturbances for which there seemed to be no corresponding damage to specific areas of the brain, thus challenging the claim that all symptoms of language impairment were the result of excised brain tissue (Goodglass, 1968; Steinthal, 1871; Whitaker, 1971).

Those who challenged the localizationist claim mainly held a more 'holistic' view concerning the nature of the language-brain relationship. The holists claimed that the localizationist models were theoretically unmotivated and clearly unable to account for all symptoms of aphasic performance (e.g., Freud, 1953). The most fundamental problem undermining localizationist models was that often patients with remarkably similar lesion sites exhibited markedly different language disturbances, and conversely, patients with remarkably similar language disturbances were often diagnosed as belonging to different clinical categories.

The holists had various theories, all of which centered around the notion that there is a single general language ability which can be impaired. They recognized that 'psychological context' was somehow important to certain aspects of aphasic language (Weigl and Bierwisch, 1970). As a result of their observations, the level of analysis shifted from that of being almost entirely anatomical to being one which emphasized the total psychological involvement of the patient as he performed various tasks (Goldstein, 1948; Jackson, 1878; Luria, 1947).

The proponents of the holistic approach brought forth a number of issues regarding the importance of cognitive factors that were missed by the localizationists. There were, however, problems with the holist approaches. Specifically, they suffered from being too general and having little predictive value (Marshall, 1974). It was also pointed out that the clinical taxonomies

proposed by the holists were not significantly different than those proposed by the localizationists (Geschwind, 1964, 1970; Von Monakow, 1911).

Though the various localizationist and holist approaches to language loss in aphasia raised a number of significant issues, there were clearly a variety of problems with both viewpoints. In spite of the specific theoretical shortcomings, however, both the localizationist and the holist approaches lacked two crucial considerations. First, early investigations lacked a refined linguistic characterization of language with which to use as a tool to investigate the nature of language loss in aphasia. The focus of early aphasiology studies was primarily on the impairment of what we shall refer to here as the 'functions' of language: speaking, reading, writing, listening (e.g., Broca, 1861).

Without a principled theory of what we now refer to as 'linguistic competence', linguists were excluded from these early investigations and research was conducted mainly by a body of clinicians which generally included anatomists, neurologists and psychologists. These individuals devoted a great deal of research to determining the nature of language impairment as it was manifested in the functions of reading, writing, listening, speaking etc. Little attention was paid to characterizing specific details of language loss in aphasia.

A second shortcoming of early investigations was that they lacked tightly controlled, rigorous, empirical research methodologies. Often, early studies

focused on single case studies of one or two aphasic patients and conclusions were drawn on the basis of 'natural' observations which were made in non-experimental situations.

These natural observations have provided, and continue to provide, an abundance of useful data which permitted early researchers to form valuable hypotheses about the nature of language loss in aphasia. However, there are problems with this approach. One might have to wait a considerable amount of time before finding an adequate number of instances of the particular phenomenon that is being investigated. One has little or no control over the sample of subjects involved. In addition, one of the greatest dangers of natural observation is that the researcher has little or no control over other factors that may be influencing a subject's performance.

Controlled experiments are motivated by the desire to test specific predictions made by certain hypotheses. As Zimney (1961) states, an experiment is an "objective observation of phenomena which are made to occur in a strictly controlled situation in which one or more factors are varied and the others are kept constant". This type of controlled experimental setting was simply not part of early aphasiological research.

1.1.2. The role of linguistic theory

Reflecting back upon the early research in aphasiology it is apparent that the main 'psychological faculties' that were being investigated by Wernicke and his successors involved such things as language comprehension and

production . Descriptions of language loss tended to be unrefined and overgeneralized. Often , for example, the speech of aphasic patients was described as only being either fluent or nonfluent .

Steinthal (1871) addresses the fact that the subtleties of language loss were omitted from many clinical descriptions . He writes, " The clinical descriptions are much too incomplete and are inaccurately recorded. Our physicians have as yet no clear concept of what the function of language is " (p. 119). He was not the only early observer of this fact. Delbruck (1886) and Freud (1891) also attempted to suggest ways of sifting out finer distinctions.

However, prior to the 1950's only a handful of researchers acknowledged that linguistic theory could play a potentially useful role in characterizing the nature of language loss in aphasia (e.g., Alajouanine, Ombredane & Durand , 1939; Goldstein , 1948; Luria, 1947; Ombredane, 1951). In 1955 the linguist Roman Jakobson made a formal statement regarding the relationship between linguistic theory and aphasia. Jakobson (1955) maintained that aphasia is first and foremost a disorder of language and therefore is, to a large extent, a linguistic problem. Consequently, he felt that linguistic theory has the potential to provide insight into the disintegration of language in aphasia and, in addition, aphasic phenomena has the potential to assist in the refinement of linguistic theory.

Jakobson made a crucial point about the potential symbiotic relationship that could exist between linguistic theory and aphasiology. However, little could

be done until the field of linguistics put forth a unified theory of linguistic competence. In essence, the implication was, that without such a theory, linguists had no tool with which to characterize and investigate the nature of language loss in aphasia. It was recognized that the ability to tightly and clearly characterize language loss in aphasia is largely dependent on first possessing a theory of normal linguistic competence. However, until linguists had such a theory they were little better off than the clinicians who preceded them.

In 1957, however, the picture began to change. In that year Chomsky (1957, 1965) proposed a unified model of linguistic competence. As Lesser (1978) points out:

> This model of language was couched in detailed enough terms to make it possible to test out the extent to which a linguistic grammar was a 'mental grammar' , engendering so much experimentation that a new discipline of psycholinguistics evolved . As it turned out, in many respects these standard and extended transformational grammars have proved to be inadequate explanations for what people do in psycholinguistic experiments (see Greene, 1972 for a review). Nevertheless the hunt for an acceptable model of the mental organization of language is on and aphasia is playing an increasingly important part in this search. (p.21)

Chomsky (1957) proposed what was considered to be one example of what Lesser refers to as "an acceptable model of the mental organization of language". Along with the formulation of this model, however, a very interesting and important question was raised as regards the nature of aphasic language: Can language loss in aphasia be characterized by using theories of normal linguistic competence or is aphasic language qualitatively different from normal language, and thus requiring a separate theory of 'aphasic linguistic competence' ?

In several instances it has been demonstrated that certain sound errors made by aphasic patients can only be accounted for by postulating that brain damage either creates a new function that is not found in normal behavior or releases the expression of a function that is inhibited in normal behavior (Brown, 1979, 1980, 1982). This would seem to support the idea that aphasic language is qualitatively distinct from normal language and therefore models of normal linguistic competence may not assist in characterizing abnormal or impaired language states.

It is entirely plausible that aphasic language is qualitatively different from normal language especially in light of the fact that lesions in the brain are rarely circumscribed or 'neat'. However, a large body of evidence indicates that there is generally a great overlap between normal language and aphasic language (for further discussion see: Caplan, 1987). This suggests that if we are going to form characterizations of the types of linguistic structures that are

lost (and retained) in aphasia, we first require models of normal language competence.

This approach to the analysis of language loss in aphasia is sometimes referred to as the 'deficit hypothesis' approach (e.g., Klein , 1978). Because aphasia is an acquired language pathology (in most cases) , this approach assumes that prior to the onset of aphasia grammatical knowledge is at a normal state. Thus, characterizing an acquired language loss of the type(s) found in aphasia can be accomplished by relating the abnormal state to theories of normal linguistic competence that existed prior to impairment.

If one is to employ the deficit hypothesis approach to language loss in aphasia, several things must be recognized. First , the strength of the characterization of language loss in aphasia is very much dependent on the strength of the theory of normal linguistic competence that is employed . The danger is that we have no way of knowing in advance whether a specific theory of normal linguistic competence provides an accurate characterization of the normal state, or if it has any neurological basis. Second, it may be the case that linguistic theory can account for only a portion of the aphasic data and then we must call upon other theories or heuristic strategies to assist in characterizing what it is that aphasics do when they attempt to produce and comprehend language (Bever , 1970; Caramazza & Zurif, 1976).

One way of dealing with the issue of choosing an appropriate theoretical framework within which to study aphasic language, is to first consider what

type of linguistic framework would be compatible with the deficit hypothesis approach. If we want to characterize the specific components of normal linguistic competence which might be subject to impairment, then it would be useful to employ a theory in which linguistic competence is characterized in terms of specific subcomponents or modules.

Such a 'modular' theory of linguistic competence was formulated by Chomsky in 1981. This theory , known as Government and Binding Theory (GB Theory) , is a highly constrained , explicit characterization of linguistic competence that has been employed by a number of recent investigations as a theoretical framework within which to study language loss in aphasia (e.g., Grodzinsky, 1984a, 1986; Caplan, Baker, & Dehaut, 1985; Caplan & Hildebrandt, 1986).

By choosing a 'modular' theory of linguistic competence we are more constrained in terms of predicting the specific components that can be subject to impairment. It should be emphasized, however , that regardless of which framework we choose, we have no guarantee that the components of linguistic competence characterized by the framework are actually the same as the components that are embedded in neurological makeup of the brain. This is entirely an empirical issue. If, however, it turns out to be the case that specific types of language impairments in aphasia can be accounted for in terms of the subcomponents of the theoretical framework, then we have evidence to support the psychological reality of those subcomponents.

One example of the importance of linguistic theory is evident in the characterization of agrammatism, which is considered to be a language disturbance often associated with Broca's aphasia. The disturbance is characterized by the relative omission of certain grammatical elements primarily in sentence production, although there is evidence which suggests that it is also realized in comprehension (e.g., Goodenough, Zurif & Wientraub, 1977). Agrammatism was first described in the late 1800's (Pitres, 1898) and is characterized in the following summary by Tissot, Mounin & L'hermitte (1973):

1. The deletion of function words in discourse, that is, the deletion of conjunctions, prepositions, articles, pronouns, and auxiliary verbs, and copulas (Notable exceptions to this are the conjunctions and and because).
2. The predominance of nouns, at the expense of verbs, in some forms of agrammatic speech.
3. The loss of verb inflection, with substitution of the infinitive for finite verb forms.
4. Loss of agreement of person, number, and gender, most notable in inflected languages.

Kean (1977a, 1977b, 1979, 1980, 1982, 1985) suggests that agrammatism can be characterized as a phonological deficit that results from the difficulty that agrammatics have with elements which function as so-called 'phonological clitics' and which do not affect stress placement in English. Lapointe (1983),

maintains morphological theory can provide an alternative description and there is an abundance of claims which maintain that agrammatism results from various forms of syntactic deficits (e.g., Bradley, Garret, & Zurif, 1980; Caramazza & Zurif , 1976; Kolk, 1978; Saffran , Schwartz & Marin, 1980; Scholes, 1977; Von Stockert & Bader, 1976; Whitaker, 1970; Zurif & Blumstein, 1978).

The debate over the nature of the language deficit which results in agrammatism is very much an active one (for further discussion see: Kean, 1985). However, for the purposes of this discussion, the important point is that regardless of whether the deficit exists at a phonological, morphological, syntactic, or semantic level of representation, it is undoubtedly a linguistic deficit. It appears that in reference to Jakobson's statement that was noted earlier, there <u>are</u> certain disorders associated with aphasia which are exclusively linguistic and agrammatism is clearly one example.

1.1.3. The role of empirical design

As noted earlier, the first century of research in this area focused on the collection of clinical observations which were gathered in a somewhat informal manner and which noticeably lacked any standardized procedures or protocol. Recently, however, it has been recognized that if we are to systematically analyze aphasic symptoms so that accurate conclusions can be drawn, then we are in need of employing rigorous research methodologies as well as standardized procedures for the analysis of subsequent experimental findings. Goodglass and his associates (e.g., Goodglass, 1968, 1973;

Goodglass & Berko, 1960; Goodglass & Kaplan, 1972, 1982), were the first to pioneer research in aphasiology using strict and well defined experimental and quantitative methods.

One of the consequences of adopting more refined empirical methods was that investigators began to study groups of patients. This was a striking contrast to earlier research where the greatest portion of investigations were clinical case studies involving an indepth analysis of one or two individual patients from which several inferences were drawn (for a defence of the single case-studies see: Badecker & Caramazza, 1985; Caramazza , 1986).

The shift towards more rigorous empirical methods was not the only reason that group studies became important. As more and more case studies were conducted , it became apparent that not all aphasic symptoms could be easily pigeon-holed into a rigid taxonomy of aphasic categories (e.g., Beauvois and Dérouesné, 1979) . In fact, even with revised versions of the clinical taxonomy (for further discussion see; Benson and Geschwind, 1971), it is often the case that patients exhibit symptoms that defy the traditional clinical classification scheme, thus leaving them to be described as being either 'mixed aphasics' or unclassifiable (Caplan, 1987 ; Schwartz, 1984).

It has become evident that many factors are involved in determining the extent to which a lesion in a particular area will affect the resulting language impairment. Factors such as age, sex, education, handedness, extent and location of brain damage and nature of brain damage (e.g., disease, stroke

etc.) all contribute to some degree to the type and severity of aphasic symptoms. In order to deal with these factors and the problem of correlating symptoms of language loss with some sort of anatomically based clinical classification scheme, some researchers have set aside the case study approach and instead have begun examining groups of aphasic patients (e.g., Goodglass & Kaplan , 1972).

This latter approach generally involves first administering a standardized 'aphasic test battery' to a large number of aphasic patients and then statistically analyzing the results of these tests with the aim of clustering groups of patients according to similar patterns of performance.

The most commonly used standardized test batteries[1] are divided into sections according to 'language function', which are in turn comprised of various subtests. So, for example, on the Boston Diagnostic Aphasia Examination (B.D.A.E) (Goodglass & Kaplan 1972, 1982), one section is devoted to Auditory Comprehension which is in turn divided up into numerous subtests involving word discrimination, responding to commands, body part identification and dealing with ideational material. Another section is devoted to oral ability, and is comprised of subtests involving such things as repetition of words, phrases and sentences.

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[1] The standardized test batteries most commonly used by those hospitals whose patients were involved in the current investigation were: a) The Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1971 , 1982), b) The Western Aphasia Battery (Kertesz , 1979), and c) The Token Test (De Renzi & Vignolo , 1962).

Unfortunately , the results of these group studies do not provide conclusive information concerning the clustering of aphasic symptoms nor do they , as Caplan (1987) points out , ".... support any special status for the constellations of symptoms identified in the classical syndromes" (p. 139) .

Because of the problems of non-homogeneity of aphasic symptoms within the clinical classification scheme(s) and the inability of these schemes to capture and adequately characterize some of the more detailed symptoms of language loss (Badecker & Caramazza, 1985, 1986), the current trend in neurolinguistics is now directed more toward achieving a thorough linguistic description of aphasic impairments .

In summary , when rigorous empirical methodologies began to be imposed on research in aphasia, there was a shift from the case study approach to the group study approach. However, the primary goal of the research did not shift substantially. It was still largely directed toward correlating symptoms of language loss with location of lesioned brain tissue in an attempt to reconcile the nature of the clinical categories.

Even though standardized tests such as the B.D.A.E. provide information concerning various 'language functions' , it is crucial to note that they are not based upon any particular theory or model of linguistic competence nor are they designed to offer a thorough description of the impairment of linguistic elements .

The standardized tests provide a reasonable baseline for establishing whether a particular patient is a nonfluent (Broca-like) or fluent (Wernicke-like) aphasic, and they also achieve a degree of success in filtering out disturbances which commonly accompany aphasia (e.g., anomia). They cannot however, accurately account for the subtleties of language loss.

There are many examples of neurolinguistic studies involving both empirical methods and aspects of linguistic theory. Molfese and his associates (Molfese, 1977, 1978, 1980a, 1980b; Molfese, Freeman & Palermo, 1975) have investigated the recognition of sounds and words by using sophisticated techniques for measuring the electrical activity that is associated with a particular stimulus. Timed lexical decision tasks and priming tasks are also examples of refined investigative tools that are now a substantial part of modern neurolinguistic research (Coltheart, 1978; Milberg and Blumstein, 1981; Seidenberg, Waters, Barnes & Tanenhous , 1984).

We come to the conclusion of this section with certain insights about the goals of early studies and the focus of more resent research. The early investigations were , for the most part, concerned with finding anatomical correlates for language disturbances which were described primarily in terms of comprehension, production, reading, writing, etc. In addition, the early studies were conducted mainly by clinicians who usually gleaned aphasic data in uncontrolled and methodologically irregular ways. By adopting rigorous, empirical research methodologies with refined aspects of linguistic theory, current researchers have the potential to reach substantially beyond

the general and relatively unconstrained observations of their early predecessors.

As we proceed to examine the details of the current investigation it is important to be aware of the degree to which linguistic theory and empirical methodology permit us to explore the research questions posed in the first section of this chapter. In Chapter 2 , we will consider relevant aspects of the theoretical framework employed by this study, and in Chapters 3 and 4 we will see how rigorous research methods permit us to control the empirical setting so that valid observations about the nature of aphasic performance can be made.

Chapter 2

Theoretical Framework and Test Paradigm

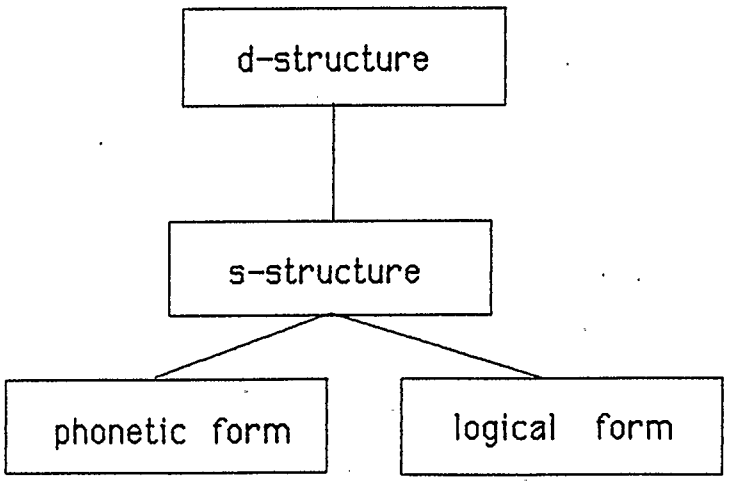
2.0.0 Introduction

The test sentences have been created to reflect contrasts crucial to the framework of Government and Binding Theory (GB Theory) (Chomsky 1980a, 1980b, 1981, 1982). The aim of this chapter is to outline those aspects of the theory that are relevant to the current investigation, then to present a paradigm of test sentences and describe how GB Theory accounts for the interpretation of those sentences which contain pronominals and anaphors.

2.1.0 Aspects of Government and Binding Theory

GB Theory represents a model of linguistic competence that accounts for the formation and interpretation of sentences. The model consists of four main levels as represented in Figure 1 (Sells, 1985, p. 19).

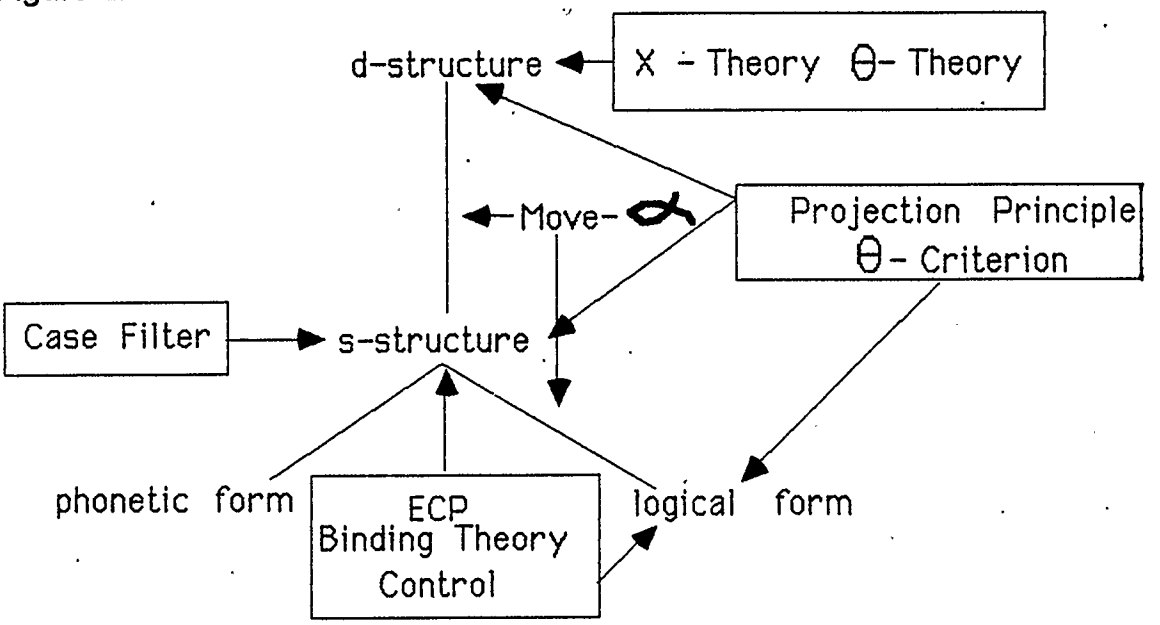
Figure 1.



The framework claims that 'd-structure' and 's-structure' are mediated by a single transformational operation called Move Alpha. Logical Form represents the level that is the output of the grammar at the 'meaning' end and Phonetic Form represents the level that is the output of the grammar at the 'sound' end.

This model can be further broken down into a number of other components that are responsible for principles of well formedness at each level of representation. A more complete model of GB Theory which contains these components is presented in Figure 2 (Sells, 1985, p. 20).

Figure 2.

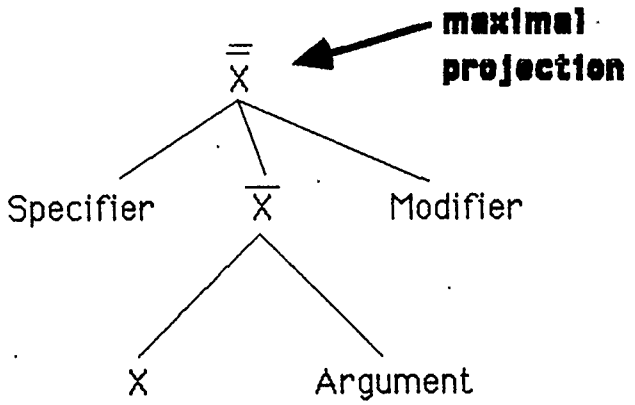


The components that are responsible for well formedness at each level of representation can be further broken down into a number of principles and concepts. $\bar{X}$-Theory (read as 'X-bar theory), for example, is primarily

responsible for the characterization of sentence and phrasal structure and is characterized by the X̄-schema.

Of upmost importance to the X̄-schema is the concept of the head, which is the obligatory part of the syntactic unit which gives it its essential character. So for example, the head of an NP is an N, the head of a VP is a V and so on. Phrases, therefore are considered to be projections of the head and all lexical heads and their projections are subject to the X̄-schema. The X̄-schema for English is diagramed in Figure 3 (Sells, 1985, p. 28)

Figure 3.



Note in Figure 3, that the largest category of any particular type is represented by the $\overline{\overline{X}}$ (called 'X double-bar') which corresponds to the maximal projection of the head. It is important to note that NP is a notational variant of $\overline{\overline{N}}$, both indicate the maximal projection of N. So , for example, according to this scheme NP would be represented by $\overline{\overline{N}}$ which is the maximal projection of N, VP would be represented by $\overline{\overline{V}}$ which is the maximal projection of V, etc.

At the very bottom level in this schema is the head and its arguments. Arguments are considered to be those elements that the head subcategorizes for and are thus sisters of the head. For a transitive verb (such as hit, for example), its argument would be the direct object. The next level up is characterized by X̄ and its accompanying specifiers and modifiers. Specifiers are elements such as determiners in an NP (e.g., the boy) and modifiers may be such things as prepositional phrases (e.g., The owner sold the car at a profit). Both specifiers and modifiers are sisters of X̄.

While the other components of Figure 3 are important for the well formedness of sentences, the component that is most important to this investigation is one called the Binding Theory which is mainly responsible for the distribution of pronominals (e.g., him) and anaphors (e.g., himself). The Binding Theory posits a set of three principles, two of which are important to this investigation because they pertain to the interpretation of sentences containing pronominals and anaphors. We will present a definition of these two principles along with a definition of Binding .

Definition 1. **Binding Principles** (Chomsky , 1982, p. 20)

Principle A: An anaphor must be bound in its Governing Category.

Principle B: A pronominal must be free in its Governing Category.

Definition 2. **Binding** (Sells , 1982 , p. 67)

α binds β iff

(a) α c-commands β, and

(b) α and β are coindexed.

Coindexing refers to the assignment of identical indicies to certain elements, thus indicating that they are coreferential. To capture the notion that Binding Principles A and B apply to a particular domain, the Binding Theory employs the concept of Government. Government is defined in terms the structural notion 'c-command'. The notion of c-command is structural in the sense that it describes a particular relation that is dependent on the hierarchical configuration of tree structures. The definition of c-command used by this investigation is contained in Definition 3.

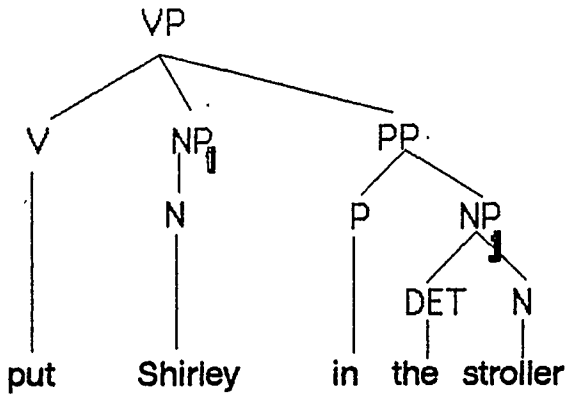
Definition 3. **C-command** (Sells , 1982 , p. 39)

α c-commands β iff

every maximal projection dominating α dominates β.

An example of c-command is given in Figure 4, where P c-commands NPi and NPj, and P c-commands PP . It should be noted that for the sake of simplicity, in Figure 4 and henceforth throughout this discussion, $\bar{X}$ projections will be ignored where irrelevant. This implies that in many instances intermediate levels of $\bar{X}$ may not be represented.

Figure 4.



The notion of Government, which is primarily a sisterhood relation, is defined as follows.

Definition 4. **Government** (Sells, 1985, p. 40)

α governs β iff:

(a) α c-commands β, and

(b) $\alpha = X^0$, i.e., $\alpha \in \{ N, V, P, A, INFL \}$, and

(c) every maximal projection dominating β dominates α.

In Figure 4 note that V governs NP_i and P governs NP_j. Thus it is said that V is the governor of NP_i and P is the governor of NP_j. Note that Binding Principles in Definition 1 claim that an element must be either bound or free within a Governing Category. Governing Category is how the framework accounts for the fact that some syntactic processes apply within the local domain of NP's or S's. For the interpretation of the majority of test sentences containing a pronominal or an anaphor, the following slightly simplified version of Governing Category is used.

Definition 5. **Governing Category** (Chomsky , 1981 , p. 211)

The Governing Category for α is the smallest NP or S containing α , a governor of α and a subject.

To illustrate how these concepts work in concert with one another to account for the grammaticality the ungrammaticality of certain sentences , consider the sentences in Figures 5 and 6 .

Figure 5. $John_i$ saw $himself_i$.

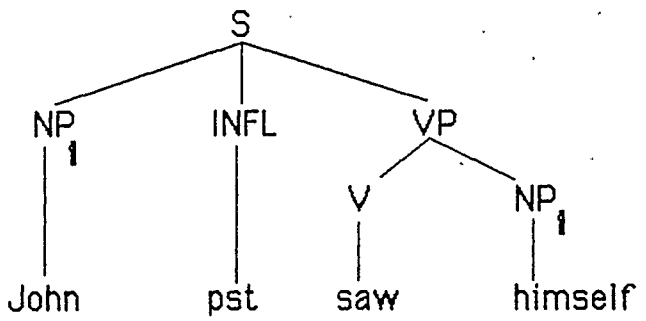
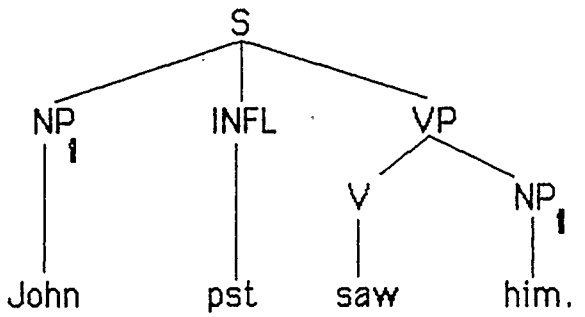


Figure 6. *$John_i$ saw him_i .



In Figure 5, note that the governor for NPi (himself) is V (saw). Thus the Governing Category is the entire S because it is the smallest S that contains

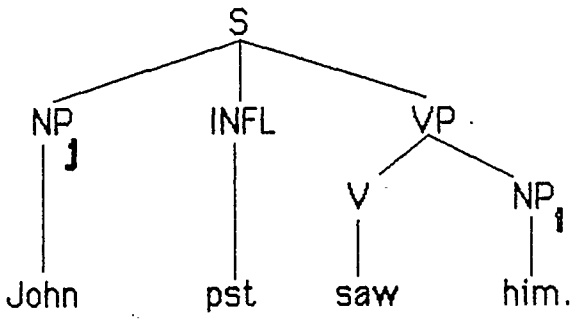
NPi (himself) and the governor of himself which is V (saw) and a subject. There is no NP that contains himself and the governor of himself.

According to the Binding Theory, himself is an anaphor and is subject to Principle A of the Binding Theory. Thus, according to Principle A, himself must be bound in its Governing Category. The requirements of this principle are met because himself is coindexed with and is c-commanded by the NP (John) which is in the Governing Category for himself. The sentence is grammatical because it meets the requirements of the Binding Principle A.

The sentence in Figure 6, however, is ungrammatical and the Binding Theory accounts for this ungrammaticality in the following way. Him is a pronominal which is subject to Principle B of the Binding Theory and so must be free in its Governing Category. Because him is both coindexed with and c-commanded by NPi (John) it is actually bound within its Governing Category (the entire S), when it should be free.

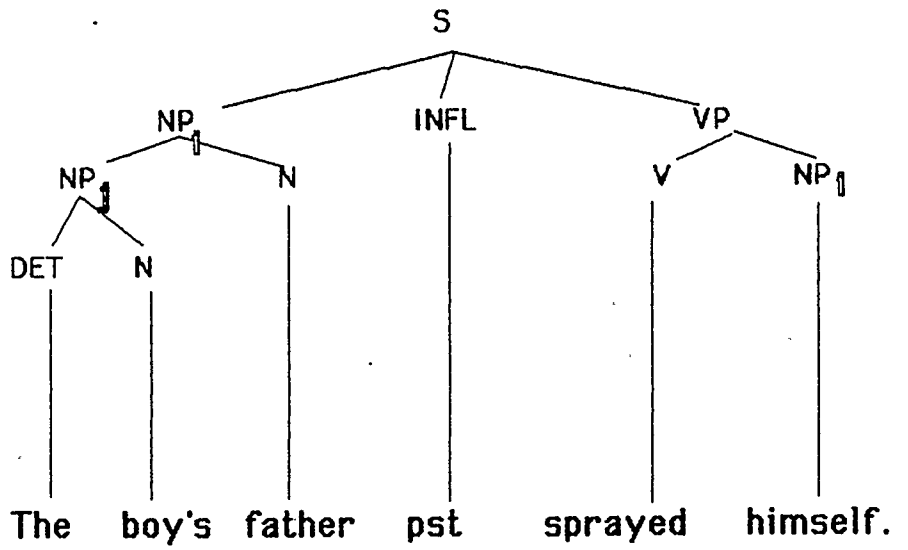
On the other hand, the sentence in Figure 7, illustrates a case where him is free within its Governing Category because, even though him is c-commanded by John , him is not coindexed with John and thus, him is not bound.

Figure 7. John$_j$ saw him$_i$.



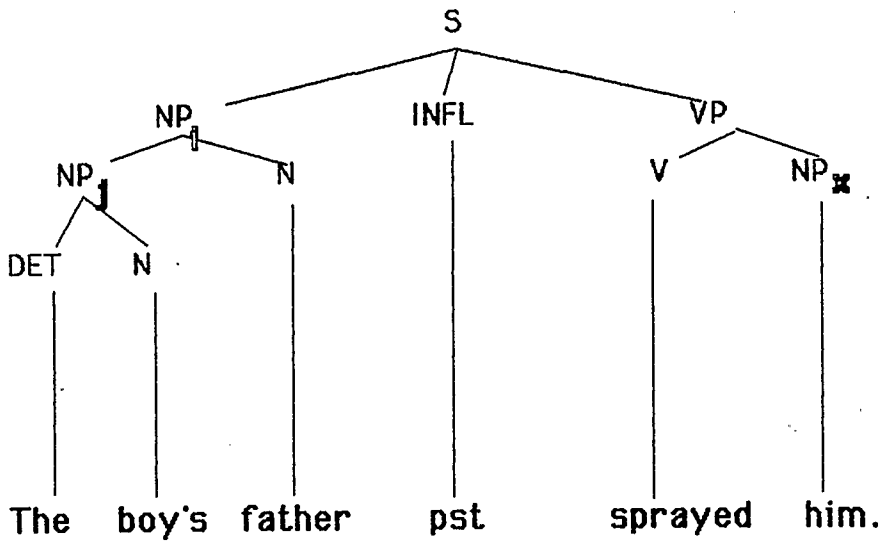
Of particular importance to this investigation are structures such as those illustrated in Figures 8 and 9. In Figure 8, V (sprayed) governs NPi (himself) and thus the governing category for himself is the entire S because S also contains a subject. Note that NPj cannot bind to NPi (himself) because NPj does not c-command NPi (himself). In this example, hierarchical structure and the notion of c-command are crucial to the correct interpretation of the sentence because together these notions clearly indicate that NPi (The boy's father.) is the only c-commanding NP to which the anaphor can be bound.

Figure 8.



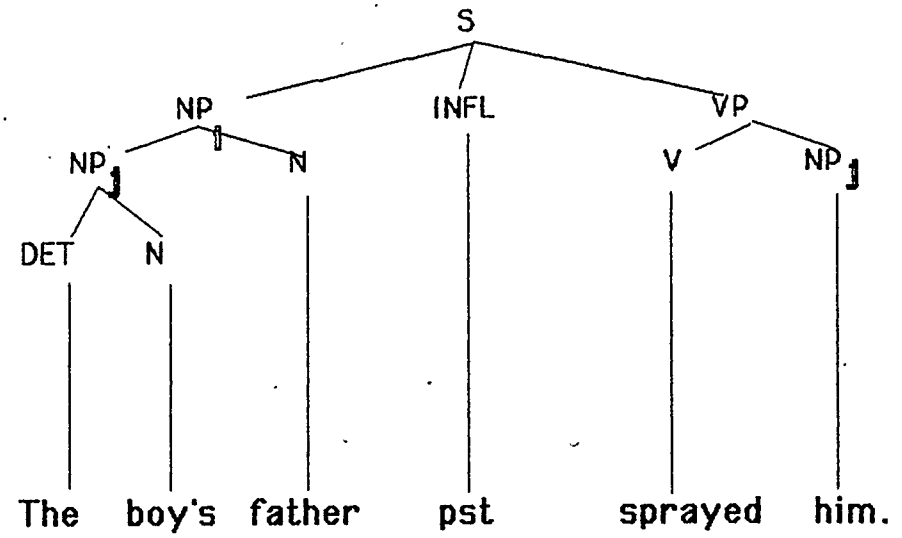
In Figure 9, once again V (sprayed) governs NPi (himself) and thus the governing category for him is the entire S. As the indexing suggests, him is free within its governing category .

Figure 9.



The theoretical framework states that a pronominal must be free within its governing category, but it does not explicitly state that there are occasions, such as that illustrated in Figure 10., where there may be a possible antecedent for the pronominal within the pronominal's governing category.

Figure 10.



Note in Figure 10, that him is still free within its governing category because it is not bound by a c-commanding NP (i.e., the boy's father). However, there is a non-c-commanding NP (i.e., the boy's) that can be coindexed with him. At this point it is important to recognize that 1) in sentences like that represented in Figure 10. there is a possible antecedent for the pronominal within the pronomial's governing category and 2) the theory only explicitly states that a pronominal must be free within its governing category and it does not explicitly state that a non-c-commanding NP can serve as the antecedent to a pronominal. Nor does the Binding Theory explicitly state that a pronoun can have and antecedent outside its governing category.

In summary, GB Theory explicitly characterizes the distribution of pronominals (e.g., him) and anaphors (e.g., himself) in terms of the Binding Theory. It does this primarily through Binding Principles A and B which incorporate the notions that pronominals must be free and anaphors must be bound within a particular domain referred to by the theory as the Governing Category.

It is worthy of note that the Binding Theory does more than simply account for antecedence relations of pronominals such as him and anaphors such as himself. However, because these are the two aspects of the theoretical framework which are the most central to this investigation, the other aspects of the Binding Theory will not be detailed here.

The intention now, is to employ the principles of the Binding Theory (and other relevant theoretical concepts) to construct a paradigm of test sentences. In the next section, this paradigm is presented along with descriptions of how GB Theory accounts for the interpretation of those sentences containing pronominals and anaphors.

2.2.0 The Test Paradigm

The sentences that make up the test paradigm are as follows :

1. The boy sprayed the flowers.
2. The boy sprayed him.
3. The boy sprayed himself.
4. The boy's father sprayed the flowers.
5. The father of the boy sprayed the flowers.
6. The boy sprayed the girl's shoe.
7. The boy sprayed the shoe of the girl.
8. The boy showed the baby to the girl.
9. The boy showed the girl the baby.
10. The boy showed the girl the picture of the baby.
11. The boy showed the man the picture of him.

12. The boy showed the man the picture of himself.
13. The boy's father sprayed him.
14. The boy's father sprayed himself.
15. The father of the boy sprayed him.
16. The father of the boy sprayed himself.

Notice that within the paradigm of test sentences, sentences containing pronouns are preceded by similar sentences which do not contain pronouns. So for example, The boy sprayed the flowers. comes before The boy sprayed him. and The boy sprayed himself. This type of arrangement , of presenting a sentence without pronouns before presenting the same pattern with pronouns was done for the following reason. If only the sentences containing pronouns were presented to the patient, then if the patient erred, it would not be clear as to whether the error was due to the presence of the pronoun, or due to some other aspect of the sentence.

The remainder of this section contains structural representations for all of the test sentences. Because the sentences containing pronouns are the primary focus of this investigation, they are the only sentences that are described here. It should be noted however, that GB Theory offers an account for the interpretation of all the test sentences even though all such accounts are not detailed here.

In addition, because this chapter deals primarily with how the theoretical framework accounts for the interpretation of a specific group of sentences, we

will only illustrate interpretations that are explicitly stated by the theory. As we noted in Figure 10, there are instances where a possible antecedent for a pronominal exists within the pronominal's governing category but the framework does not offer an explicit account for such interpretations. These alternate interpretations will be discussed at greater length in Chapter 5 .

Figure 11.

1. The boy sprayed the flowers.

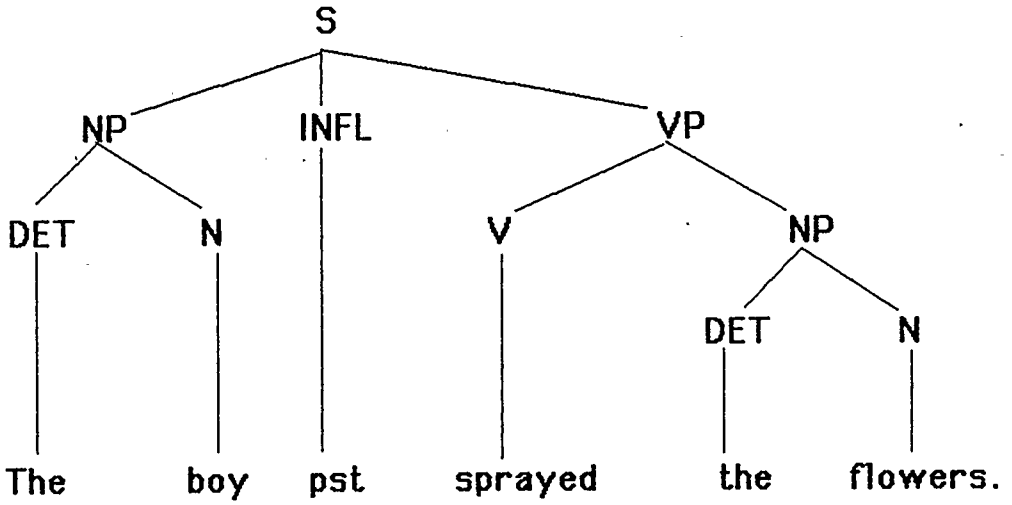
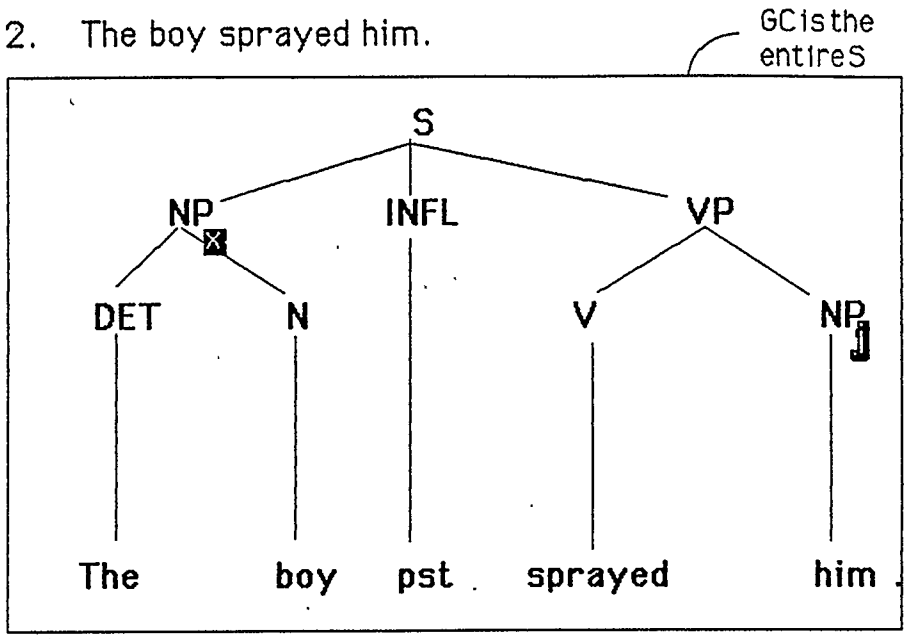


Figure 12.

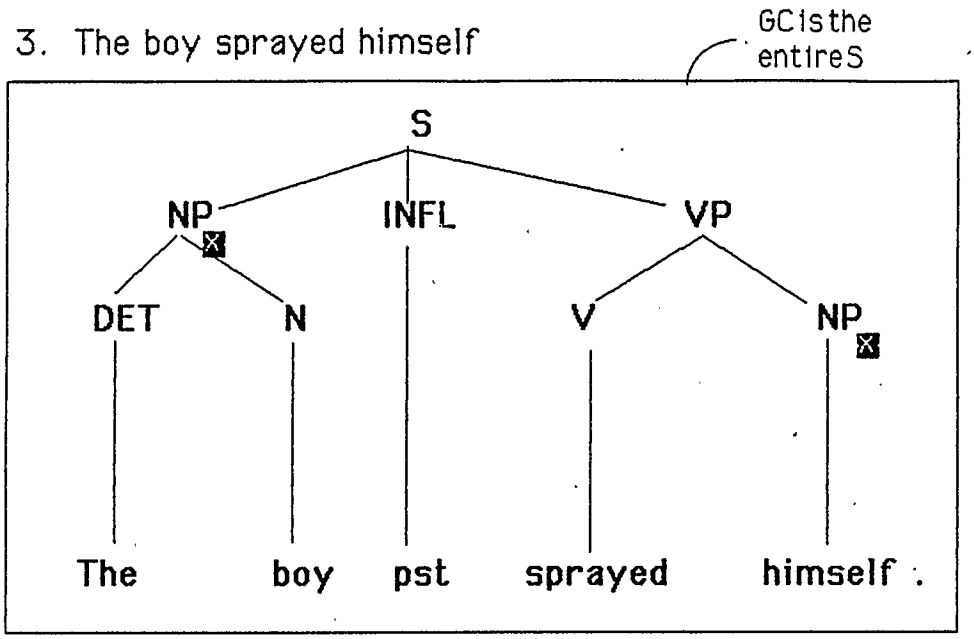
2. The boy sprayed him.



Theoretical account for the interpretation of sentence 2:

Him is a pronominal which is subject to Principle B of the Binding Theory and must therefore be free in its Governing Category which is the entire S. Although NP_X c-commands NP_j , NP_X is not a binder of NP_j because the two are not coindexed. Thus , NP_j is free in its Governing Category .

Figure 13.



Theoretical account for the interpretation of sentence 3:

Himself is an anaphor which is subject to Principle A of the Binding Theory and must therefore be bound in its Governing Category which is the entire S. NP_X (the boy) both c-commands and is coindexed with NP_X (himself) and is therefore the binder of NP_X (himself). Thus the anaphor himself is bound within its Governing Category.

Figure 14.

4. The boy's father sprayed the flowers.

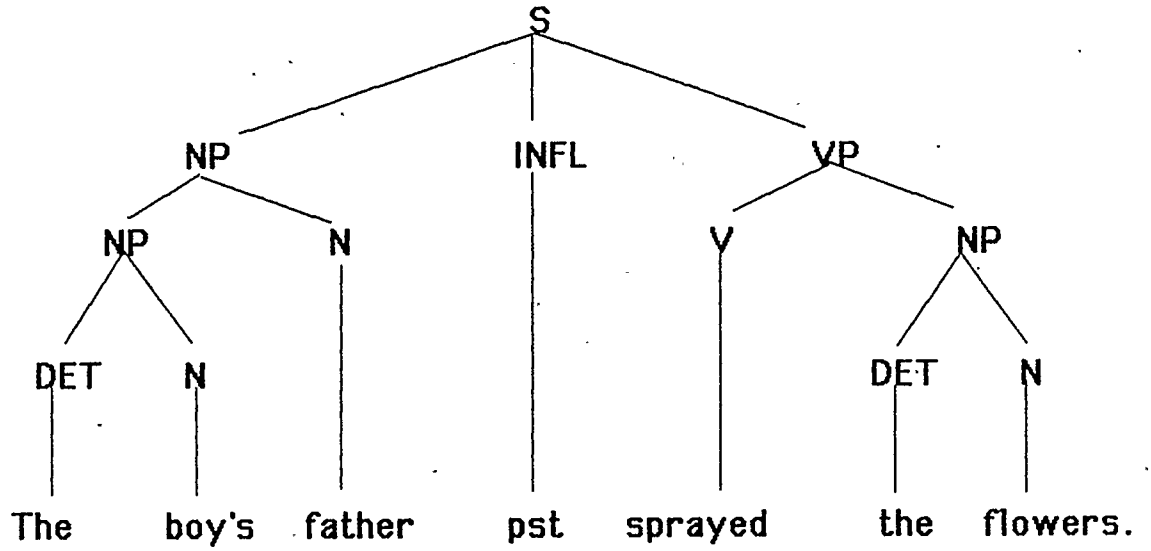


Figure 15.

5. The father of the boy sprayed the flowers.

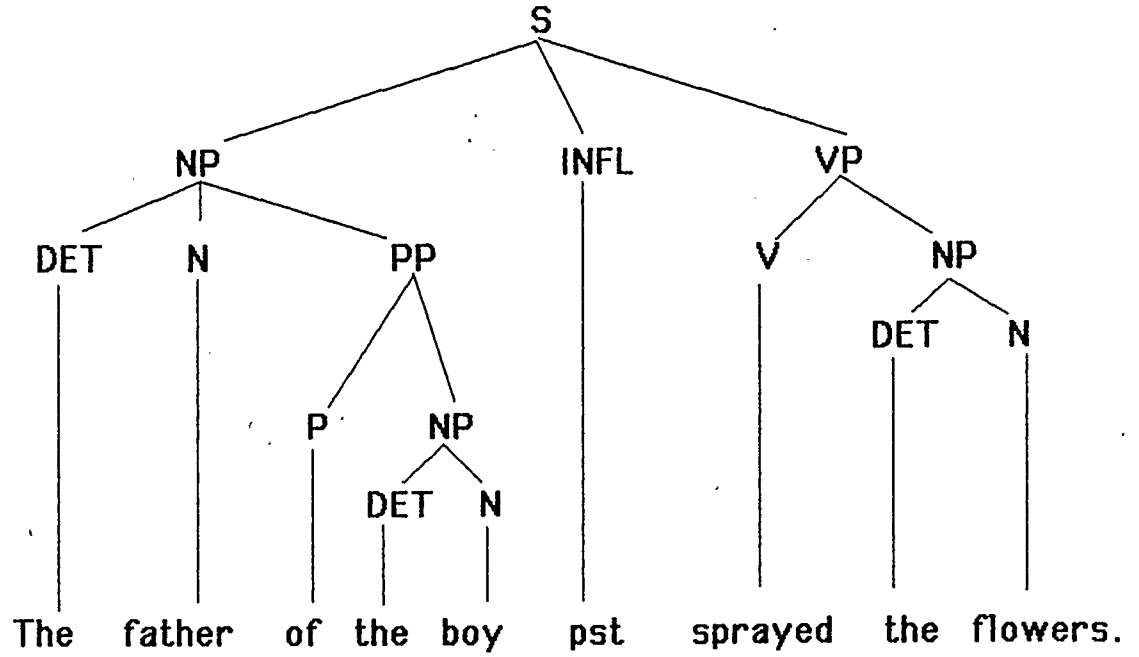


Figure 16.

6. The boy sprayed the girl's shoe.

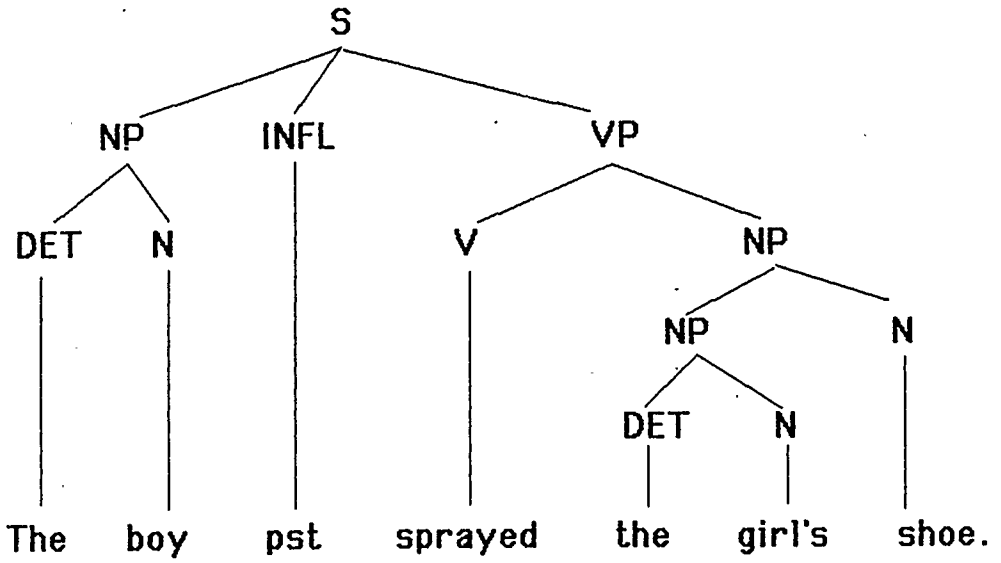
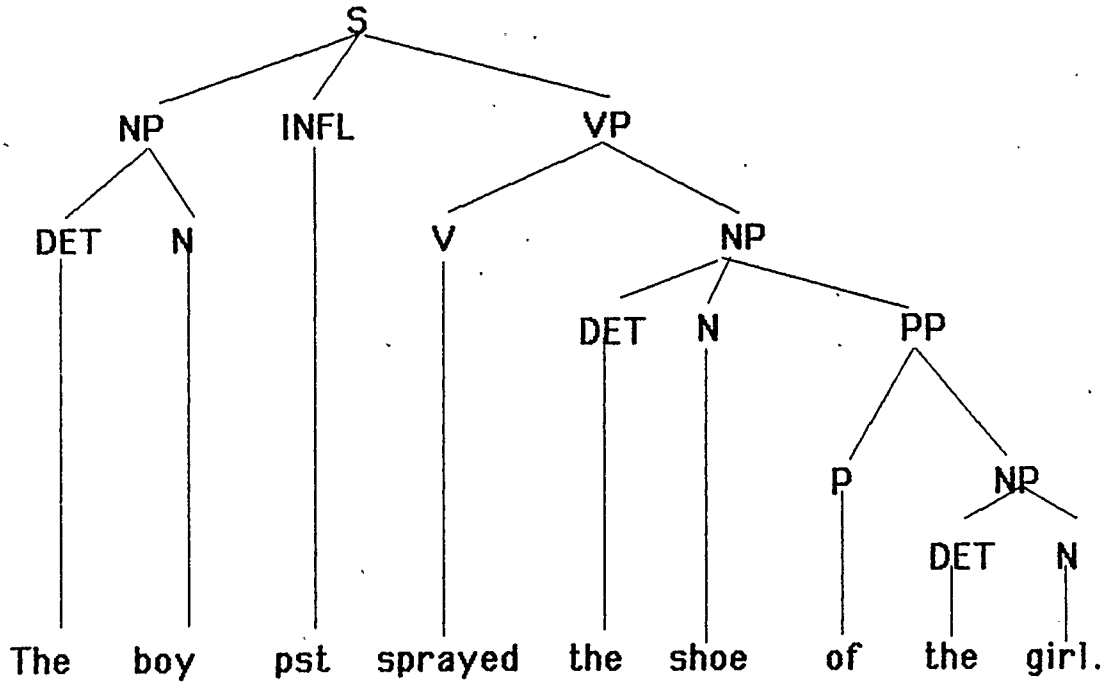


Figure 17.

7. The boy sprayed the shoe of the girl.



It should be acknowledged that the structures in Figures 15 and 17 each contain a subcategorized prepositional phrase (i.e., of the boy, of the girl), whereas the structures in Figures 14 and 16 do not. As will become apparent in Chapter 5, this has no bearing on the current investigation.

Figure 18.

8. The boy showed the baby to the girl.

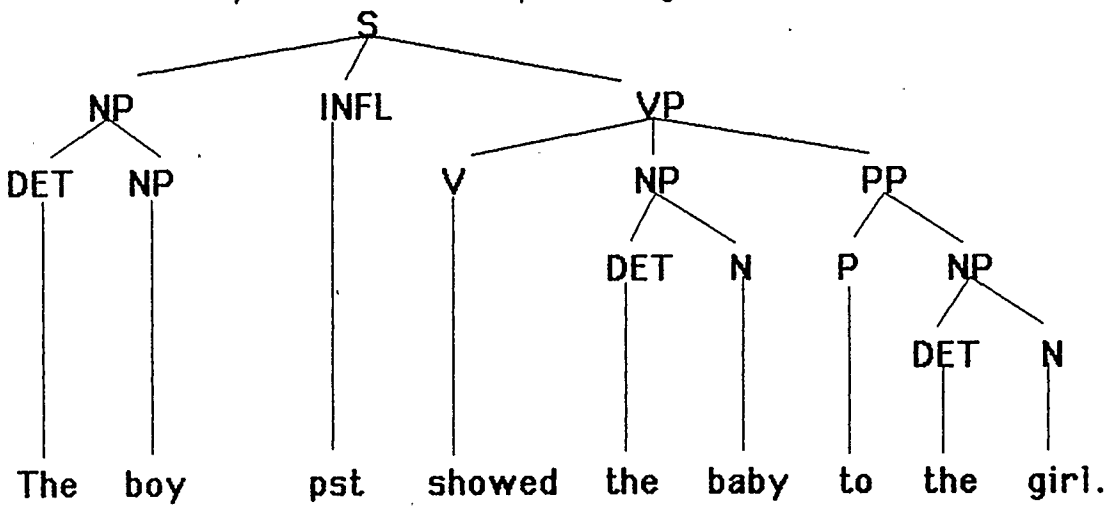


Figure 19.

9. The boy showed the girl the baby

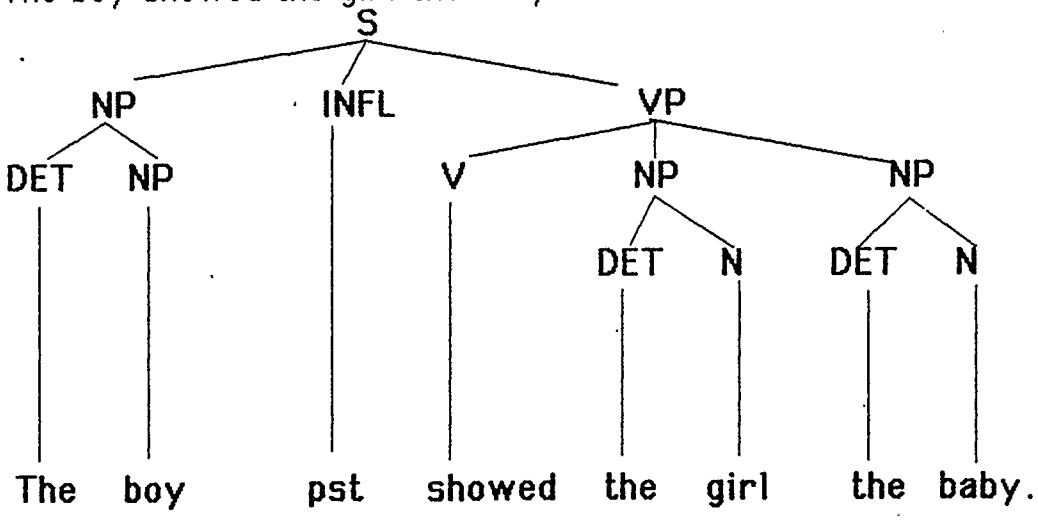
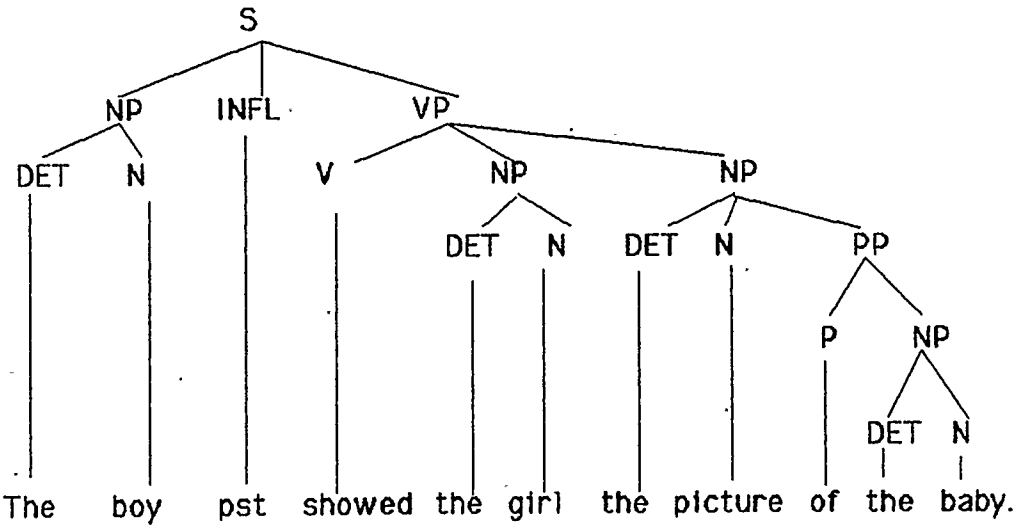


Figure 20.

10. The boy showed the girl the picture of the baby.



The next pair of sentences in the paradigm are The boy showed the man a picture of him. and The boy showed the man the picture of himself. To account for the interpretation of these sentences the theory employs several other notions that will not be described here because they require complex revisions to the theoretical concepts presented in 2.1.0 and they are not part of the version of the framework being used in this investigation (for further discussion see: Sells, 1985).

In addition to this, these two sentences play a very different role in the test paradigm as compared to the other sentences containing pronouns. Sentence 12, The boy showed the man a picture of himself., is included in the paradigm primarily to determine which of the two possible clausemate antecedents patients will select as the referent of himself. Sentence 11, The boy showed the man a picture of him., is included only for the purposes of

comparing with results of sentence 12 to determine if there is any strategy patients use in the selection of antecedents.

Tree structures for these two sentences are give below in Figures 21 and 22 respectively. It is important to note that in the version of the theory employed by this investigation, the Governing Category , in each case is the entire S . The consequence of this is that in the case of sentence 11 , there are no clausemate antecedents for the pronominal him . However, in sentence 12 there are two possible clausemate antecedents for the anaphor himself.

Figure 21.

11. The boy showed the man the picture of him.

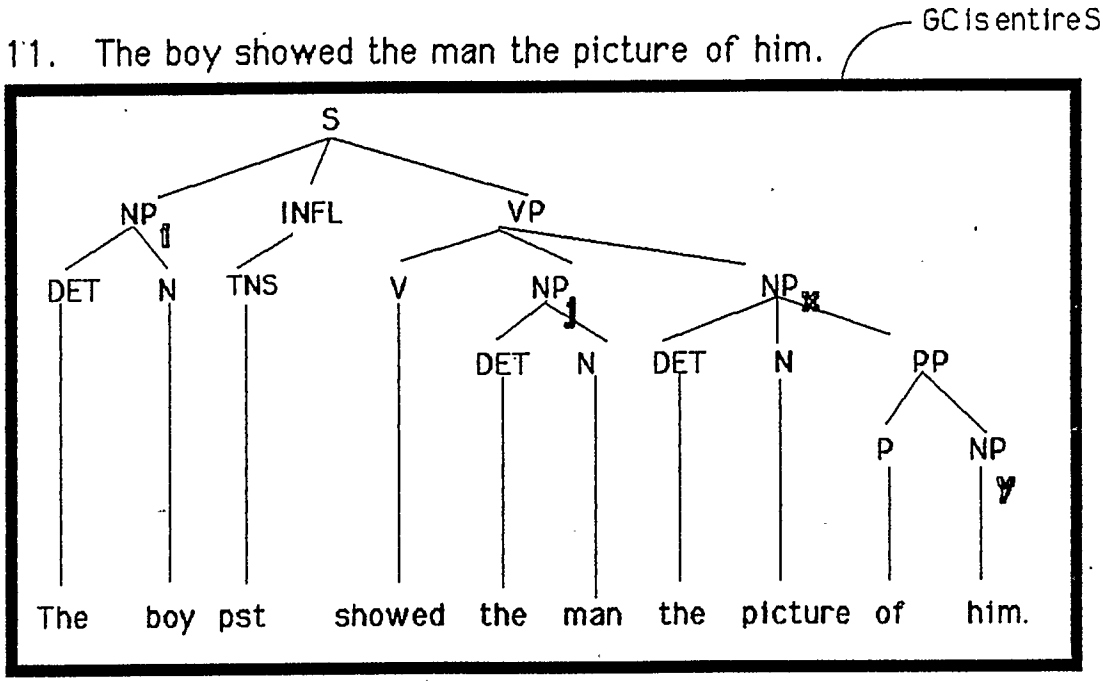


Figure 22.

12. The boy showed the man the picture of himself.

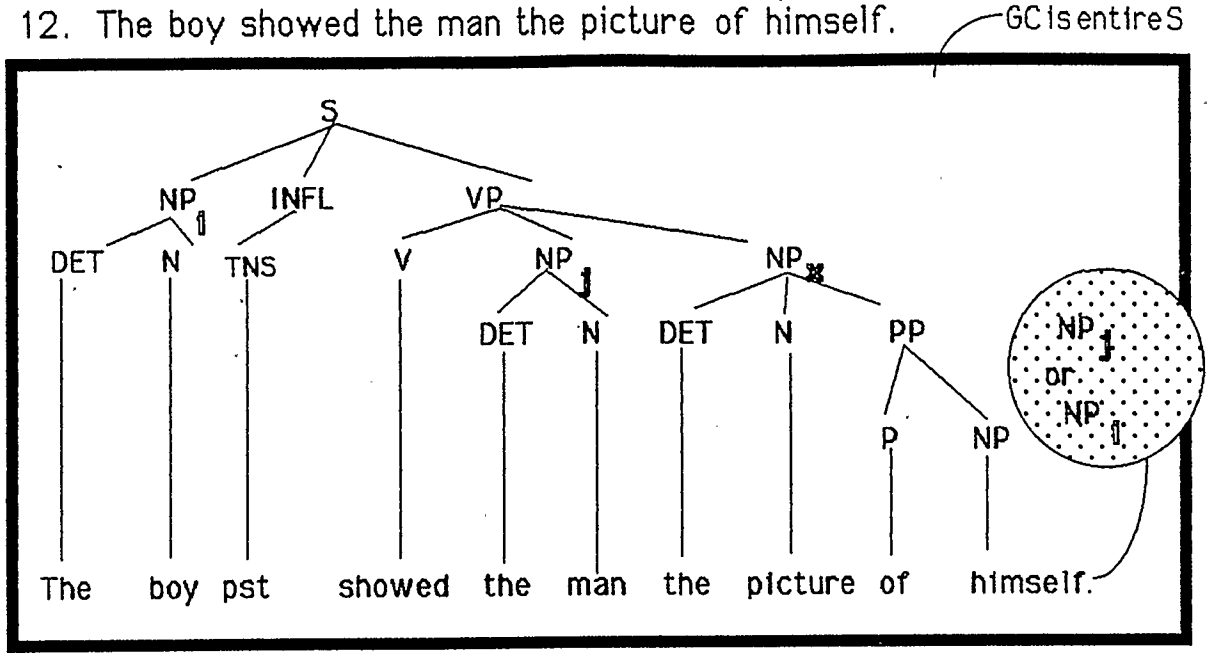
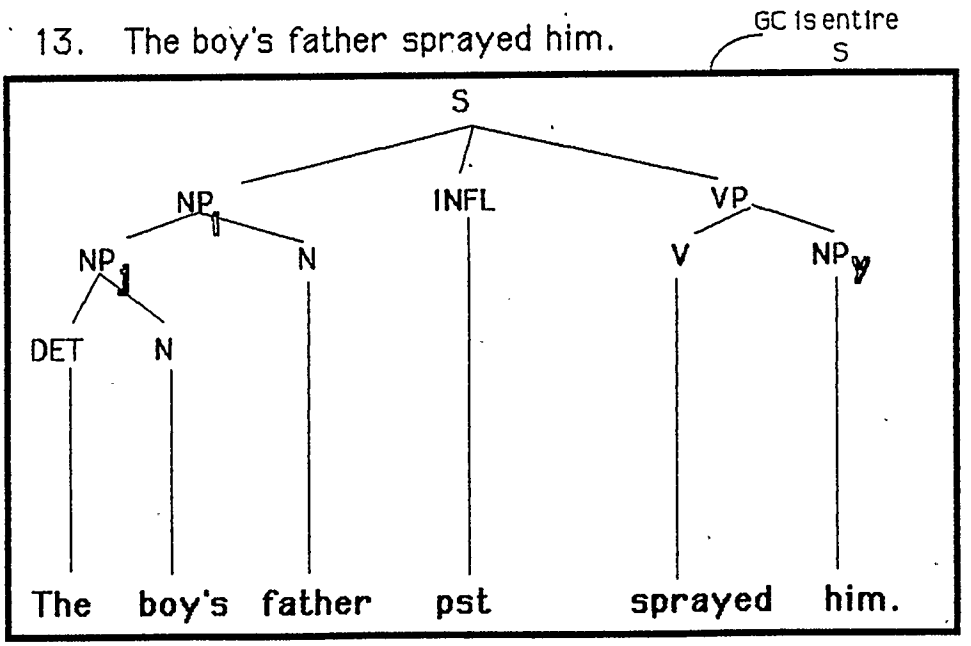


Figure 23.

13. The boy's father sprayed him.

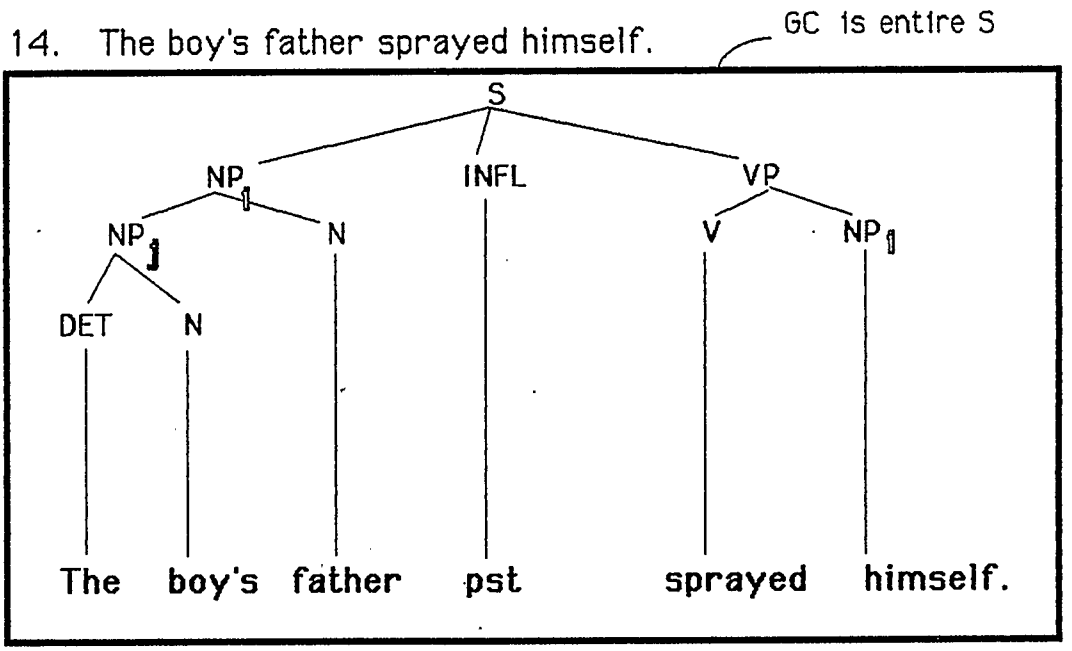


Theoretical account for the interpretation of sentence 13:

Him is a pronominal which is subject to Principle B of the Binding Theory and must therefore be free in its Governing Category which is the entire S. Although NP_i c-commands NP_y , NP_i is not a binder of NP_y because the two are not coindexed. Thus , NPy is free in its Governing Category .

Figure 24.

14. The boy's father sprayed himself.



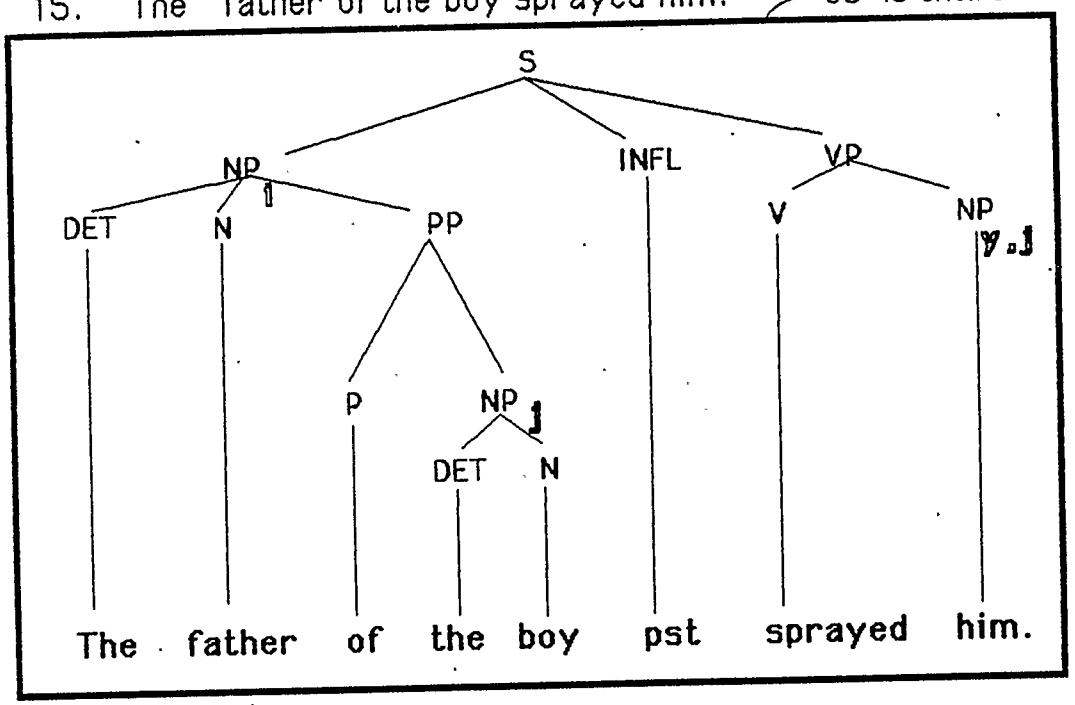
Theoretical account for the interpretation of sentence 14:

Himself is an anaphor which is subject to Principle A of the Binding Theory and must therefore be bound in its Governing Category which is the entire S. NP_i (the boy's father) both c-commands and is coindexed with NP_i (himself) and is therefore the binder of NP_i

(himself). Thus the anaphor himself is bound within its Governing Category.

Figure 25.

15. The father of the boy sprayed him. — GC is entire S

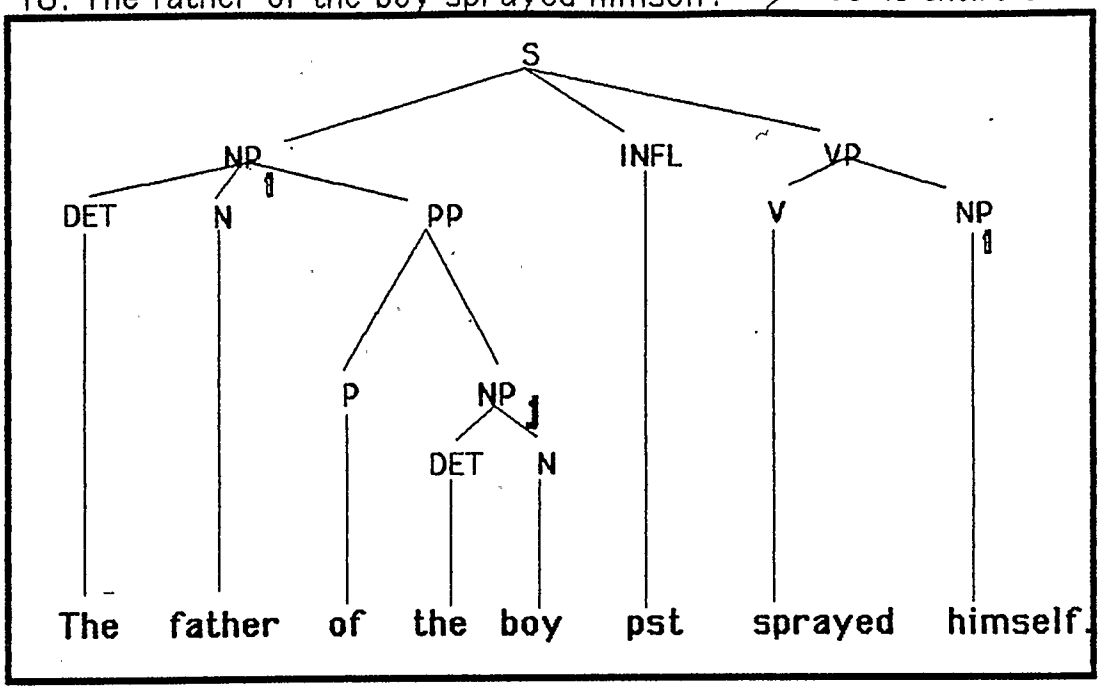


Theoretical account for the interpretation of sentence 15:

Him is a pronominal which is subject to Principle B of the Binding Theory and must therefore be free in its Governing Category which is the entire S. Although NP_i c-commands NP_y , NP_i is not a binder of NP_y because the two are not coindexed. Thus , NP_y is free in its Governing Category .

Figure 26.

16. The father of the boy sprayed himself. ← GC is entire S



Theoretical account for the interpretation of sentence 16:

> Himself is an anaphor which is subject to Principle A of the Binding Theory and must therefore be bound in its Governing Category which is the entire S. NP_i (the father of the boy) both c-commands and is coindexed with NP_i (himself) and is therefore the binder of NP_i (himself). Thus the anaphor himself is bound within its Governing Category.

Having established that Government and Binding Theory (especially The Binding Theory) provides an explicit characterization for the interpretation of sentences containing pronominals and anaphors, we can now ask the following question. If language breakdown in aphasia affects one's ability to

interpret sentences containing pronominals and anaphors, can that breakdown be characterized using notions from the Binding Theory? We need to develop an empirical task that can assist us in examining this question. Chapter 3 describes the creation of one such task.

Chapter 3

Experimental Design

3.0.0 Introduction

The investigation involves a picture-pointing task where an aphasic patient is presented with a sentences and four pictures. The patient must select the picture that he/she[2] feels best represents the meaning of the sentence.

This chapter is composed of four sections. The first three sections describe how the sentences and pictures were incorporated into stimuli for use in the picture-pointing task. The final section briefly describes highlights of a pilot study that was conducted using the test stimuli and a group of normal subjects.

3.1.0 Stimuli Design and Organization

3.1.1 The Pictures

The pictures were created specifically for the purposes of this study and were therefore not borrowed or modified versions of other aphasia test batteries. Four criteria were considered important in establishing a reasonably standardized set of pictures which were to be interpretable by aphasic patients. These criteria were:

---

[2] To avoid the ackwardness of continually repeating such pairs as he/she or him/her, I have chosen to use only the masculine form. In consideration of the reader, it should be emphasized that at no point in this thesis is there meant to be any intended sexist bias.

1) The picture and the action that it represented had to represent concrete concepts. For this reason, the verbs sprayed and showed were used because they represented a concrete action that was easily and clearly illustratable.

2) The picture had to be as simple as possible without compromising content. A more cartoon like style was chosen and an attempt was made to construct the pictures with approximately the same amount of detail.

3) The objects and persons illustrated in the pictures had to represent concepts familiar to the patient. It was reasoned, for example, that notions such as the boy and the father would be more familiar to patients than concepts such as the diplomat or the engineer.

4) A limited number of characters appear in the pictures so as to prevent overloading the patient with novel visual detail that might influence his responses.

The characters used in the test pictures are illustrated in Figure 1. It must be noted that throughout this discussion the pictures presented are reductions of the originals and a certain amount of detail and clarity has been compromised in the shrinking process. The original test pictures averaged approximately 2" in height and were presented in one of four quadrants on 11" x 17" white paper. They were made particularly large so as to lessen visual strain and fatigue during the testing sessions.

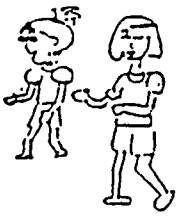
Figure 1. The Primary Characters.

a) the boyj

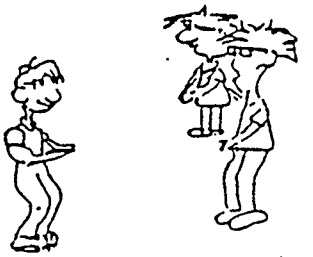
b) the boy'sj father

c) the girl

d) the baby

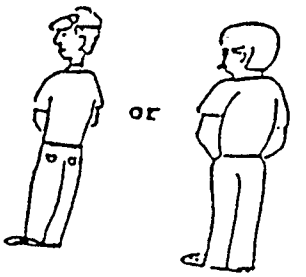


e) the girls



f) the boys

g) the dog

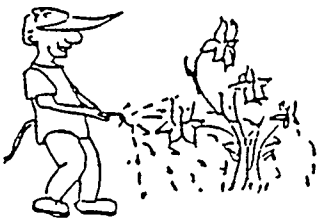


h) the man

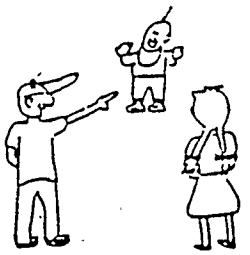
The picture format was also standardized so that the agent of the action was placed on the left side of the picture and the patient or the observer on the right. This was done to accommodate what is considered to be a normal left to right scanning bias for native speakers of English. As an example, Figure 2 illustrates the target pictures of two of the test sentences.

Figure 2.

Examples of standardized Agent → Patient
action



a) The boy sprayed the flowers.



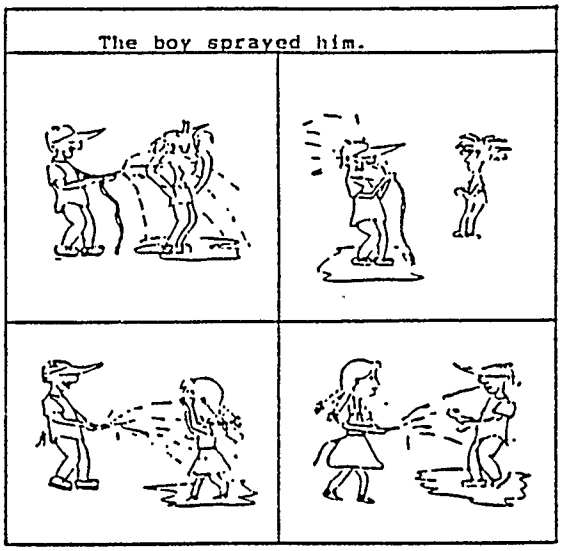
b) The boy showed the baby to the girl.

An attempt was made to control the amount of detail one picture contained relative to the other three pictures on the same page. Not only does this keep the pictures balanced with respect to detail but it also may help decrease the

chance of the patient selecting a particular picture simply because it stands out visually from the others.

The amount of detail in the pictures was balanced. In Figure 3, for example, note that each picture contains two characters even though the two characters in each picture may not be involved in the action.

Figure 3.



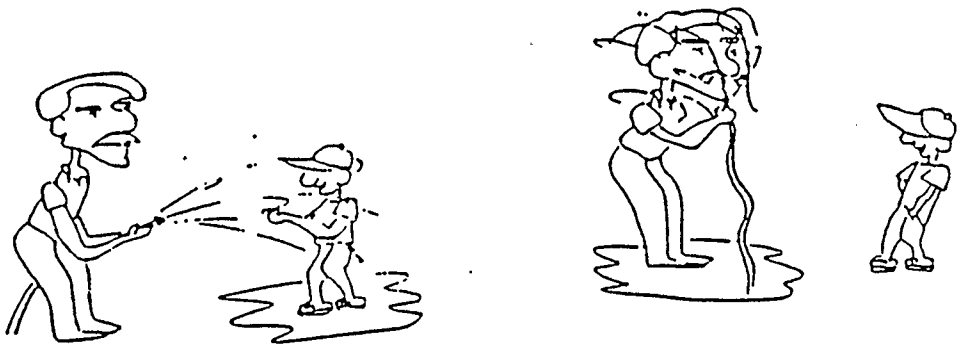
3.1.2 The Construction of the Stimuli

The way in which the test sentences were incorporated into the picture-pointing task is described in the discussion that follows. Sentence 13 (The boy's father sprayed him.) and sentence 14 (The boy's father sprayed himself.) are used as examples. Each test sentence is presented with four pictures and for convenience, this arrangement is referred to as a frame.

The target picture is the only picture which corresponds to the correct interpretation of the test sentence (except in the case of sentences 11 and 12).

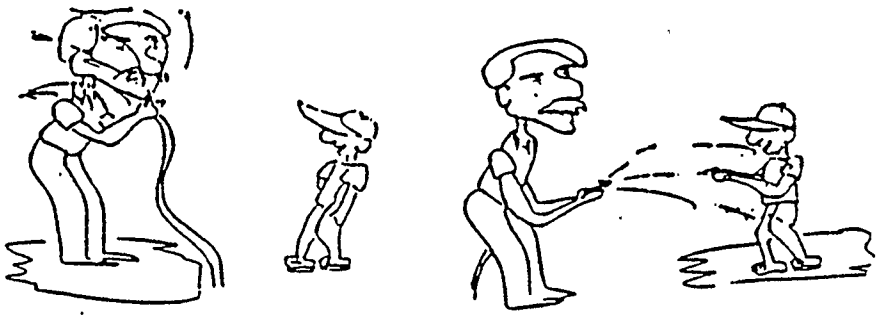
Picture #2 often represents a case where a pronominal is misinterpreted as the corresponding anaphor (or vice versa) . So for example, if the test sentence contains a pronominal , picture #2 would illustrate the sentence as if it contained the corresponding anaphor. This is illustrated in Figures 4 and 5.

Figure 4. Test sentence: The boy's father sprayed him.



Target ('him') #2 ('himself')

Figure 5. Test sentence: The boy's father sprayed himself.



Target ('himself') #2 ('him')

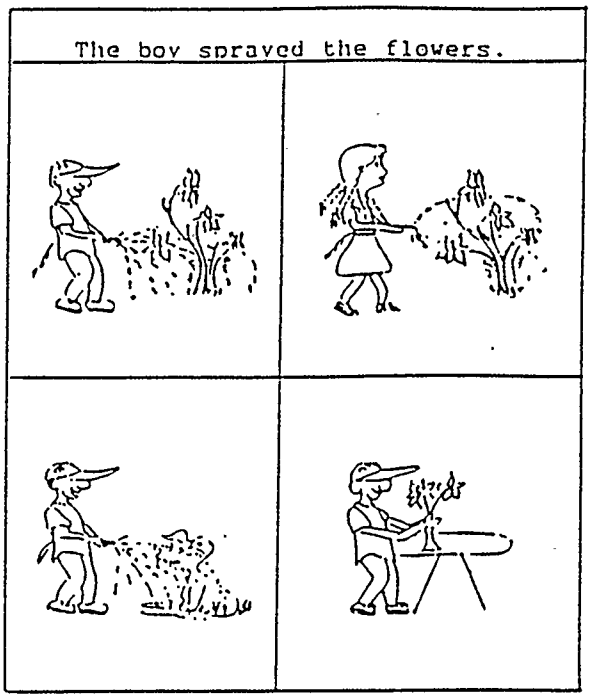
In addition to the target (T) and #2 pictures, two other pictures are included with each test sentence. Pictures #3 and #4 serve the following three primary functions. First, they decrease the possibility of the patient selecting the target picture by chance alone. With four pictures the patient has only a 25% chance of randomly choosing the correct picture whereas with only two pictures he would have a 50% chance of selecting the target . Second, they serve as distractors from the target. Third, sentences #3 and #4 provide additional information concerning the types of errors that the patient may make if he cannot, for whatever reason, select the target.

The three nontarget pictures play a crucial role in this investigation because each of them represents a possible misinterpretation of the test sentence. If the patient is presented with the same frame randomized over repeated trials and consistently selects one of the nontarget pictures then we can examine his errors and be able to make informative observations concerning some aspect of his language impairment.

In the experimental setting, when the patient is given a sentence and asked to point to the picture described by the sentence, he must select from an arrangement like the one in Figure 6.

Figure 6.

T #2



#3 #4

Sentences corresponding to the pictures:

Target: The boy sprayed the flowers.

#2: The girl sprayed the flowers.

#3: The boy sprayed the dog.

#4: The boy arranged the flowers.

Throughout this discussion, when referring to a given frame like that represented in Figure 6, labels for pictures and sentences corresponding to the meaning of pictures may be given. It is important to note that in the actual task , however, the patient was presented with a frame that consists only of the test sentence and the four pictures. Also, for the purposes of this discussion, whenever a frame is presented , the order of the pictures will follow that illustrated in Figure 6, unless otherwise specified. This type of fixed ordering represents an 'unshuffled frame'. The unshuffled state is reflective of the

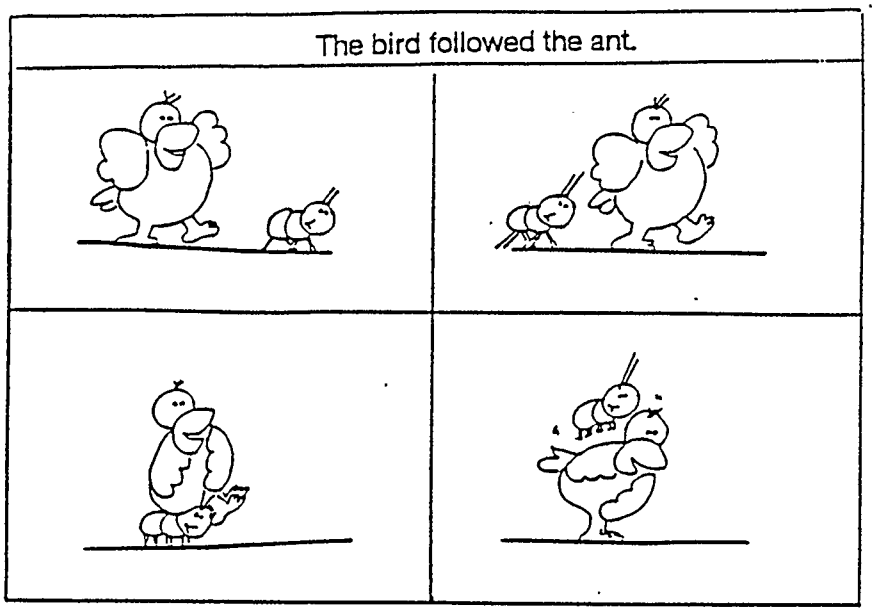
layout before randomization. However, in the actual test situation the frames were pseudorandomized.

As a word of clarification, when a certain sentence is said to correspond to a specific picture, this is not to imply that the patient actually generates that particular sentence in his mind. We are simply entertaining probable interpretations for each of the pictures and reasoning that if one of the three nontarget pictures is consistently chosen, then this should provide some insight as to how the target sentence is being misinterpreted.

3.2.0 The Fillers

Subsequent to the shuffling or randomization procedure, a set of filler frames were inserted between each of the test frames. The fillers consisted of sentences that did not contain pronouns and which used a different set of characters that were all animals. An example of a filler is given in Figure 7.

Figure 7. A Sample Filler



The fillers deliberately employ different characters and sentences than those used in the test frames. This reflects an attempt to decrease the cumulative overload effect that a patient may experience if presented with many test frames, the majority of which contain sentences with him or himself. If there is any type of saturation effect, the patient's performance on the task would deteriorate and , consequently, so would the reliability of his judgements.

There is also a possibility that if the patient is presented only with frames containing the test sentences, then he may become alert to the fact that several of the test sentences have a similar sentence construction. One of the liabilities of this is that the patient may develop a response pattern that is based on the construction of the stimulus sentences.

This may be especially true if the patient is unsure of the appropriate response to a given sentence. In such an instance, when presented with a new stimulus

sentence (S2) containing a construction that he has already seen in a previous sentence (S1), the patient may select a picture for S2 based upon a judgement that he made when he was presented with S1.

The fillers, then, serve two primary functions. They decrease the possibility of the patient experiencing some sort of cumulative saturation effect and they help to prevent the patient from constructing a response strategy that is based on the ordering of the test frames.

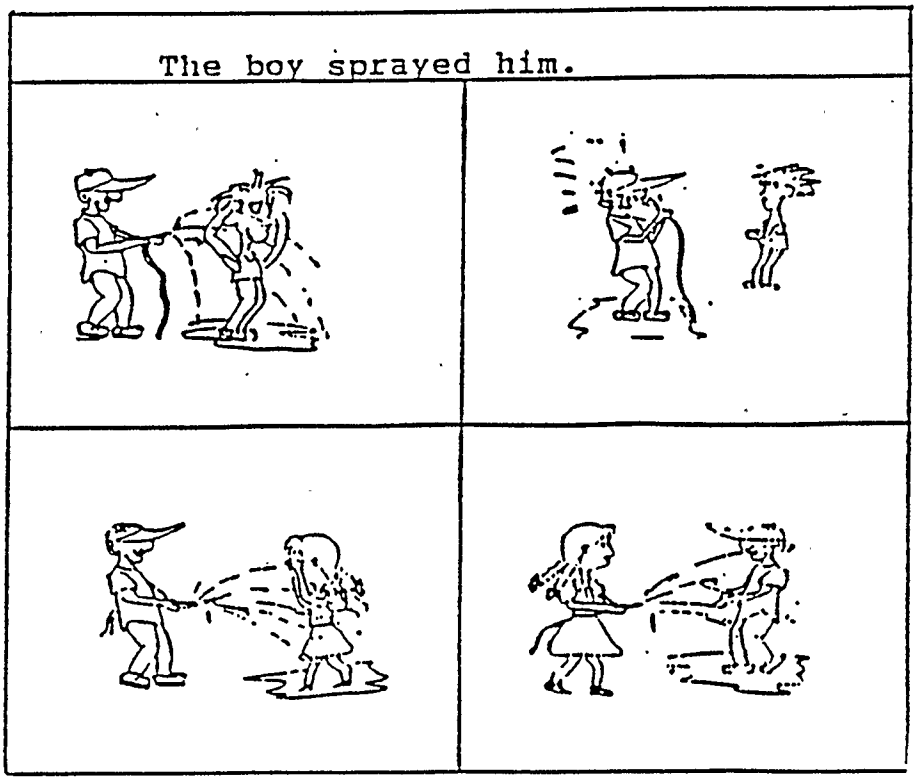
3.3.0 The Stimuli

This section presents the test frames that involve pronominals and anaphors.

3.3.1 The boy sprayed him.

The boy sprayed himself.

Figure 8.



Sentences corresponding to the pictures:

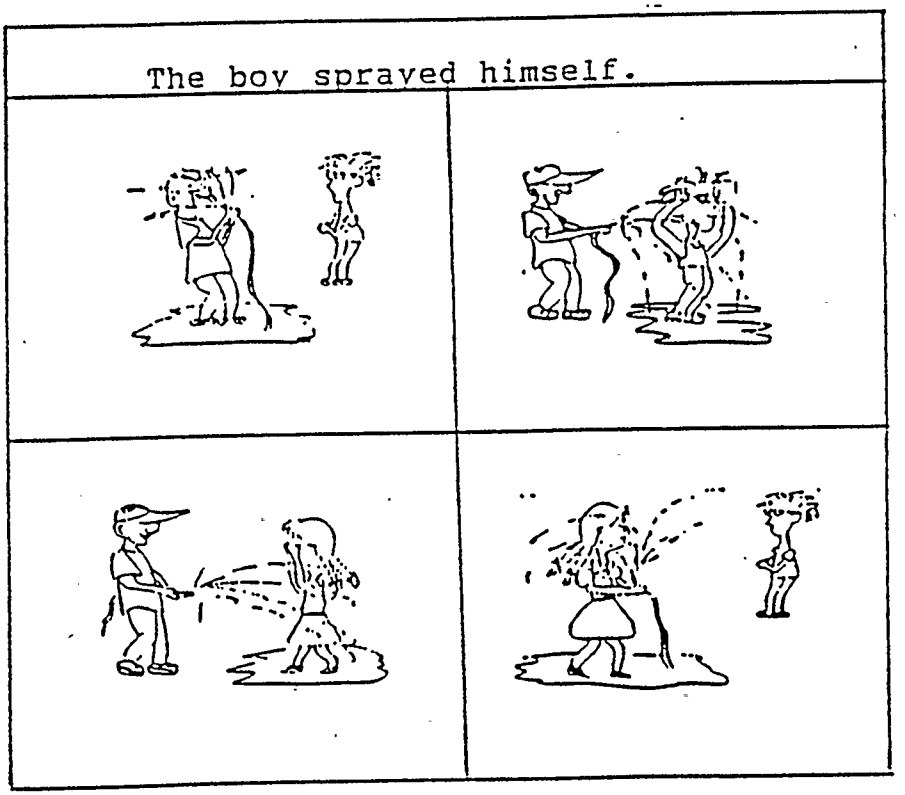
T: The boy sprayed him.

#2: The boy sprayed himself.

#3: The boy sprayed her/the girl.

#4: The girl sprayed him/the boy.

Figure 9.



Sentences corresponding to the pictures:

T: The boy sprayed himself.

#2: The boy sprayed him .

#3: The boy sprayed her/the girl.

#4: The girl sprayed herself.

Possible interpretations of pictures in Figures 8 and 9:

T: If the patient selects (T) in both frames it indicates that the patient can distinguish between him and himself

#2: a) If the patient selects #2 in both cases, it indicates that the patient interprets him as the anaphor and himself as the pronominal.

b) If the patient selects #2 in Figure 8 and (T) in Figure 9 then it would appear as if both himself and him were being interpreted as if they were anaphors.

c) If the patient selects #2 in Figure 9 and (T) in Figure 8 then it would appear as if both him and himself were being interpreted as if they were pronominals.

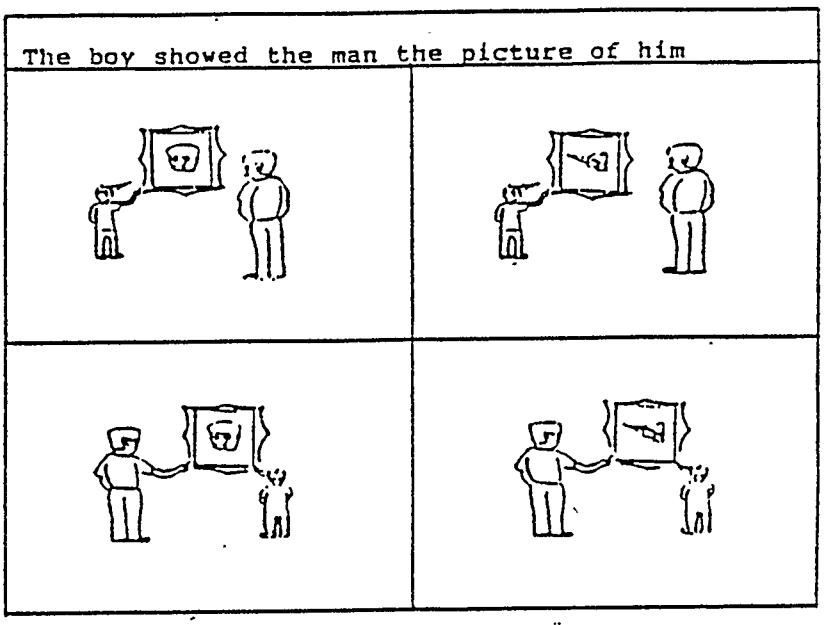
#3 & #4: If the patient selects #3 or #4 for either frame it may indicate a problem involving gender distinction.

3.3.2 The boy showed the man the picture of him.

The boy showed the man the picture of himself.

Figure 10.

T_o



$\#2_o$

Sentences corresponding to the pictures:

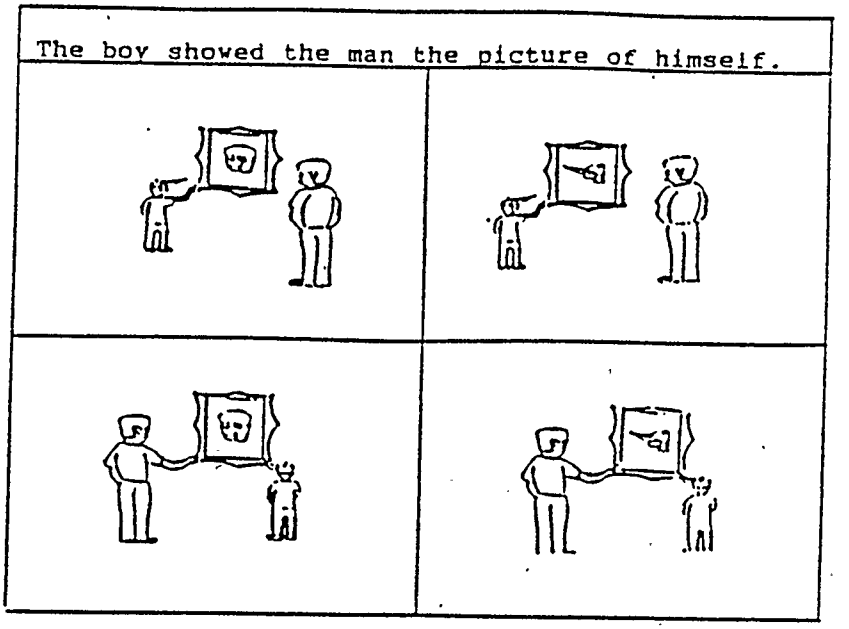
T_o & $\#2_o$: [3] T he boy showed the man the picture of him.

#3 & #4 : The man showed the boy the picture of him.

---

[3] Where To and 2o represent the fact that there may be no clausemate antecedent for 'him'.

Figure 11.



Sentences corresponding to the pictures:

T_1 & T_2: The boy showed the man the picture of himself.

#3 & #4 : The man showed the boy the picture of himself.

Possible interpretations of Figures 10 and 11.

If the patient selects T_1 in Figure 11 it indicates that he interprets the man as the antecedent of himself. If he selects T_2 in Figure 11 it indicates that he interprets the boy to be the antecedent of himself.

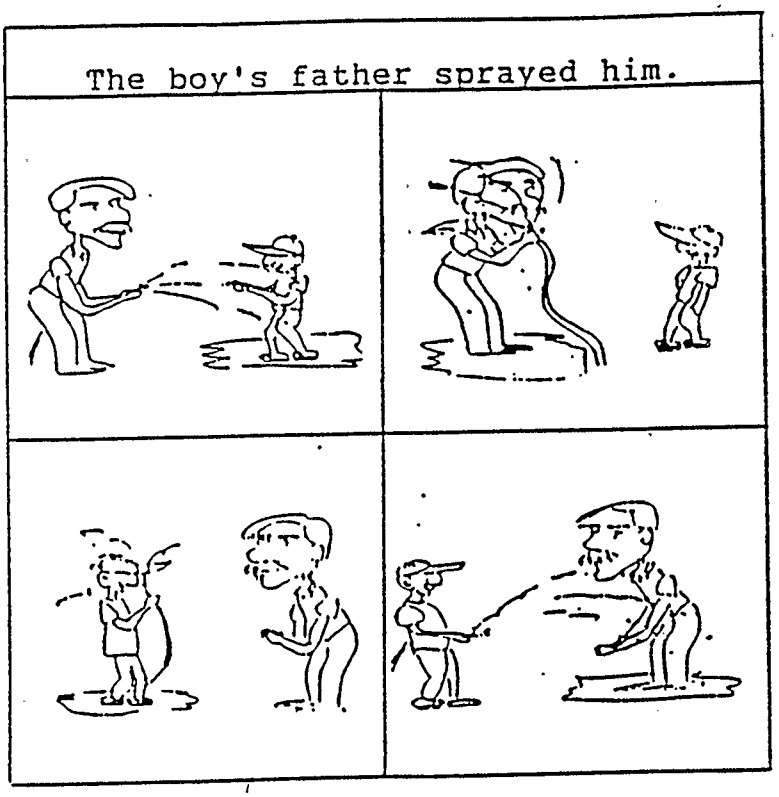
Note that in Figure 10 there are no pictures corresponding to the target interpretations of the sentence and that the pictures in Figure 10 and Figure 11 are identical. The reason for this is as follows. If the patient selects T_0 in

Figure 10 and T_1 in Figure 11 or $\#2_o$ in Figure 10 and T_2 in Figure 11 it indicates that he interprets <u>him</u> as <u>himself.</u>

3.3.3 The boy's father sprayed him.

The boy's father sprayed himself.

Figure 12.



Sentences corresponding to the pictures

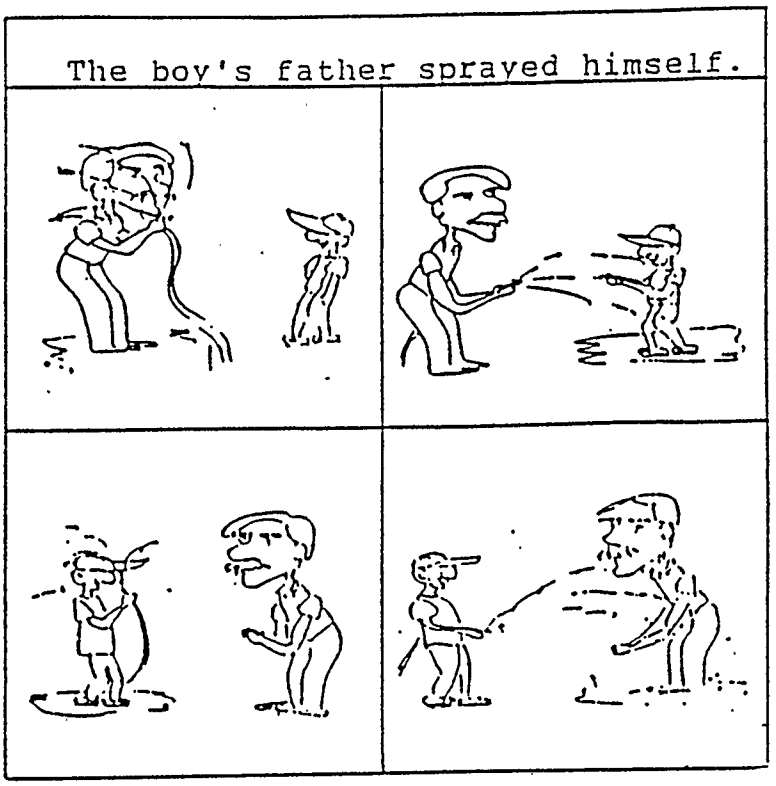
T: The boy's father sprayed him.

#2: The boy's father sprayed himself.

#3: The boy sprayed himself.

#4: The boy sprayed him.

Figure 13.



Sentences corresponding to the pictures

T: The boy's father sprayed himself.

#2: The boy's father sprayed him.

#3: The boy sprayed himself.

#4: The boy sprayed him.

Possible interpretations of Figures 12 and 13:

T: If the patient selects (T) in both Figure 12 and 13, it indicates that the patient can distinguish between him and himself

#2: a) If the patient selects #2 in both cases, it indicates that even though the patient is able to distinguish between him and himself , he interprets him as the anaphor and himself as the pronominal.

b) If the patient selects #2 in Figure 12 and (T) in Figure 13, then it would appear as if both himself and him were being interpreted as if they were anaphors.

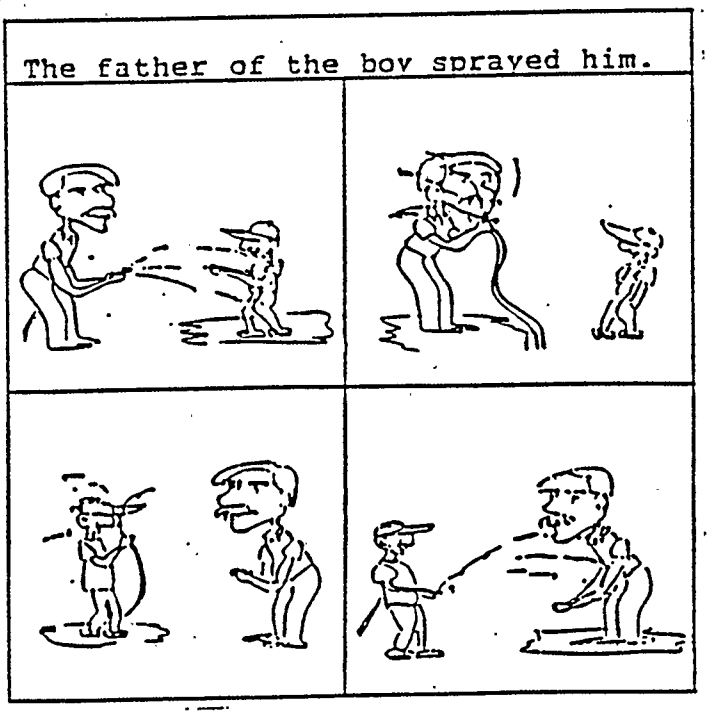
c) If the patient selects #2 in Figure 13 and (T) in Figure 12 then it would appear as if both him and himself were being interpreted as if they were pronominals.

#3 & #4: If the patient selects #3 or #4 in Figures 12 and/or 13, it may indicate that the patient interprets the subject of the sentence to be the boy.

3.3.4 The father of the boy sprayed him.

The father of the boy sprayed himself.

Figure 14.



Sentences corresponding to the pictures

T: The father of the boy sprayed him.

The boy's father sprayed him.

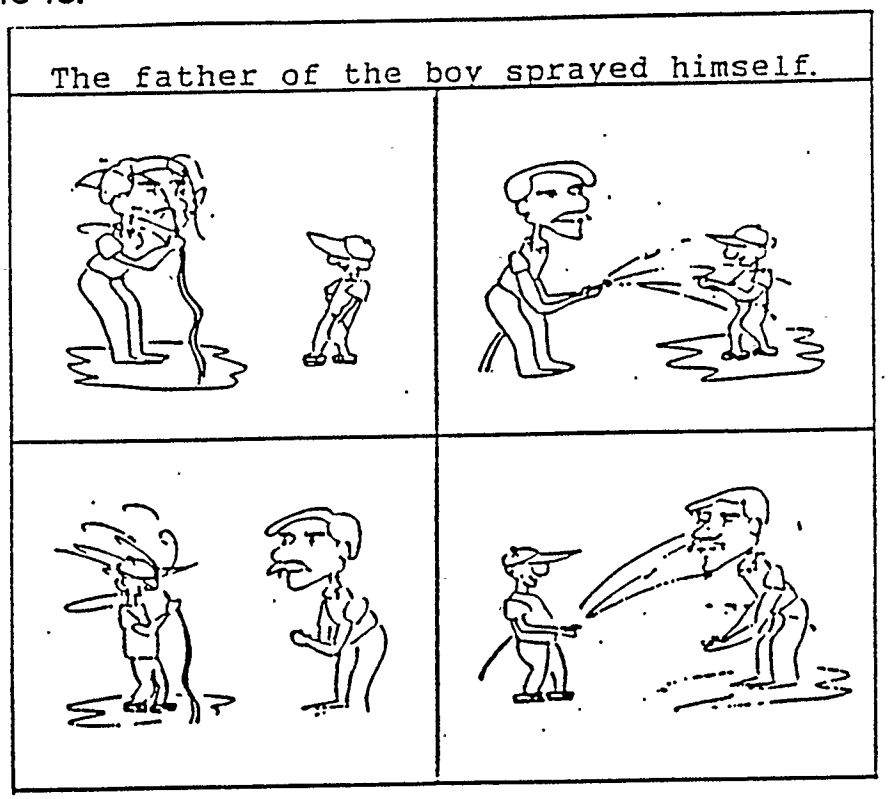
#2: The father of the boy sprayed himself.

The boy's father sprayed himself.

#3: The boy sprayed himself.

#4: The boy sprayed him.

Figure 15.



Sentences corresponding to the pictures

T: The father of the boy sprayed himself.

The boy's father sprayed himself.

#2: The father of the boy sprayed him.

The boy's father sprayed him.

#3: The boy sprayed himself.

#4: The boy sprayed him.

The possible interpretations of Figures 14 and 15 are similar to those given in 3.3.3 for Figures 12 and 14.

Once all of the test and filler frames were assembled and pseudorandomized a modified version of the task was administered to a group of normal subjects as part of a pilot study. Relevant details of this study are included in the following section.

3.4.0 Pilot study

The pilot study involved 35 undergraduate university students. They were divided into two groups and each group was asked to perform one of two tasks. Group A consisted of seventeen individuals who were given a Sentence Creation Task and Group B consisted of 18 individuals who were administered a Picture-Pointing Task. We will consider the picture-pointing task first.

3.4.1. Picture-Pointing Task

(i) Introduction

The Picture-Pointing Task was basically the same as the task which was administered to aphasic patients. It was given to normal subjects for two reasons. First, it was necessary to determine whether normal subjects would

select all the pictures that had been designated as targets. Second, the results from the task involving normal subjects might provide information which could be compared to results from the investigation involving aphasic patients.

(ii) Procedure

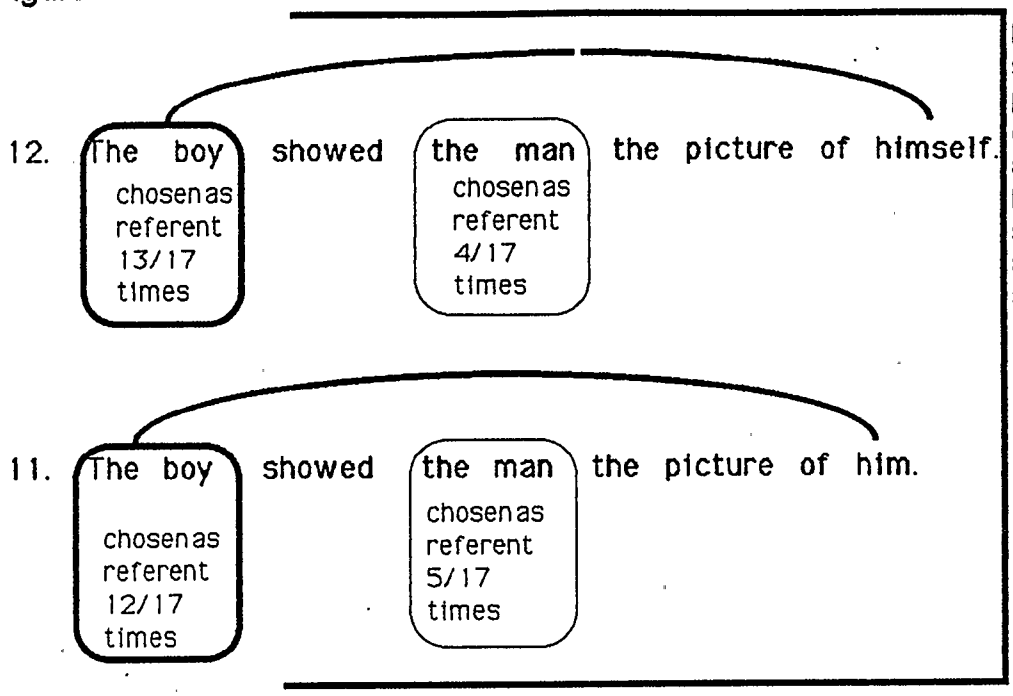
Each of the eighteen subjects in Group B was given a copy of twenty-six frames involving only sentences from the test paradigm. The subjects were instructed to read each sentence silently, examine the four pictures, and then select which picture best represented the meaning of the sentence. It was stressed that time was of the essence and that they should proceed through the frames as quickly as possible without guessing at or missing a frame.

(iii) Results

All eighteen subjects selected the appropriate target pictures. This confirmed that those pictures which had been called targets by the creators of the test, correctly illustrated the normal interpretation of each of the test sentences.

Of specific interest were the pictures that normals selected for the sentences The boy showed the man the picture of him. and The boy showed the man the picture of himself. Figure 16 illustrates these selections. Sentence 12 is presented first because there are two possible target selections. Notice that the majority of normals chose the boy as being the antecedent of himself. In addition, normals also choose the boy as the antecedent of him in sentence 11.

Figure 16.



Based on the selection of pictures, it appears that normals chose an antecedent for him , in sentence 11, as if him was the corresponding anaphor himself. A discussion of this particular pattern will be presented in greater detail in Chapter 5. It is significant to note however, that the selection of antecedents for him in sentence 11 is not random but follows a particular pattern similar to that of antecedent selection for himself in sentence 12.

3.4.2. Sentence Creation Task

(i) Introduction

The Sentence Creation Task was designed to address the following question: Do normal subjects interpret the pictures in the same way as the artist intended them to be interpreted ? It was reasoned that if the pictures were standardized, then in principle, if normals were asked to write sentences

corresponding to each of the pictures, the sentences for each picture should be more or less the same because the normals' interpretations of the pictures would be more or less the same.

(ii) Procedure

All of the pictures created for the task were sorted according to the verbs that each was supposed to represent. One group consisted of pictures illustrating the verb sprayed and the other the verb showed. Normal subject Group A was given two sheets of paper. At the top of each sheet one of the two verbs was printed in large bold type. Subjects were instructed to examine the pictures individually and then to write one sentence that described each of the pictures. They were told that the sentences must contain whatever verb appeared at the top of the page.

(iii) Results

Not all of the sentences given by normals are listed here because they are too numerous to mention. Ninety-five percent of the sentences that were written corresponded to close variations of the interpretations that had been established at the outset. The only variation notable was in the nouns used for the subject and direct object. Most of the subjects (i.e., 74%) used the proper names John and Mary whereas the characters are known in the test as the boy and the girl.

The close correspondence in the sentences that were written by normals indicated that, for the most part, the intended meaning of each of the pictures was clear. In several cases, however, there was significant variation in the

subjects' identification of picture components. Any findings of this nature resulted in the relevant pictures being redrawn or altered so that potential ambiguity was removed prior to the presentation of the material to aphasic patients.

Once the piloting of the task was complete and important alterations had been made, it was then administered to a group of aphasic patients. Details of this study are as follows in Chapter 4.

Chapter 4

The Empirical Study

4.0.0 Introduction

The aim of this chapter is to describe the three main components of the empirical study. The first component deals with relevant subject information and guidelines for subject selection. The second component describes experimental methodology that was used in this investigation. Particular emphasis is given to the physical setting in which the test took place and the procedural guidelines for administering the test. The third component of this chapter involves a summary of the various factors pertaining to experimental control.

4.1.0 Subjects

A list of candidacy requirements was submitted to the speech and language pathology departments of three hospitals in central Alberta. Patients were prescreened by attending clinicians who were familiar with both the experimental test and procedures for its administration. The three primary selection criteria for patients required that, 1) they be able to point or somehow (verbally or otherwise) indicate their picture selection , 2) that they not be so severely impaired that they could not comprehend monoclausal sentences of approximately 5 - 10 words in length , and 3) that they be able to attend to the task without extreme difficulty.

Clinicians were instructed to eliminate those potential candidates who clearly demonstrated disturbances which would somehow influence test results. The

most important example of this is memory. If, through other assessment procedures, clinicians were able to diagnose a significant degree of pure memory loss such that patients might, for example, be unable to recall what the task required of them, then those patients were considered ineligible for the study.

Because of different assessment procedures used by each of the institutions none of the patients were diagnosed as belonging to a specific clinical category of aphasic type. In addition, CT scan (computed tomography) information was only available for two of the patients which implied that exact lesion site was either undetermined or unreported for the remaining patients. Because of nonstandard procedures of clinical assessment and because of limited information concerning the exact lesion site, it was decided that patients would be classed only as being either fluent or nonfluent aphasics.

Twenty-two patients were interviewed for the the study. Of those interviewed six patients were inappropriate because they were either so mildly impaired that they failed to err on the test or they were fluent aphasics who were so severely impaired that they could not perform the task. Table 1 presents relevant patient information including the etiological details that were available for the sixteen patients who were eligible for the study . All sixteen patients were right-handed and with one exception, all were native speakers of English. The mean patient age was 50 years and the mean number of months post onset was 27.

Table 1. Subject Information

Subject	Sex	Age	No. of Months Post Onset	Etiology
1.	M	43	18	LCVA
*2.	M	64	17	LCVA
*3.	M	41	64	LCVA
4.	M	52	6	LCVA
5.	F	69	6	LCVA
6.	M	65	26	LCVA
7.	M	21	15	L. Temporal hematoma after head injury
8.	F	27	12	L. aneurysm
*9.	M	48	43	LCVA
10.	F	51	6	LCVA
11.	F	41	73	LCVA
12.	F	69	11	LCVA
13.	M	58	21	LCVA
14.	M	68	13	LCVA
*15.	F	21	60	LCVA
*16.	M	67	48	LCVA

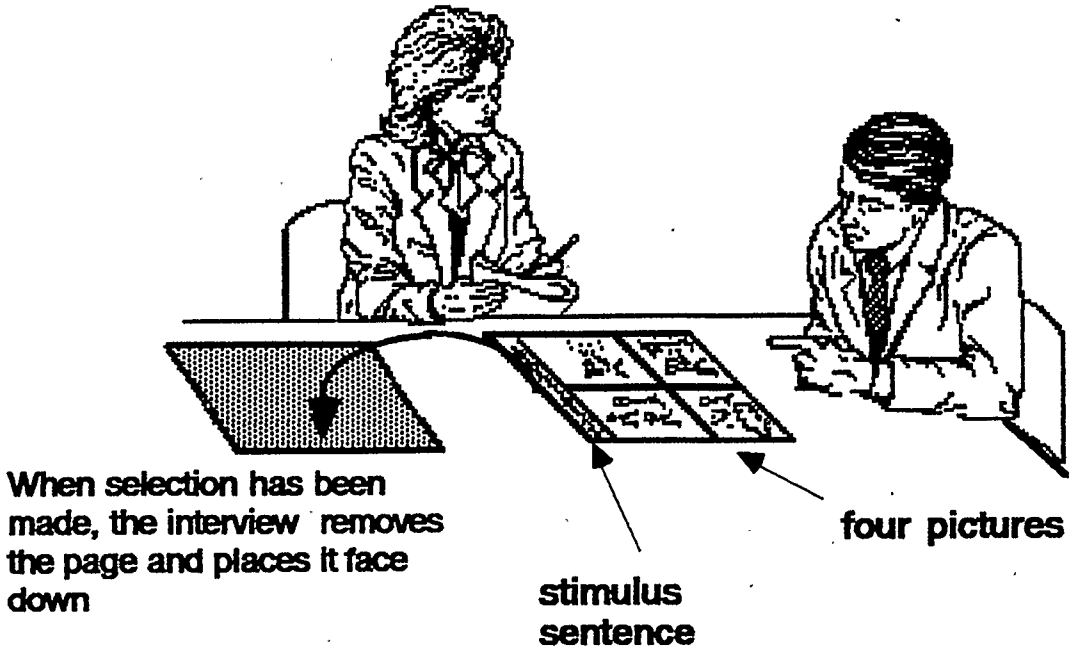
* Indicates multiple cerebral accidents within the period of post onset

4.2.0 Method

4.2.1 Physical setting

Testing took place either at one of the hospitals or in the patient's home. In all instances the physical setting was that denoted by the picture in Figure 1, where the interviewer sat to the right of the patient. This particular positioning was important because in almost all cases patients used their left hand to point to a picture. After the patient had selected a picture the interviewer would take the page off and lay it face down, thereby exposing a new frame for the patient to look at. By sitting to the right of the patient, this movement of papers did not interfere with the patient moving his left hand to select a picture.

Figure 1.



In all cases , only the interviewer and the patient were present in the room where testing was conducted. The testing table was clear of all other materials so that the only object on it was the test. This was done to eliminate any type of visual distraction. Even the coding sheets used by the interviewer were not placed on the table but were held by the interviewer in such a way they were not visible to the patient. In addition, all auditory distractions such as hallway noise and radio music were suspended for the duration of testing. This ensured that the only auditory input the patient was receiving was that of the interviewer reading the test sentences .

As testing averaged forty-five minutes to one hour, the patient was made as comfortable as possible at the outset of the session. The patient was also informed that if he needed a brief break to move, have a drink of water, etc.,

he could do so. In fourteen out of sixteen cases these breaks were unnecessary. The remaining two cases involved more severely impaired patients relative to the others, and it was necessary for them to periodically take a few moments to relax.

4.2.2 Procedure

The administration of the test involved five steps: (i) Introductory Remarks, (ii) Pretest , (iii) Test, (iv) Cooldown, (v) Concluding Comments. Details of each of these steps will be described in detail .

(i) Introductory Remarks

Once the patient was positioned at the table he was told that the study had to do with some aspect of how people understand sentences and that it involved a picture-pointing task. The interviewer then read and explained the contents of an consent form which was subsequently signed by the patient. The table was cleared and the test was placed in front of the patient. The top page was a blank piece of paper and the patient was told that under the paper was a page containing all the people and animals that he would see in the pictures that followed. The blank page was then removed exposing a sheet of characters .

The interviewer introduced each of the characters twice, starting from the top of the page and working toward the bottom. The patient was then asked to point to whatever character the interviewer instructed him to. This demonstrated the patient's ability to recall the characters as well as his ability to point. All sixteen patients performed this task with 100% accuracy. The

page of characters was reintroduced twice during the actually testing session and the patient was asked , "Can you please point to _____?". Once again, all sixteen patients achieved 100% accuracy , which demonstrated that in all cases the patients were able to recall names and identity of the specific characters.

(ii) The Pretest

The character sheet was lifted off exposing the first of five pretest frames. The aim of the pretest was to 1) introduce the patient to the physical presentation of the stimulus frames, 2) provide the patient with a set of instructions for test, 3) to determine whether the patient understood the instructions and was aware of the type of performance that the task demanded of him. In essence, the pretest served as a warmup to the actual test and familiarized the patient with the testing procedure. These frames were not scored. The sentences used in these frames did not contain any pronouns. Both the sentences and the pictures were designed to be as simple as possible so that the patient gained confidence about his performance prior to the actual test frames.

When the patient was presented with the first pretest frame, he was given the following instructions.

> Interviewer : On each of the pages that follow, you [the patient] will see a sentence at the top and four pictures below it like this..... [the interviewer pointed to each one of the four pictures starting from the upper left corner, proceeding right, then lower left corner, proceeding right].

Interviewer : I will read the sentence out loud to you. Try to read the sentence silently to yourself. If you need me to repeat the sentence for you, I will . You must then look at each one of the pictures very carefully .....[again , the interviewer pointed to each one of the four pictures starting from the upper left corner, proceeding right, then lower left corner, proceeding right].

Interviewer : Once you have looked at all of the pictures, you must point to the picture that goes with the sentence. Try not to take too long on any one sentence. We can go as fast or as slowly as you need to, but you must try to point to a picture as quickly as you can . Try not to guess. Do you understand what you have to do ?

Patient: [generally nodded or said 'yes'].

Interviewer : Good. Now let's practice. I will start with this first sentence [that of the first pretest frame]. 'The man waved'. Look at each one of the pictures carefully. Please point to the picture that goes with the sentence.

At the conclusion of the last pretest frame the interview once again asked the patient if he knew what he was supposed to do. If the patient appeared uncertain or if the patient had erred on one or more of the pretest frames , the interviewer started from the the beginning of the pretest and repeated all five frames. Although some patients erred on the first round of the pretest, they did not err on the second round. All sixteen patients accomplished the pretest frames with 100% accuracy on the first and/or the second round.

The patient was asked if he had any questions and if he was ready to proceed with the rest of the pictures. If there were questions, they were addressed and the actual test was then begun.

(iii) The Test

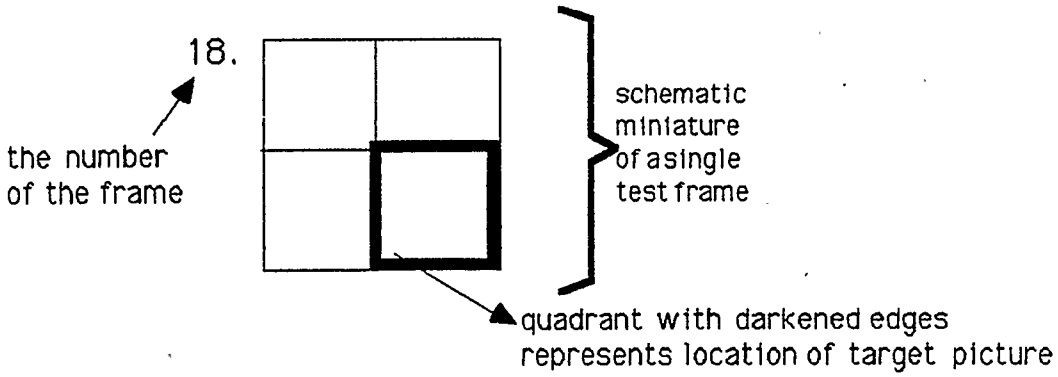
During one round of the test, the patient responded to 53 sentences , 26 of these were test sentences and the remaining 27 were fillers. To increase the reliability of results, the testing session allowed for a maximum of three repeated trials or rounds of the test.

It tended to be the case that those patients who were mildly impaired were able to proceed through three trials in one testing session . Those with a more severe impairment tended to respond much slower and were unable to complete three rounds of the test. In all cases however, a minimum of two test trials were completed.

If a patient had trouble with a particular frame, and asked to skip it and go on to the next, at the end of the testing session the interviewer came back to the missed frames and presented them to the patient again. This ensured that all frames were answered.

A portion of the coding sheet is illustrated in Figure 2.

Figure 2.

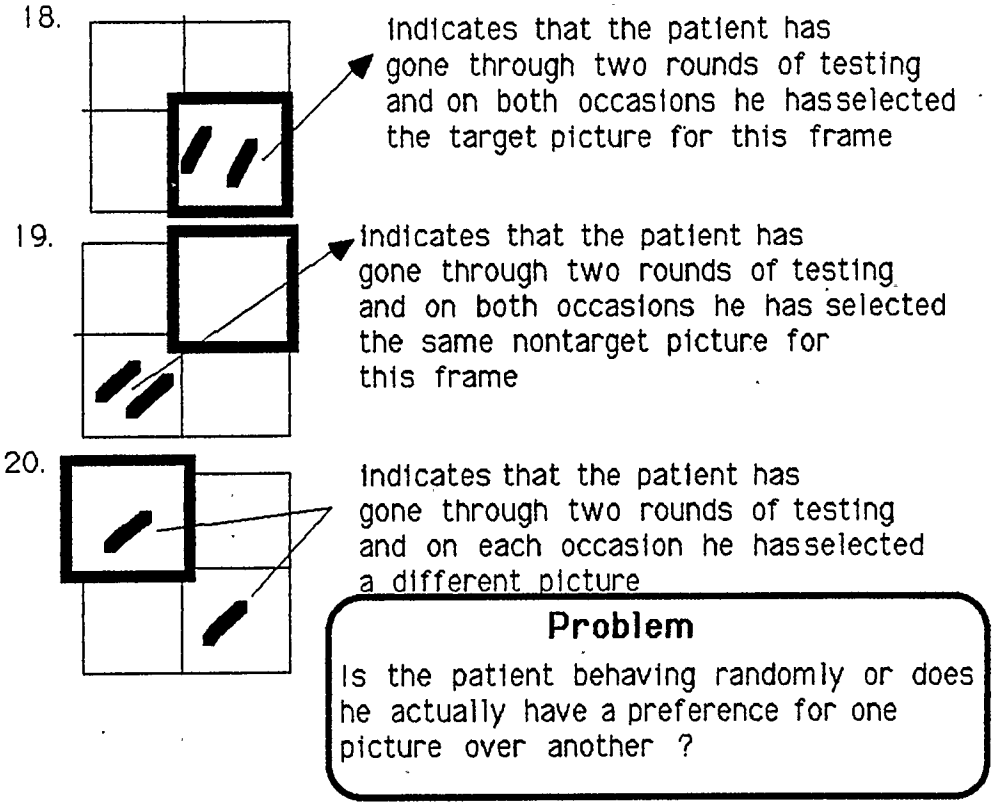


In reference Figure 2, when the patient was presented with frame #18, he would point to the picture of his choice and the interviewer would put a mark indicating the patient's selection in the corresponding quadrant on the coding sheet.

The coding sheet was structured so that the interviewer could glance quickly over the patient responses and determine on which test frame(s) the patient appeared to respond randomly . Three coding frames are illustrated in Figure 3 and each contains possible patient responses that have been marked by the interviewer.

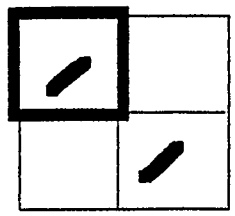
Notice that #20 poses a problem because if the patient has only seen test frame #20 twice, then we cannot be sure if his picture selection is truly random .

Figure 3.

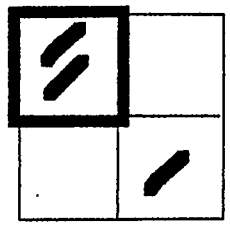


To eliminate this problem and increase the reliability of patient responses, the interviewer , at the end of the testing session, returned to the relevant test frames and asked the patient to once again point to the picture that goes with the sentence. This is exemplified in Figure 4.

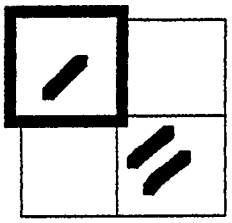
Figure 4.

20. 

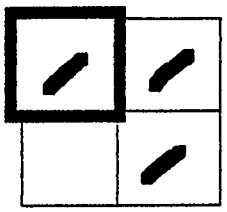
Solution
If the patient only does two rounds of the test then, once round two is complete, go back and ask patient to point to picture that goes with sentence.

20. 

If patient response is something like this, then the target picture selection is taken to be the patient's choice

20. 

If patient response is something like this, then the nontarget picture selection is taken to be the patient's choice

20. 

If patient response is something like this, then assume that his choice is random

It should be noted this technique of going back and readministering specific test frames eliminated approximately 97% of the cases where patient responses were uncertain.

(iv) The Cooldown

At the conclusion of the testing session there was a cooldown stage which consisted of presenting the patient with the same five frames as he had seen in the pretest. The function of this section was simply to conclude the testing session.

The frames in the cooldown session were intentionally the same as those of the pretest so that the patient would be encounter something easy and familiar. If the testing session had proven difficult for certain patients, it was felt that the cooldown could help end the session on a positive note .

(v) Concluding comments

At the conclusion of the testing session, patients were thanked for their involvement in the study and asked if they had any questions concerning either the study or any of the test frames they had seen.

Eleven of the sixteen subjects responded to this by asking if they could go back to specific test frames, reexamine the respective sentences, and get the interviewer to show them the target picture. Not all patients found the same test sentences difficult to interpret. Of interest , however, is the fact that in all instances these eleven patients asked to reexamine test sentences containing a pronominal. This would seem to suggest that patients found sentences containing a pronominal more difficult to interpret than 1) sentences which did not contain any pronoun, and/or 2) sentences which contained an anaphor.

4.3.0 Summary of Experimental Controls

The controls in this investigation are crucial to the reliability and validity of the results and to the elimination of possible sources of secondary variance that would in turn influence results. In this section, many of the controls already discussed at length above and in other sections will be condensed and summarized . This section has been divided into a number of subsections each of which deals with a factor pertaining to a specific aspect of

experimental control. Many of these factors overlap with one another and thus may be mentioned in more than one section.

4.3.1 Factors pertaining to randomization of stimuli

The pictures were pseudo-randomized within test frames so that the target picture was not in the same quadrant for more than two consecutive frames. The test frames and the filler frames were pseudo-randomized separately and then one filler frame was inserted between each test frame to ensure that at no time would two test frames appear consecutively. The test and filler frames together, comprised the test block which was administered to each patient at least twice and sometimes three or four times to help ensure the reliability of results.

4.3.2 Factors pertaining to physical setting

The testing environment was standardized as much as possible even though the test was administered in a variety of both hospital and residential settings. The physical layout of the test setting was the same for all patients and lengths were taken to eliminate any audio or visual distractions.

4.3.3 Factors pertaining to the interviewer and to coding

The testing was done exclusively by one interviewer and the coding of patient responses was such that it involved no subjective analysis on the part of the interviewer. The standardized coding sheet permitted an immediate coding of patient responses and allowed the interviewer to determine which test frames were necessary to readminister to help determine whether or not a patient's picture selection was random .

4.3.4 Factors pertaining to patient instructions

Instructions to the patient were standardized and made as clear as possible. One function of the pretest was to determine whether or not the patient understood the instructions by administering five frames and allowing the patient to select the appropriate picture. This also acquainted the patient with the layout of the test so he knew and became familiar with the task prior to being administered the actual test frames.

The patient's task was clearly defined in that all he was allowed to do was to listen to and/or read the test sentence, examine the pictures, and then point to one. The patient was not permitted to turn the test pages, smoke, drink or do any other activity that would distract him or make him deviate from the task.

Patients were instructed to proceed through the test as quickly as possible but not to guess. The former request was given to prevent prolonged deliberation of the pictures and the latter to prevent patient's from guessing. Both these things would adversely influence the reliability of the results.

4.3.5 Factors pertaining to number of trials and timing of the task

Prior to the testing of aphasic patients who were selected for the investigation, the test was administered to one aphasic patient 'J'. J was required to go through as many rounds of the test as he could in ninety minutes and instructed to indicate whenever he felt fatigue.

The number of errors 'J' made on each of the test trials is shown in Table 2. Trial 4 and Trial 5 show an increase in errors greater than fifty percent as compared with any one of the first three trials.

Table 2.

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
number of errors	12/53	8/53	10/53	25/53	28/53

It was felt that the increase in errors at the fourth and fifth trial mark would suggest that beyond the third trial, results may not be reliable. For this reason , even though the test was in essence self-paced, patients were not permitted to exceed 60 minutes nor were they (with the exception of one mildly impaired patient), permitted to exceed three trials. It was felt that beyond these limits, performance might drop drastically due to fatigue and a cumulative overload effect of sentences containing similar elements (i.e., pronouns). As it turned out, the average number of trials that patients completed was 2 and the average time for those two trials was forty five minutes.

4.3.6 Factors pertaining to memory and other deficits that might influence results

Two main precautions were taken to control for possible problems involving memory deficits. First, the patients were all introduced to the characters contained in the pictures and tested to see whether or not they could recall the

names for characters both before and during the test. All subjects did this with 100% accuracy.

Second, the test sentences were presented in two modalities, auditorily and visually. Thus, if it was the case that a patient could not hold on to the auditory input of a sentence long enough to interpret it and select a picture, the sentence was also visually presented . Likewise, if the patient was unable to read, the sentence was presented auditorily, and repeated a number of times so as to allow the patient opportunity to comprehend the sentence.

Chapter 5

Results

5.0.0 Introduction

This chapter is divided into three sections. The first section deals with preliminary analyses which aim to establish the reliability of test scores and to determine whether other variables affect performance on the task. The second section is comprised of three individual analyses which investigate relevant aspects of patient performance that can be ascertained from test score accuracy. The final section contains two analyses that examine the types of errors made on specific sentences.

5.1.0 Preliminary Analyses

To assess the reliability of patient responses it is necessary to determine whether patient performance remained constant across two trials (which was the average number of trials). Each patient's test scores were calculated on the basis of percent correct for trial one and for trial two. The overall mean percent correct for Trial 1 and Trial 2 were 60.7 % and 62.3 % respectively. The results of a paired t-test indicated no significant difference in scores on trial one as compared to trial two ($t(13) = .311$, $p = .76$). The results of three Pearson Product Moment Correlation analyses indicated: 1) The pattern of responses was consistent between Trial 1 and Trial 2 ($r = .74$), 2) There was no correlation between age and test score ($r = -.189$), 3) There was no correlation between sex and test score ($r = .0003$).

Table 1 presents sentence length, as measured by number of words in a sentence, and the mean percent correct for each length category. The results of a Pearson Product Moment Correlation analysis indicated no significant correlation between number of words in a sentence and test score (r =-.296).

Table 1

Number of words in sentence	4	5	6	7	8	9	10
Mean % correct	65	84	78	56	65	44	78

The results of these preliminary analyses indicate that patient performance was consistent across trials and was not affected by either sex or age. In addition, it appears that sentence length does not influence performance on the test. However, the possible relationship between sentence complexity and sentence length is further explored in Analysis 1.

5.2.0 Main Analysis : Accuracy

The following sentences are relevant to the analyses in this section and the section dealing with the error analysis. Each analysis explores a different issue and may therefore employ a different subset of the following sentences.

a) examples of sentences containing him.

2. The boy sprayed him.
11. The boy showed the man the picture of him.
13. The boy's father sprayed him.
15. The father of the boy sprayed him.

b) examples of sentences containing himself.

3. The boy sprayed himself.

12. The boy showed the man the picture of himself.

14. The boy's father sprayed himself.

16. The father of the boy sprayed himself.

5.2.1 Analysis 1

Prior to investigating the affect that the presence of a pronoun has upon the interpretation of a sentence, we need to determine whether structual complexity affects the ease with which a specific set of sentences is interpreted.

In this analysis, as in all analyses in this chapter, accuracy is reflected by the percentage of correct responses on a specific sentence. We will examine accuracy (percentage correct) on the following :

sentence 3 : The boy sprayed himself.

sentence 14: The boy 's father sprayed himself.

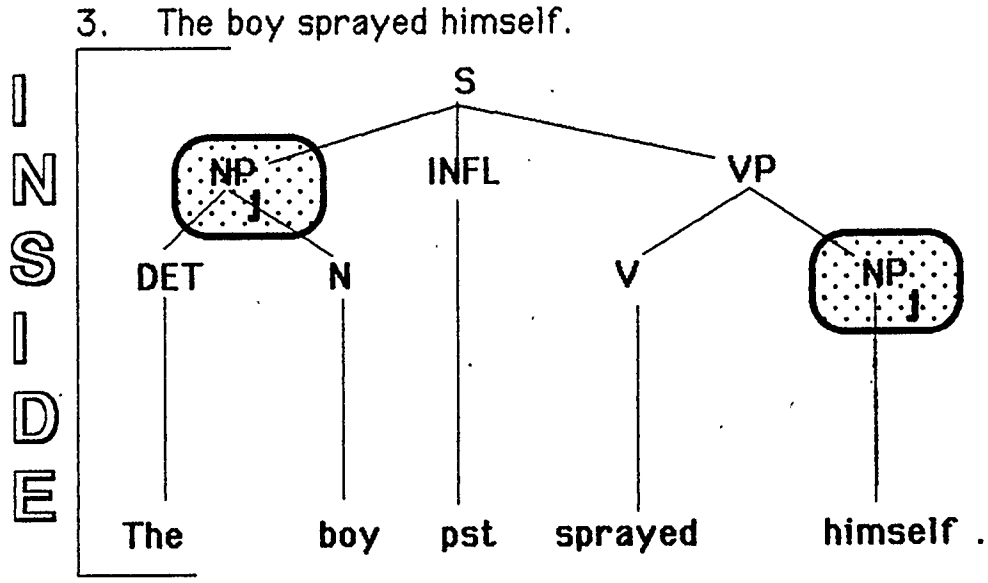
sentence 16: The father of the boy sprayed himself.

These sentences are relevant to this analysis because they only vary according to the structural nature of their respective subject NP's. Each of these three sentences contains an anaphor for which there is a sentence internal antecedent, and consequently do not vary in this regard. However, the him analogues of these sentences (i.e., sentences 2, 13, & 15) do vary

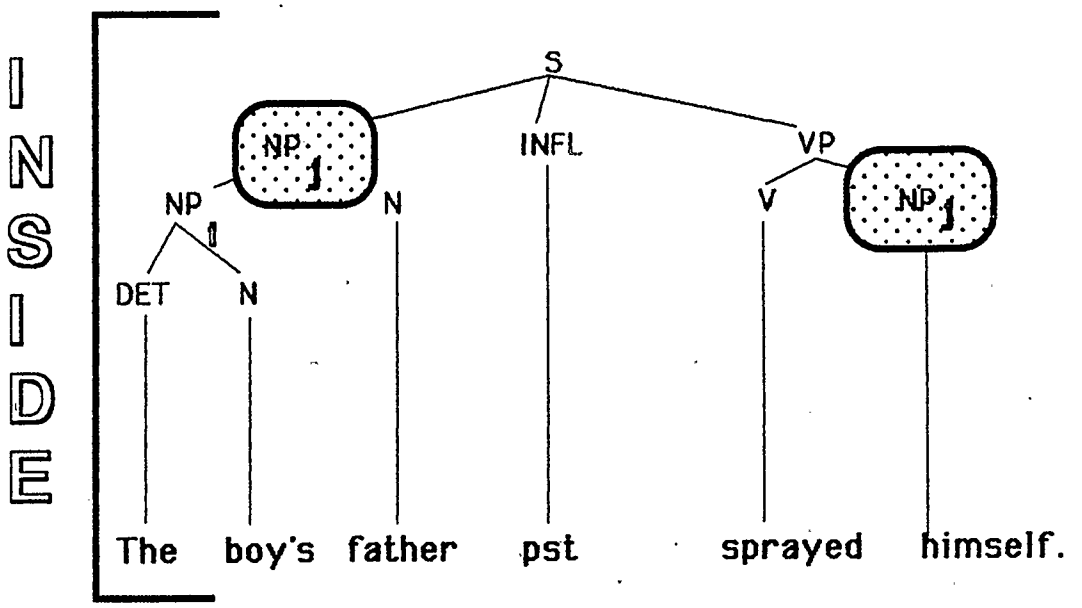
according to whether or not they contain possible sentence internal referential information. This will be further explored in Analysis 2 and 3.

Information concerning the antecedent of himself is contained inside each of these sentences as illustrated in Figure 1. Note that for these sentences the anaphor himself is bound in its Governing Category, which in each case is the entire sentence.

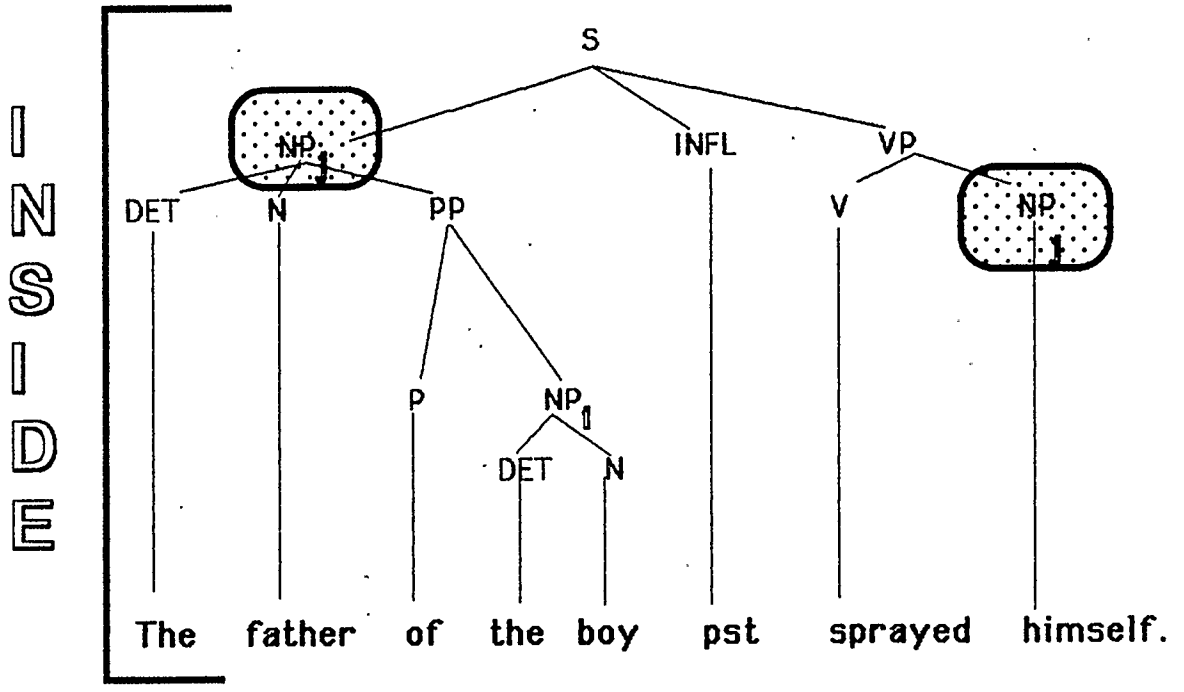
Figure 1.



14. The boy's father sprayed himself.

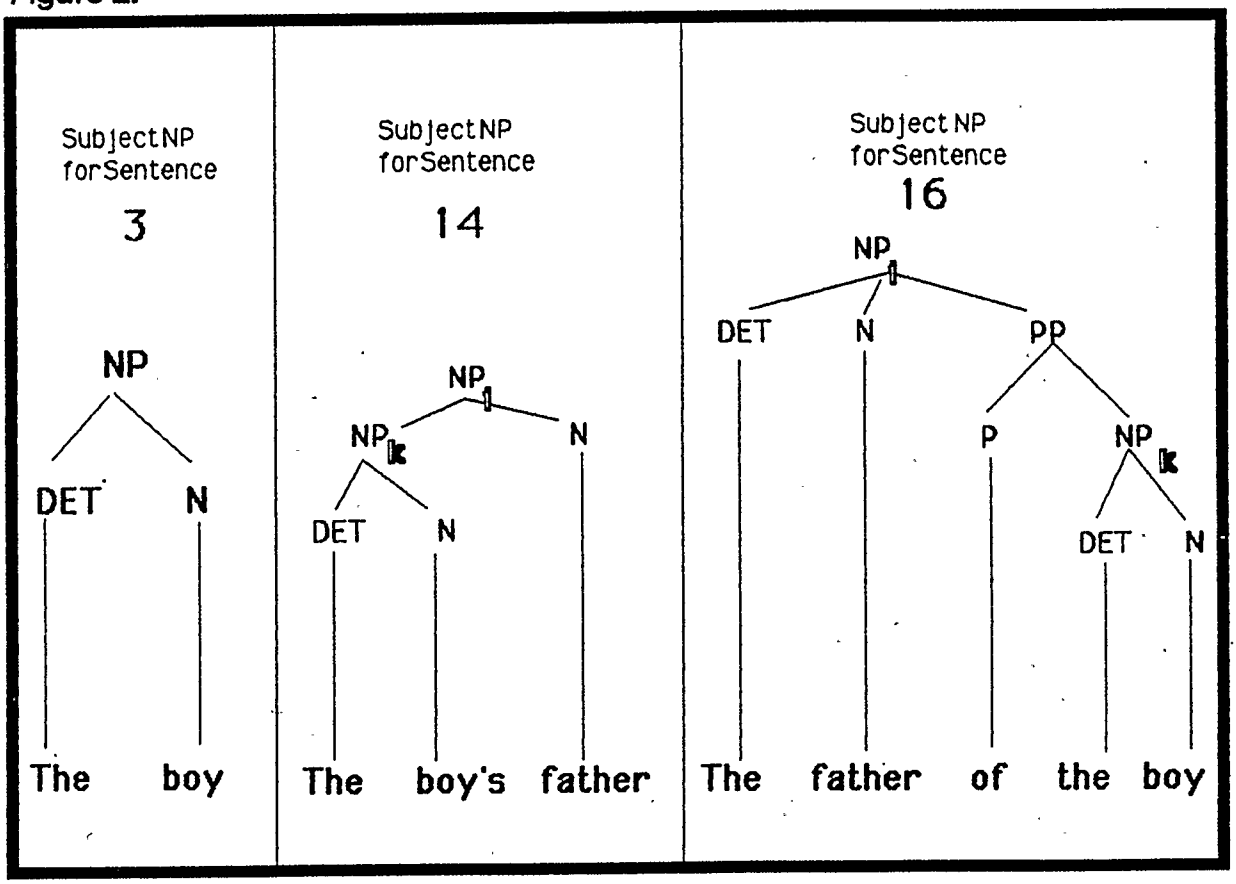


16. The father of the boy sprayed himself.



As Figure 2 illustrates, not only do sentences 14 and 16 contain two preverbal NP's but there appears to be a difference in complexity of the subject NP's. Sentence 3 contains the least complex subject NP , sentence 14 contains the next most complex subject NP and sentence 16 contains the most complex subject NP. Complexity here, is operationally defined as the number of branching nodes . If patients experience a difference in difficulty interpreting these sentences, it could be because the sentences have subject NP's that differ in structural complexity.

Figure 2.



Because sentences 3, 14, and 16 are similar to one another in that they all contain an anaphor which is bound within its Governing Category (i.e., the sentence), we would predict that if there is a difference in difficulty in interpreting these sentences, the difference should be due to the structural complexity of the various subject NP's.

Table 2 displays the overall means and standard deviations for the percentage of correct responses for sentences 3 , 14, and 16.

Table 2. Sentences 3, 14, and 16.

Sentence Number	3	14	16
Mean % correct	90.6	81.2	75
Standard Deviation	17.9	34.7	36.5

N =16

A one factor repeated measures ANOVA yielded no significant results, $F(2,30) = 1.31$, $p = .2839$. It appears as if complex structures are <u>not</u> significantly more difficult to interpret. However, if one examines the mean percent correct for each of the three sentences used in this analysis (re: Table 2) , it would appear as if there is a trend toward the more complex structures being more difficult.

It seems likely that complexity does affect ease of interpretation even though the results presented here failed to reach significance. In the case of multi-embedded sentences, for example, one might speculate that there is a point at which structural complexity overrides the importance of finding referential information.

To investigate whether this might be the case, subsequent to this investigation, scores from the sentence a) The boy sprayed himself., were compared with scores from the sentence b) The boy the man kicked sprayed himself. The latter of these two is a biclausal structure which contains a reduced relative clause. The results of a paired t-test indicated that there was a significant difference between scores on these sentences such that b) was significantly harder than a) ($t(15)=4.98$, $p<.01$). This finding suggests that at some point, sentence complexity is a variable which affects performance.

It is important to note that even though we have operationally defined complexity as referring to the number of branching nodes, if we reexamine the subject NP's presented in Figure 2, it becomes apparent that we could have defined complexity in terms of number of words. A thorough examination of the relationship between length and sentence complexity is beyond the focus of the current research. However, the results from Analysis 1 suggest that length is a factor that is related to sentence complexity .

Nonetheless, it has been determined that structural complexity (however it is defined) does not significantly affect the difficulty that patients have interpreting comparable sentences in the test paradigm. Therefore, it can be concluded, that any difference between these sentences must be due to the presence of the pronoun and not due the structural configuration of a particular sentence.

5.2.2 Analysis 2

As was discussed in Chapter 2, GB Theory is primarily a theory of linguistic competence and thus does not comment on which is more difficult to interpret, a sentence containing an element which must be free or a sentence containing a element which must be bound. This is entirely an empirical issue. Consequently, this analysis aims to determine whether patients experience a difference in difficulty interpreting sentences containing a pronominal or an anaphor.

We will examine accuracy on the following pair of sentences, which represent the difference discussed above.

sentence 2 : The boy sprayed him.

sentence 3 : The boy sprayed himself.

Table 3 displays the overall means and standard deviations for the percentage of correct responses for sentences 2 & 3.

Table 3. Sentences 2 and 3

Sentence Number	2	3
Mean % correct	36.4	90.6
Standard Deviation	35.2	17.9

N = 16

The results of a paired t-test indicate that the difference is significant ($t(15) = 6.05$, $p < .01$). Sentence 2 is clearly more difficult for patients to interpret than sentence 3. If we employ aspects of the theoretical framework to interpret these findings we might conclude that sentences containing pronominals are

simply more difficult to interpret than the corresponding sentences containing anaphors. This interpretation is limited, however, in the sense that it does not indicate why sentences containing pronominals should be more difficult to interpret , nor does this interpretation take into account what the patient must do in order to select the target picture.

As we noted earlier, G.B. Theory is primarily a theory of linguistic competence. However, we are not directly measuring competence. We are directly examining patient performance on a specific task in the hope that it sheds light on the nature of the underlying linguistic competence. Since we are examining performance, it is crucial to consider what the patient must do in order to comprehend a particular sentence within the context of the empirical task.

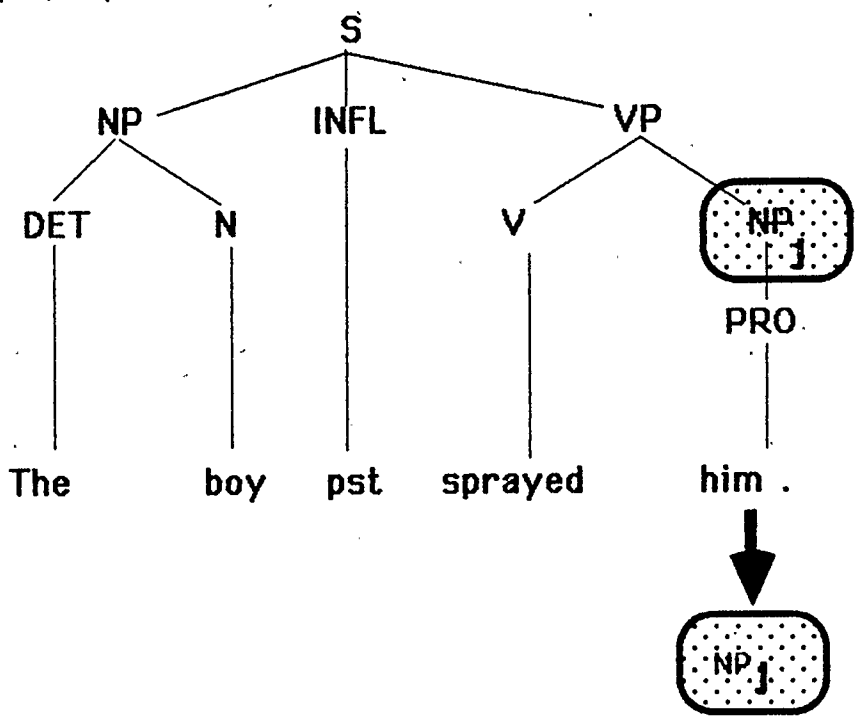
Let us first examine sentence 2 and consider a possible scenario for what must happen in order for a patient to correctly comprehend the sentence and select the appropriate target picture . In order to do this, the patient must recall the specific characters involved in the test pictures. We determined in the pretest that all patients were able to do this with 100% accuracy. In addition to this, if a patient is to choose the target picture for sentence 2, he needs information about the antecedent of him.

As Figure 3 illustrates, in sentence 2 there is nothing within the sentence that suggests who him refers to. Him can refer to an NP but it cannot be the boy. As the theoretical framework suggests, reference to the NP the boy is blocked

because the boy is not coindexed with him. Thus, since no referential information can be found within the sentence the patient must look **OUTSIDE** of the sentence (i.e., to the pictures) to find such information.

Figure 3.

2. The boy sprayed him.



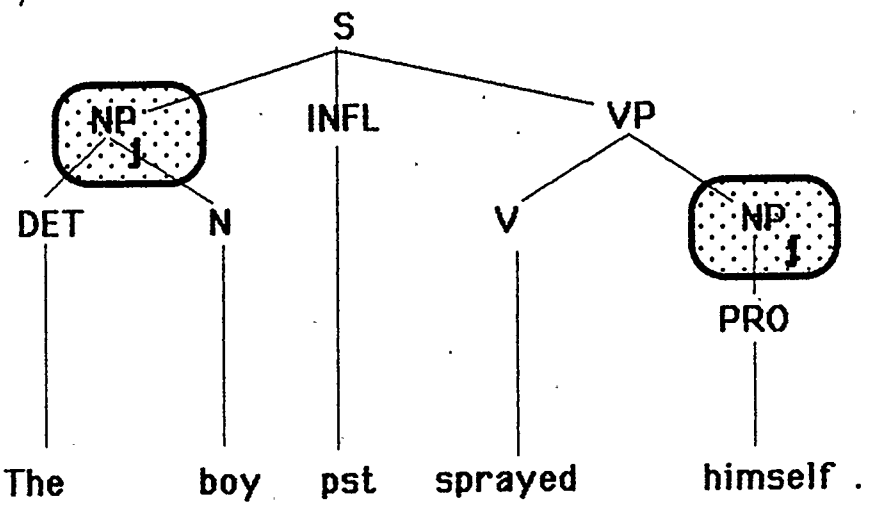
However, as the patient goes OUTSIDE the sentence to find referential information , he carries with him a certain amount of information that he has gleaned from the sentence itself. In the case of sentence 2, this information consists of knowing that the boy is spraying some other [+male] character. This knowledge allows the patient to form a mental image in his mind about the boy spraying another male, but this image is incomplete until the patient considers

each of the four pictures and determines what character in the test pictures might correspond to him in sentence 2.

In essence, then, the patient has an incomplete mental image of sentence 2 until he goes outside of the sentence and searches through the pictures for an appropriate antecedent for the pronominal. This is not the case with sentence 3. As Figure 4 illustrates, the patient can get all of the information he needs to interpret the sentence, including referential information, from INSIDE the sentence itself.

Figure 4.

3. The boy sprayed himself.



When the patient hears and/or reads this sentence, prior to approaching the pictures, he can form a complete image or picture in his mind about the meaning of the sentence. Thus, the picturability of sentence 3 is high relative to that of sentence 2. Sentence 3 contains all the information, including referential information, necessary for the interpretation of the sentence. It is

therefore possible for the patient to form a complete mental image of what sentence 3 means. This was not possible with sentence 2 because all the information (i.e., referential information) was not present within the sentence .

According to this characterization, the patient must proceed through a sequence of steps in order to correctly interpret each of these sentence. With The boy sprayed himself. , all the referential information is present INSIDE the sentence, the patient can form a complete mental image of what the sentence means before he goes to the pictures and all he needs to do is match that image with a similar test picture. In this case complete comprehension of the sentence can occur prior to scanning the test pictures.

However, with The boy sprayed him., because the sentence does not contain sentence referential information for him , the patient must go to the pictures and perform a type of searching operation that will take him through each of the four pictures to find an appropriate antecedent for the pronominal. Once he finds that information, the patient can form a complete mental image in his mind as to the meaning of the sentence and at that point all he needs to do is match that image with a similar test picture. It is important to note that until the patient finds the appropriate antecedent within the test pictures, complete comprehension cannot occur.

Note that the tree diagrams in Figures 2 and 3 assume that the subject is able to generate hierarchical structure. It is not necessary that the patient do so, however, in order to interpret sentences 2 and 3. The patient does not need

hierarchical structure to determine which NP the pronominal is free from or which NP the anaphor is bound to because in each case there is only one NP. It might be argued, however, that according to the theoretical framework, since NP's are the elements that get coindexed, this alone suggests access to syntactic structure.

But it is possible that only nouns and pronouns get coindexed. Evidence for this comes from a study conducted by Caplan and Futter (1986) , where it was demonstrated that an agrammatic patient treated sentences as if they were simply strings of major lexical categories and assigned thematic roles not to NP's but to N's. So it is possible , as in the case of sentences 2 and 3, that hierarchical structure may not be necessary in order to correctly interpret the sentence.

Notice that in the case of sentence 2 and 3, if there is an inability to generate syntactic structure and/or an inability to access function words (i.e., 'the') or morphological markers (i.e., 'ed'), the patient still can interpret the sentence IF he can coindex. To coindex accurately he must know that <u>him</u> requires an OUTSIDE antecedent to be coindexed with and <u>himself</u> requires and INSIDE antecedent.

The notions of OUTSIDE and INSIDE are important notions that will be used throughout the discussion that follows and it is therefore necessary to operationally define them . The notion of INSIDE is defined as ' inside the same sentence as the pronoun'. This implies that the patient <u>first uses</u>

sentence internal information to completely comprehend a particular sentence and then, as a second step, goes to the pictures to perform a matching operation. The notion of OUTSIDE is defined as 'outside the sentence which contains the pronoun' . This implies that the patient goes to the pictures first to find referential information that will allow him to completely comprehend a particular sentence.

Unlike G.B. Theory's concepts of free and bound, the notions OUTSIDE and INSIDE emphasize finding antecedents for both pronominals and anaphors. GB Theory makes an explicit statement about 'finding' an antecedent for anaphors, however, it only indicates what elements CANNOT act as antecedents for pronominals. Implicit in GB Theory is the notion that non-c-commanding NP's can serve as possible antecedents for pronominals. This makes the notions of OUTSIDE and INSIDE useful to employ here because they refer to actual performance as opposed to the GB Theory notions of free and bound which refer exclusively to linguistic competence. The notions of free and bound may have correlates in performance but this is something which is not emphasized by the theory.

To summarize, it is being suggested that the reason sentence 2 is more difficult to interpret than sentence 3 is as follows. Sentence 2, The boy sprayed him., does not contain any referential information about the antecedent of him. Thus, the patient has an incomplete mental image about the meaning of the sentence and must go OUTSIDE to get the necessary referential information that will facilitate complete comprehension of the

sentence. In terms of the empirical task, OUTSIDE implies that the patient must go to the test pictures. He must perform a searching operation that will take him through each of the test pictures to determine which one will supply him with the correct referential information. This is an additional operation which must be performed before the subject can completely comprehend the sentence , form a mental image and match that image with one of the test pictures.

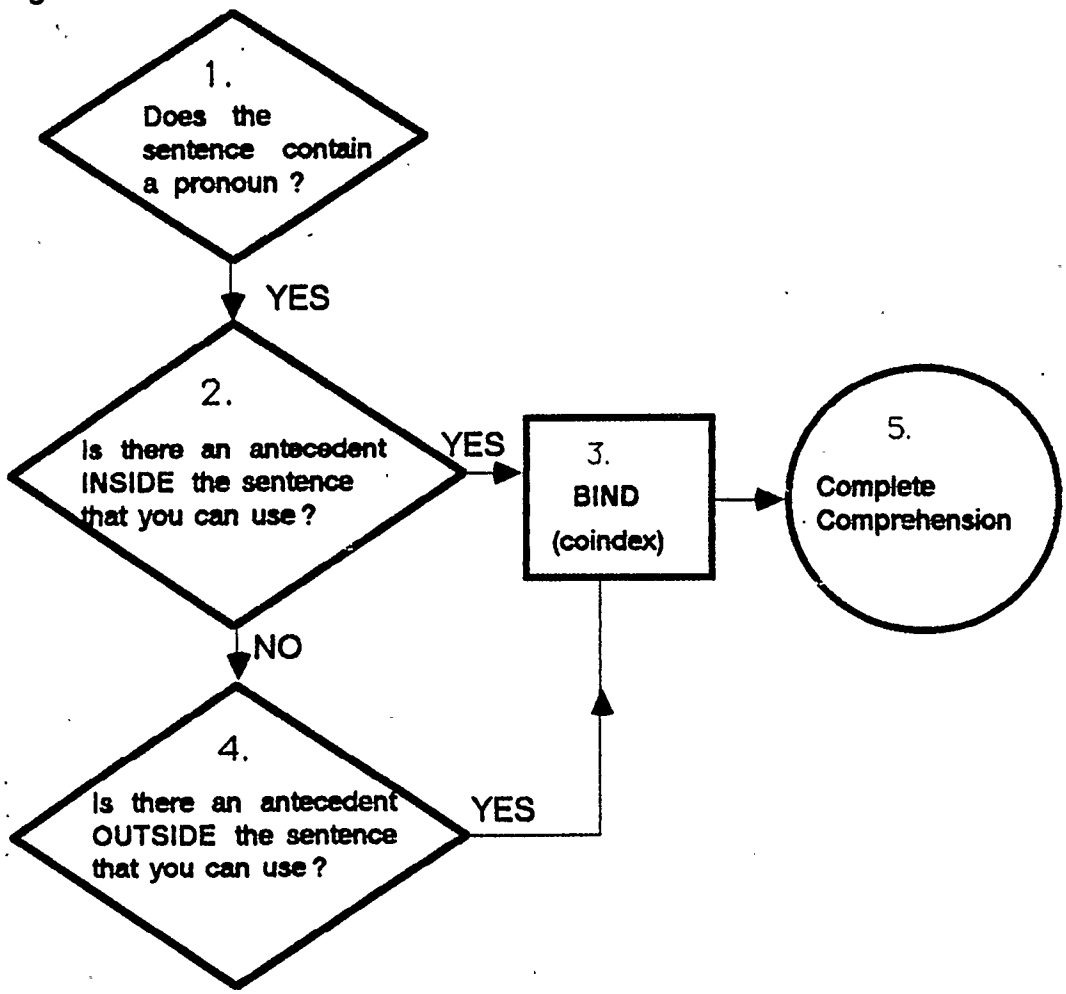
In Sentence 3, The boy sprayed himself., all the information (including referential information) is present INSIDE the sentence and the patient can form a complete mental image and thus comprehend the sentence before he examines the pictures. When he goes to the pictures all he must do is perform a matching operation to see which of the pictures is consonant with his mental image. This is a relatively easy operation to perform because the patient knows exactly who himself refers to, and thus can comprehend the sentence, prior to examining the pictures.

The theoretical framework is limited in how it can respond to the question of why a sentence containing a pronominal is more difficult for patients to interpret than a similar sentence containing an anaphor. The theory is limited in the sense that it is restricted to using the notions of free and bound which fail to capture what the patient must do in order to comprehend the sentences and select the appropriate target pictures. However, in terms of the account that we have offered using the notions of OUTSIDE and INSIDE, it becomes apparent that the difference in difficulty may have something to do with the

fact that going OUTSIDE involves the additional step(s) of having to find external referential information before complete comprehension can occur.

Consider now, Figure 5, which illustrates the possible steps that are involved in completely comprehending sentences 2 and 3. Note that each box in the flowchart is numbered for the sake of easy reference. It is not to be assumed that this numbering reflects the exact order in which one proceeds through the flowchart.

Figure 5.



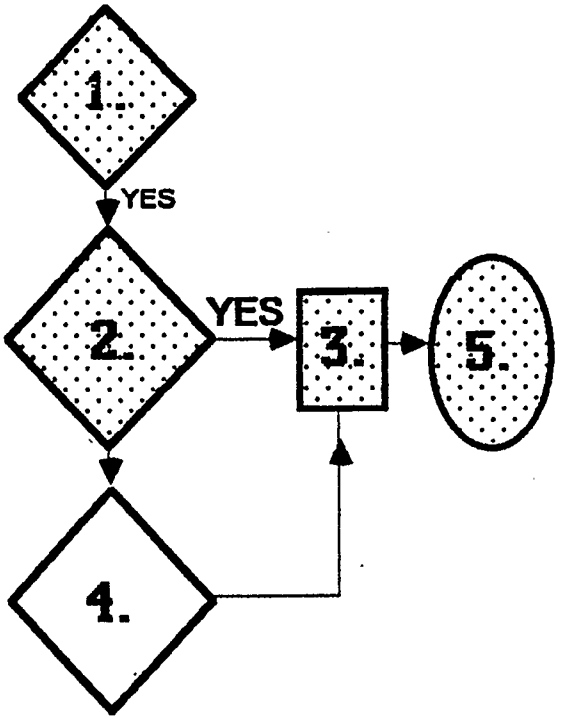
According to the flowchart in Figure 5, in the case of The boy sprayed himself., one first notes that the sentence contains a pronoun , and then determines that there is an NP within the sentence can serve as an antecedent of himself. Consequently, binding would take place and complete comprehension would result.

In the case of The boy sprayed him., one first notes that the sentence contains a pronoun but then determines that there is no antecedent INSIDE the sentence. Thus, one would proceed to go OUTSIDE the sentence, (i.e., to the pictures) , to find a referent. Once the referent is found, coindexing would take place and complete comprehension would result.

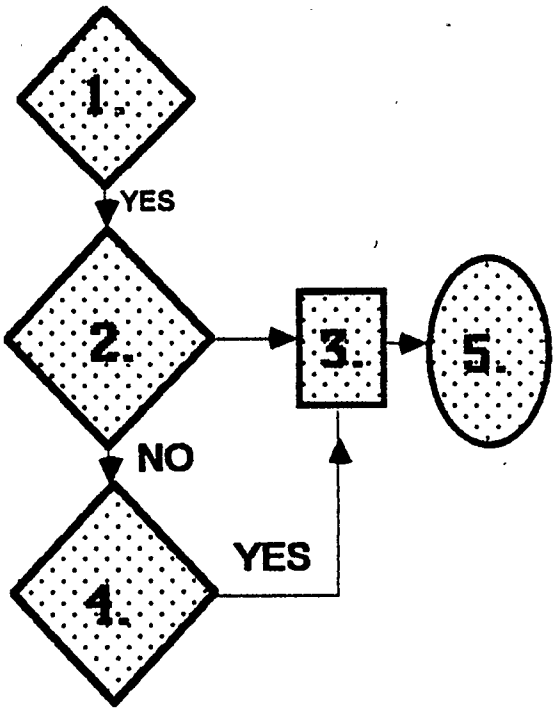
The shaded boxes in Figure 6, indicate the steps which must be gone through in order to comprehend The boy sprayed himself. and The boy sprayed him. Note that according to this interpretation, The boy sprayed him. should be more difficult to interpret because it requires that one go through the additional step of going OUTSIDE to get referential information.

Figure 6.

The boy sprayed himself.



The boy sprayed him.



It is important to note that the flowchart in Figure 5 implies that one looks INSIDE the sentence first for referential information before proceeding OUTSIDE (if necessary). Note, however, that in sentence 2, The boy sprayed him., there is only one NP that the pronominal must be free from and there is no other possible NP in the sentence which can serve as an antecedent. Thus, one must go OUTSIDE . In order to determine whether one first looks for a possible INSIDE (or OUTSIDE) , we need to examine a set of sentence where one has , in principle at least, the option of either staying INSIDE or going OUTSIDE.

5.2.3 Analysis 3

Analysis 3 aims to investigate whether one goes OUTSIDE first to find referential information for a pronominal or whether one stays INSIDE if possible. We will examine accuracy on the following sentences:

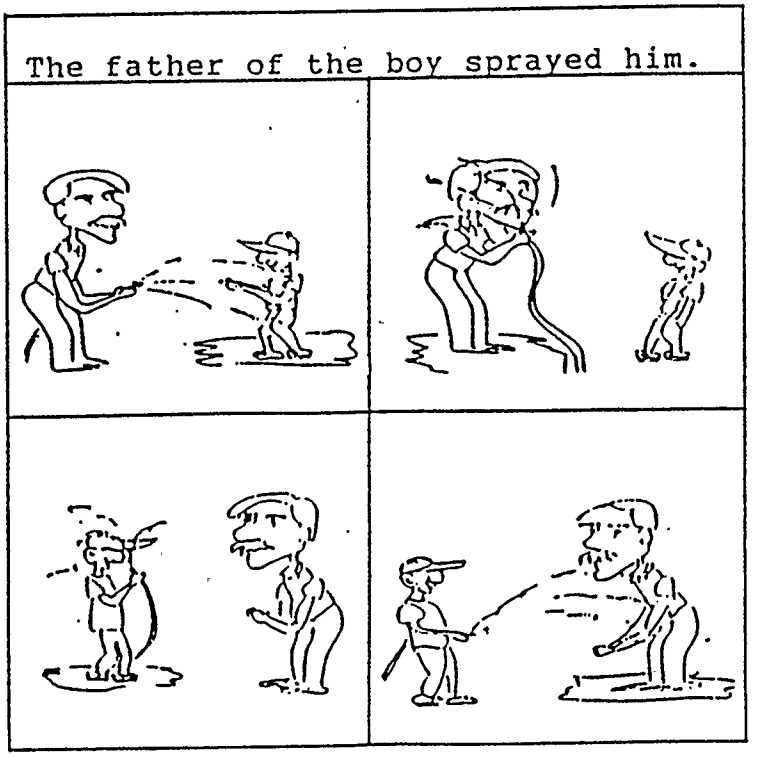
sentence 2 : The boy sprayed him.

sentence 13 : The boy 's father sprayed him.

sentence 15 : The father of the boy sprayed him.

We noted previously, that in sentence 2 one has to go OUTSIDE. Unlike sentence 2, sentences 13 and 15 each contain a non-c-commanding NP that him can be coindexed with. In each case him could refer to either the boy or some other male that is neither the father nor the boy. Recall, that in Chapter 3 when the stimuli was presented, both The boy's father sprayed him. and The father of the boy sprayed him. had the same test pictures associated with them. These are presented in Figure 7.

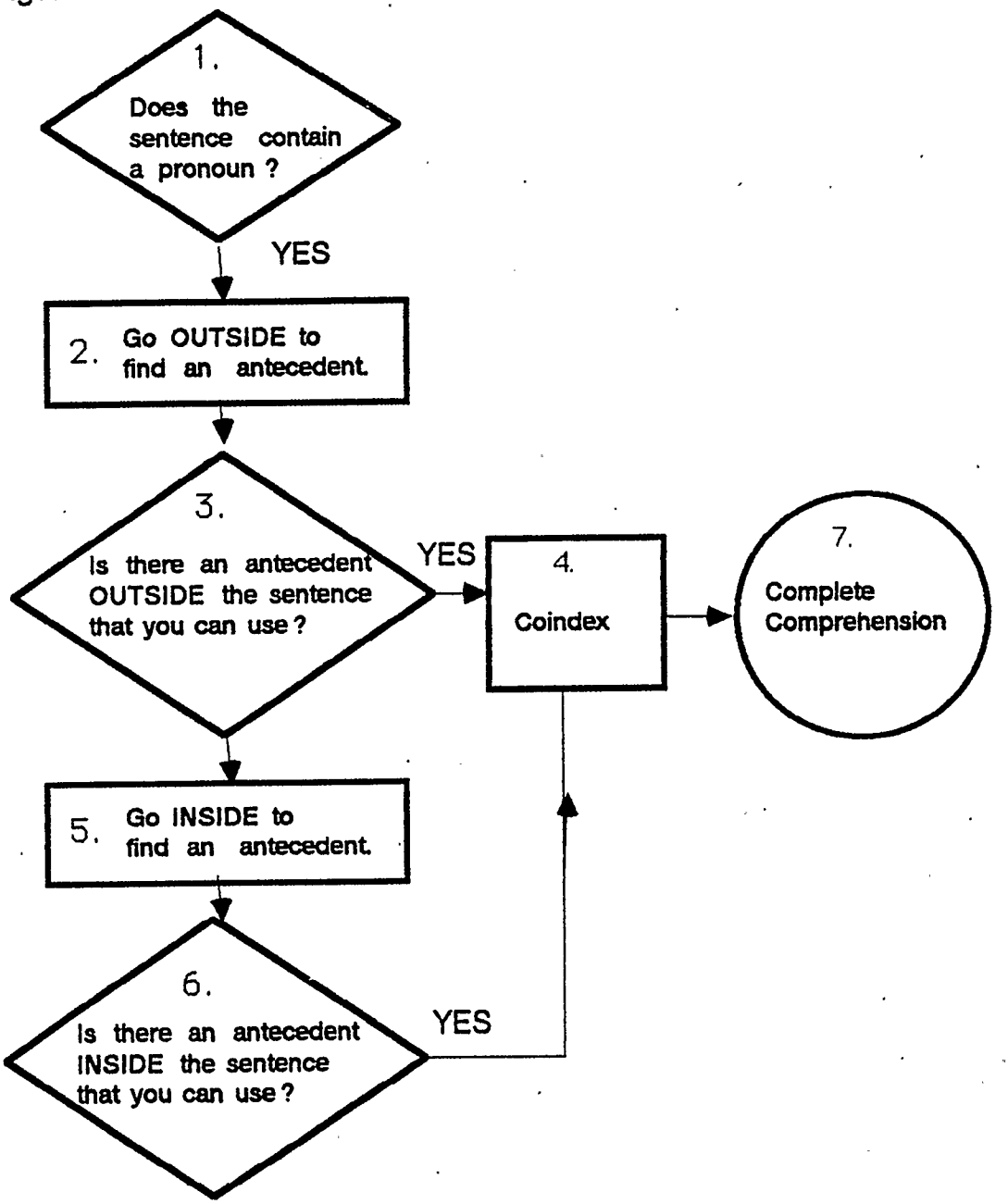
Figure 7.



It is important to recognize that in the case of sentences 13 and 15 , the test pictures do not contain a possible OUTSIDE antecedent. Thus, in terms of this particular task , him must be the boy. Let's entertain two possibilities for what patients might do , in terms of the task, to correctly comprehend sentences 2, 13, and 15.

Assuming that the patient goes OUTSIDE first to find referential information for sentence 2 we might expect that the following sequence of events takes place (re: Figure 8). The patient receives the stimulus sentence and determines that it contains a pronoun. The patient then goes OUTSIDE to the pictures, scans them , and finds one which corresponds to the boy spraying another male. As soon as it is recognized that the other male qualifies as a referent of him , complete comprehension can occur and the patient can select the target picture.

Figure 8. Go **OUTSIDE FIRST.**



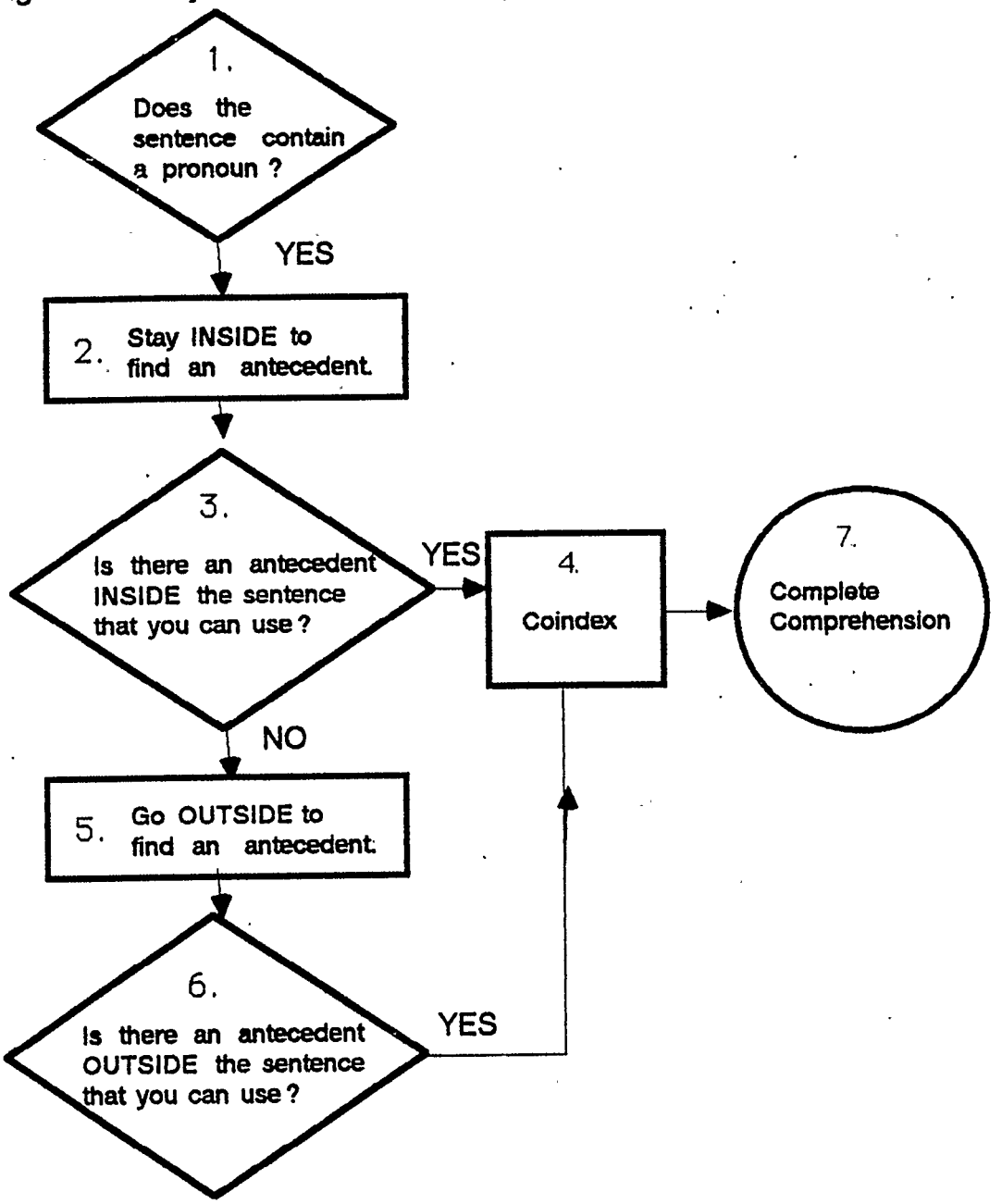
For sentences 13 and 15, (re: Figure 8), if the patient goes OUTSIDE first to find a referent of him, he would examine the pictures and find that there is no

boy. The patient must then come back to the sentence and look INSIDE for a possible antecedent of him. Once the patient recognizes that him refers to the boy, complete comprehension can occur and the patient can select the target picture.

The other possible sequence of events is that the patient stays INSIDE first to find referential information for him (re: Figure 9). With sentence 2 the patient would not be able to stay INSIDE because the boy c-commands him (within the Governing Category of him) and thus the boy is blocked as a potential antecedent of him. The patient has no choice but to go OUTSIDE if he is to correctly interpret the sentence.

In the case of sentences 13 and 15, however, if the patient stays INSIDE first, (re: Figure 9) , he would find that there is a non-c-commanding antecedent , namely the boy, which can act as a potential antecedent of him. With this information it is possible for the patient to completely comprehend the sentence prior to examining the pictures which suggests that he may be able to form a complete mental image of one possible correct interpretation of the sentence. Then, all he must do is go to the pictures and match this mental image with a picture which means the same thing.

Figure 9. Stay **INSIDE FIRST**

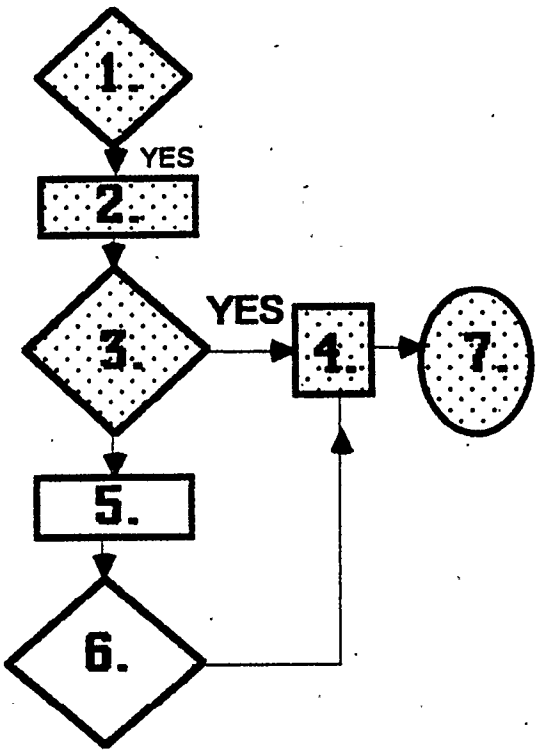


The two possible scenarios, go OUTSIDE first or stay INSIDE first, make two different predictions about the relative difficulty of sentence 2 as compared to sentences 13 and 15 (re: Figure 10). If one goes OUTSIDE first, then

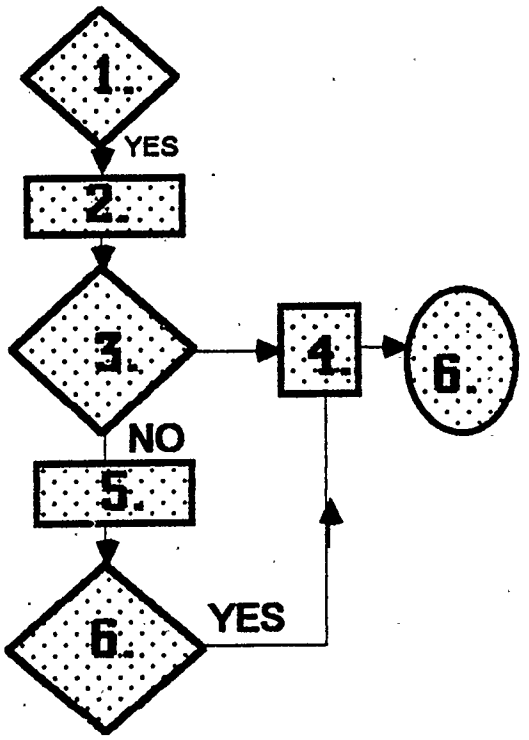
sentences 13 and 15 should be more difficult than sentence 2 because when one goes OUTSIDE of sentence 2 one finds referential information whereas with sentences 13 and 15 one does not. Since one does not find referential information by going OUTSIDE of sentences 13 and 15 it implies that one must go through the added operations of coming back INSIDE the respective sentences and conducting a search for a non-c-commanding NP to serve as an antecedent .

Figure 10. Go **OUTSIDE FIRST.**

The boy sprayed him.



The boy's father sprayed him.
The father of the boy sprayed him.

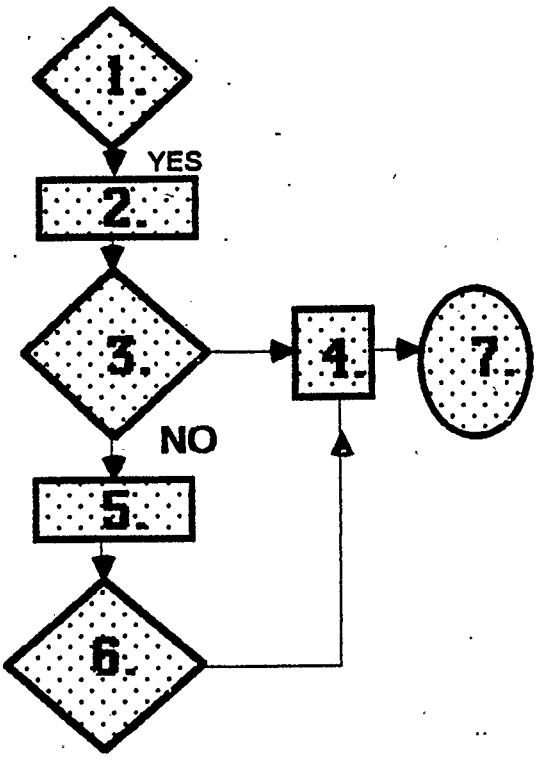


If one stays INSIDE first (re: Figure 11), then sentences 13 and 15 should be easier to interpret than sentence 2. Notice that the scenario involved with

staying INSIDE first, for sentences 13 and 15, sounds very much like the scenario suggested in Analysis 1 for The boy sprayed himself. In both cases, by staying INSIDE one has the potential to get all the information from within the sentence, thus permitting one to completely comprehend the sentence and form a mental image of the sentence before examining the pictures. In both cases one is scanning with the aim of matching a mental image with a picture and not scanning to find more information that will facilitate complete comprehension of the sentence.

Figure 11.

The boy sprayed him.



The boy's father sprayed him.
The father of the boy sprayed him.

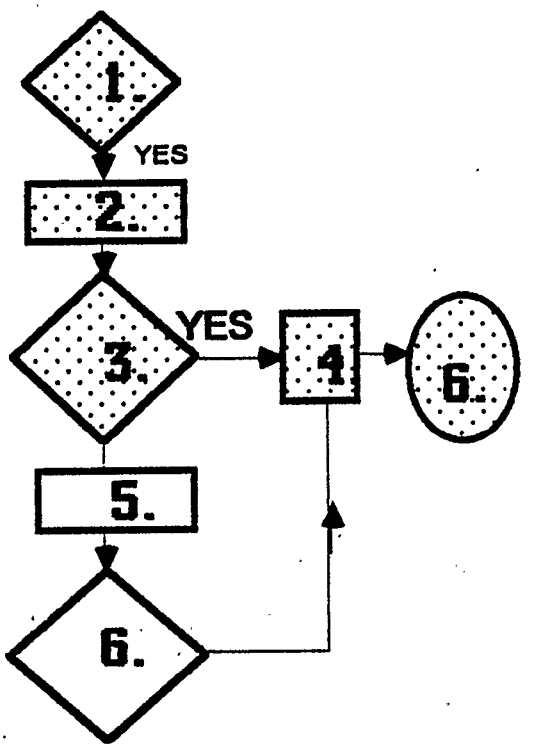


Table 4 displays the overall means and standard deviations for the percentage of correct responses for sentences 2 , 13, and 15.

Table 4 . Sentences 2, 13, and 15.

Sentence Number	2	13	15
Mean % correct	36.4	73.4	64.1
Standard Deviation	35.2	42.3	46.5

N = 16

A one factor repeated measures ANOVA indicates the results are significant $F(2,30)= 5.73$, $p < .01$. A post hoc analysis was performed to determine the locus of main effect. The results indicate a significant difference between scores on sentences 2 and 13 , $F(1, 15) = 11.85$, $p < .01$, and between scores on sentences 2 and 15, $F(1,15) = 6.28$, $p < .01$.

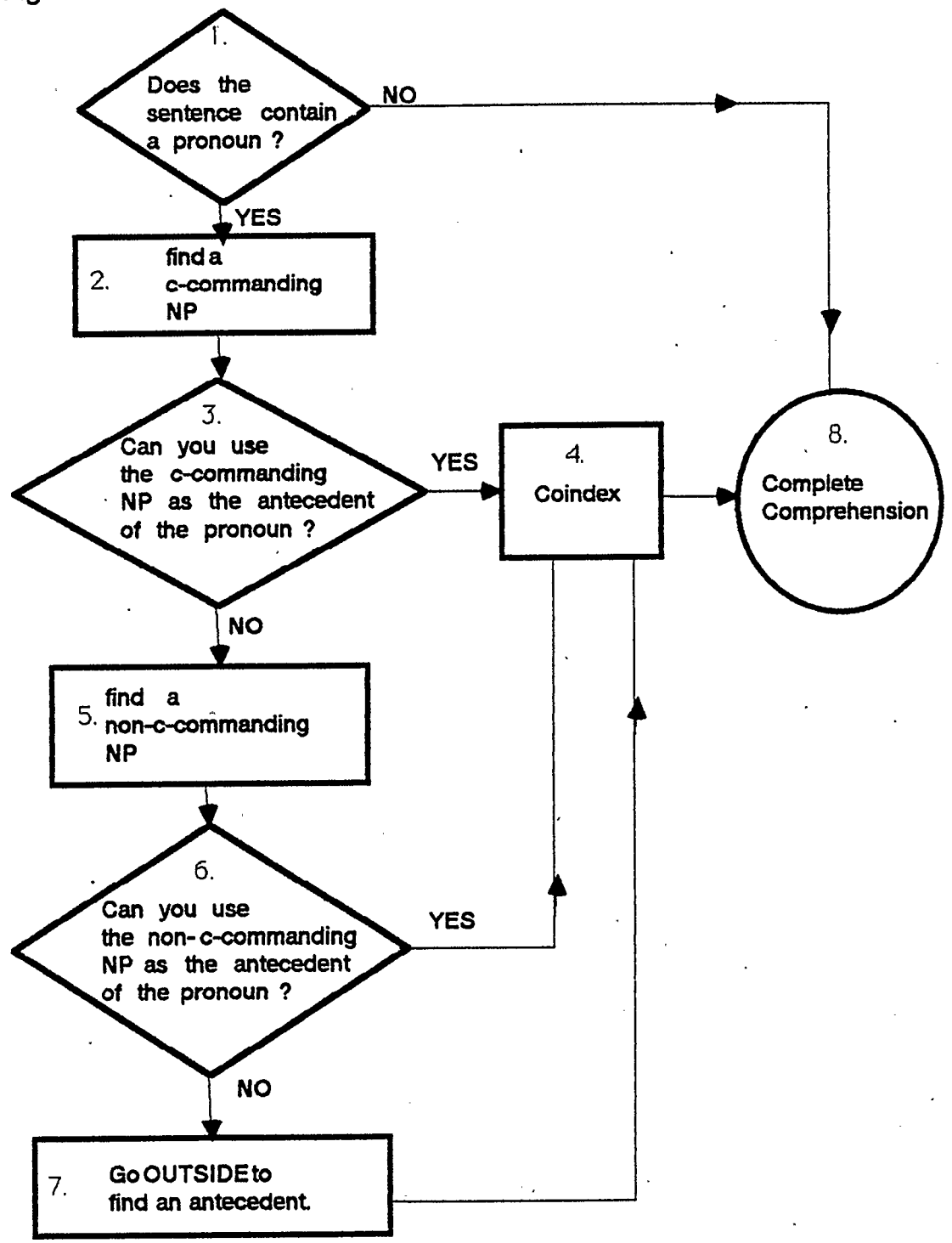
These findings clearly support the second of the two scenarios that we considered above, namely, it appears as if patients will stay INSIDE first to find referential information . This implies that there are more steps involved in completely comprehending The boy sprayed him., than there are in completely comprehending either The boy's father sprayed him. or The father of the boy sprayed him. In the former case one must go OUTSIDE to find information that will facilitate complete comprehension of the sentence, in the latter two cases complete comprehension can occur by staying INSIDE the sentence.

Recall that in Analysis 2, we determined that in order to interpret The boy sprayed him. and The boy sprayed himself. , one does not need structural

information. This is not the case with sentences 13 and 15. In order to be able to choose the NP that can serve as the antecedent to the pronoun, structural information is crucial. This has certain implications for the flowchart that we posited in Figure 9. Namely, if, as we determined in Analysis 3, one stays INSIDE first to find referential information, then one has to be able to distinguish between the NP which serves as the antecedent of himself in sentences such as The boy's father sprayed himself. (i.e., the boy's father), and the NP which serves as the antecedent of him in sentences such as The boy's father sprayed him. (i.e., the boy) .

By using notions from GB Theory we can expand the flowchart illustrated in Figure 9 in such a way that it will allow for the correct selection of antecedents in sentences where there is both a c-commanding NP and a non-c-commanding NP. Consider the flowchart in Figure 12.

Figure 12.


1.
Does the sentence contain a pronoun ?
NO
YES
2.
find a c-commanding NP
3.
Can you use the c-commanding NP as the antecedent of the pronoun ?
YES
4.
Coindex
8.
Complete Comprehension
NO
5.
find a non-c-commanding NP
6.
Can you use the non-c-commanding NP as the antecedent of the pronoun ?
YES
NO
7.
Go OUTSIDE to find an antecedent.

According to the flowchart in Figure 12, if one was attempting to comprehend The boy sprayed himself., one would determine that the sentence contains a pronoun and a c-commanding NP . At step #3, Binding Principle A would indicate that the c-commanding NP is eligible to be used as the antecedent of the anaphor, and consequently binding, and complete comprehension would occur. In the case of The boy sprayed him., at step #3, Binding Principle B would indicate that the c-commanding NP is not eligible to be used as the antecedent of the pronominal . This means one moves on to step #5 in search of a non-c-commanding NP. Because there is no non-c-commanding NP within the sentence, one would move through to step #7, at which point one would go OUTSIDE to find a referent. The referent would be found in the pictures, coindexed with the pronominal and complete comprehension would occur.

The steps involved in comprehending The boy's father sprayed himself. or The father of the boy sprayed himself., are similar to those involved in comprehending The boy sprayed himself. Namely , at step #3 , once a c-commanding NP has been identified, Binding Principle A indicates that this NP is an eligible antecedent. Binding occurs and complete comprehension results.

Note however, that in the case of The boy's father sprayed him. and The father of the boy sprayed him., one would identify a c-commanding NP at step #2, but at step #3 Binding Principle B would indicate that this NP is not eligible as an antecedent for him. One would then move on to step #4 and identify a

identify a non-c-commanding NP that could serve as a possible antecedent. At step #5, because Binding Principle B does not block the non-c-commanding NP from being a possible antecedent, one coindexes this NP with the pronominal and complete comprehension results.

The chart in Figure 12 also makes certain predictions about the relative difficulty of interpreting sentences such as The boy's father sprayed himself. and The boy's father sprayed him. If it is the case, as the chart implies, that one searches for a c-commanding NP before one searches for a non-c-commanding NP, then we would predict that The boy's father sprayed him. should be more difficult to interpret because there are more steps involved in the comprehension process. If it was the case that one searched for a non-c-commanding first then we would anticipate that The boy's father sprayed himself. would be more difficult. The results of a paired t-test involving scores on The boy's father sprayed him. and The boy's father sprayed himself. indicated that the former sentence was more difficult to interpret ($t(15) = 3.16$, $p = .007$). This finding supports the ordering of events as they are presented in Figure 12.

On the basis of Analysis 2 and 3, several significant observations emerge. First, it seems quite possible that complete comprehension of sentences containing a pronominal involves more steps than are needed to completely comprehend sentences containing a anaphor. Second, the steps involved in comprehending sentences which contain either a pronominal or an anaphor appear to be ordered. Third, as part of this ordered sequence, there

seems to be a tendency to stay INSIDE the sentence first , and use referential information which is available there, before going OUTSIDE. Fourth, it appears that if one stays INSIDE to find referential information then one is reliant upon structural information in order to determine the correct antecedent for a specific pronoun.

On the basis of aphasic data we have charted some of the significant steps involved in the comprehension of sentences which contain pronouns. It is important to recognize that this chart (i.e., Figure 12), forms the beginning of a model for some of the steps involved in normal comprehension. The chart has been constructed solely on the basis of examining those sentences which aphasic patients found more difficult to comprehend.

We have not yet examined what patients do, or more specifically, what types of errors patients make, when they have problems comprehending a particular sentence. Of particular interest, is whether the flowchart in Figure 12 can assist in characterizing the nature of the errors that patients make.

5.3.0 Main Analysis : Error Analysis

5.3.1 Analysis 4

The aim of this analysis is to examine the types of errors that patients made on a specific group of sentences and to determine whether there is relationship between 'Error Type' and severity of language deficit.

We will examine the types of errors that patients made on the following set of sentences :

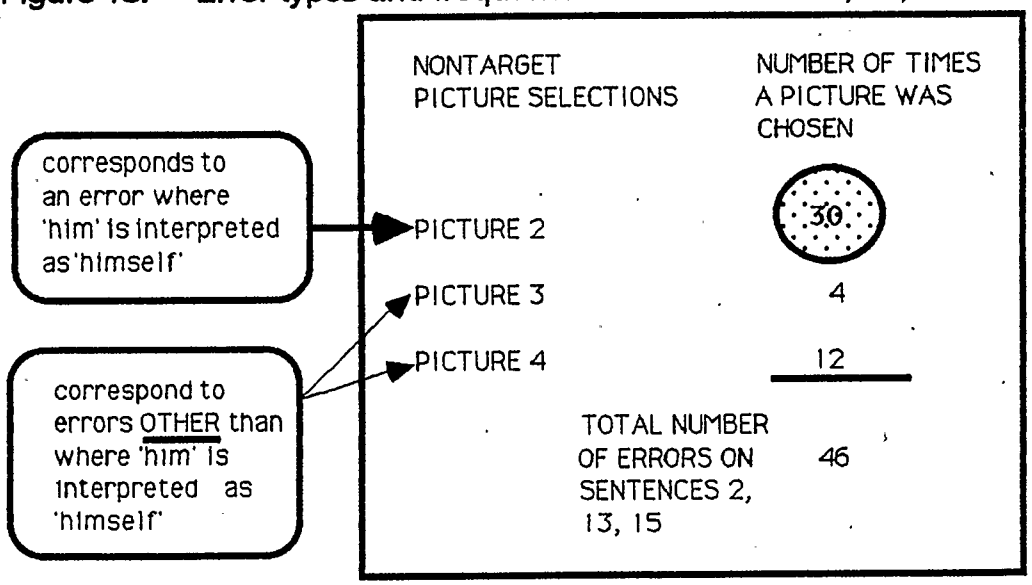
sentence 2 : The boy sprayed him.

sentence 13 : The boy 's father sprayed him.

sentence 15 : The father of the boy sprayed him.

Figure 13 contains information about the types of errors that aphasic patients made, and the frequency with which these error types occurred.

Figure 13. Error types and frequencies on Sentences 2, 13, 15



Of the total 46 errors, 65% resulted from the selection of picture 2 which corresponded to an error where him was interpreted as himself. The remaining 35% of the errors resulted from the selection of pictures 3 & 4 which both corresponded to errors other than where him was interpreted as himself.

It is important to note that the most predominant error pattern made by aphasic patients, with respect to these sentences, is one where him is interpreted as himself. Before we pursue reasons for WHY this might be so we are going to first determine whether there is a relationship between severity of language loss and the type of errors that patients made.

Figure 14 illustrates the two most significant types of errors made on sentences 2, 13 & 15. Out of 16 aphasic patients, two did not make any errors on these sentences and two made errors which did not correspond to either of the patterns in Figure 14.

Figure 14.

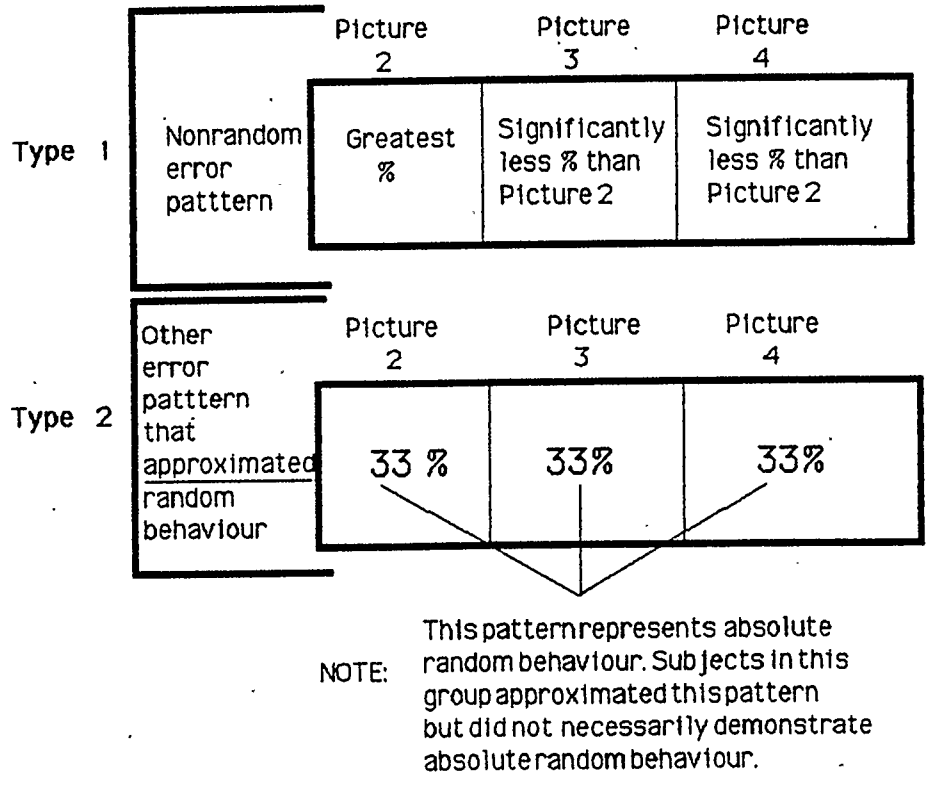


Table 5 contains 1) a listing of the 12 eligible subjects for the analysis, 2) the total percentage score that each subject received on the entire test, and 3) the Error Type category to which each subject belonged. The total percentage score is used here as a measure of severity of language loss, the rational being that the more severe the deficit the lower the test score.

Table 5.

Subject:	D	G	K	J	Ba	Sh	So	St	V	W	R	La
% Score:	54	65	54	72	68	69	38	48	67	56	85	33
Error Type:	1	2	1	1	1	1	2	2	1	1	1	2

A subject's membership in one of the two 'Error Type' groups was determined by the following 3 steps . Step One involved adding up the number of times picture 2, picture 3, and picture 4 were selected and then dividing these numbers by the total number of errors made on sentences 2, 13, and 15. The results were then turned into the percentages that appear in Table 6.

Table 6.

	Subject:	D	G	K	J	Ba	Sh	So	St	V	W	R	La
% of time a picture was chosen on sentences 2, 13, 15	Picture 2:	63%	33	86	100	67	100	50	50	100	80	100	60
	Picture 3:	0	0	14	0	0	0	50	25	0	0	0	20
	Picture 4:	37	67	0	0	33	0	0	25	0	20	0	20

Step Two involved subjectively classifying each of the subjects into one of the two Error Types described in Figure 14 . Step Three involved statistically confirming or disconfirming the classification by using a Discriminate Analysis (N = 12) which reported a 100 % accuracy on the grouping of Error Types as listed in Table 5.

Once the grouping was confirmed a correlational analysis was performed to determine if a relationship existed between severity of language loss and membership in the two 'Error Type' groups. A Point-Biserial Correlation analysis was performed using test score as the continuous variable and Error Type as the nominal variable. The resulting Point-Biserial Correlation Coefficient was .62 (N=12) indicating a significant correlation between these two variables.

It appears from these findings that there is relationship between Error Type and severity of language deficit such that the less severe the language deficit the more patterned the errors are and the only significant error pattern that emerges is one where him is interpreted as himself. In reference to whether or not the errors were patterned, it is possible to rationalize these results by speculating that when one is mildly impaired one has access to a greater body of linguistic knowledge than when one is severely impaired. It is possible that in states of extreme impairment one loses so much linguistic ability that comprehension of a specific sentence becomes random.

Loss of linguistic knowledge may account for the random performance of those patients who are more severely impaired. However, loss of linguistic knowledge may or may **NOT** be the reason why less severely impaired patients interpret him as himself.

It could be argued that the error pattern where him is interpreted as himself actually does reflect a loss of linguistic competence. So, for example, it might be suggested that aphasic patients have lost Binding Principle B, and as a possible consequence, are applying Binding Principle A to both pronominals and anaphors. Or, it might be suggested that aphasic patients have lost some sort of lexical marking that pronominals normally have, and thus pronominals are assumed to be anaphors and therefore are subject to Binding Principle A. These are only two suggestions , there are perhaps more[3] .

The other possible reason for WHY sentences containing a pronominal are most often mistakenly interpreted as sentences containing an anaphor has to do with the existence of a default mechanism that might come into play when, for whatever reason, one cannot get through all the steps that are necessary to completely comprehend a particular sentence.

One way of distinguishing between these two possibilities (i.e., loss of grammatical competence or default mechanism), is to compare the errors that aphasic patients make to errors that normal subjects make. If aphasics treat

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[3] It should be noted that a prediction of the analysis that treats pronominals as anaphors is that they cannot be used deictically (e.g. I saw him)

him as himself because they have lost some discrete aspect of linguistic competence, then we would predict that normals should NOT follow this pattern, because to be 'normal' presupposes access to a complete body of linguistic knowledge. It is significant to note, however, that when normal unimpaired subjects made a mistake interpreting sentences 2, 13, and 15, 100% of the errors were errors which corresponded to him being interpreted as himself.

There is yet another way of eliminating loss of grammatical competence as the primary reason for why him gets interpreted as himself . If it is the case that aphasic patients interpret him as himself because they have lost Binding Principle B, for example, then we would expect that patients would have identical responses to both The boy sprayed him. and The boy sprayed himself., because in both cases it would assumed that Binding Principle A applies.

Or, similarly, if it is the case that aphasic patients have lost some sort of lexical marking for pronominals and, as a consequence , treat both him and himself as anaphors, both would be susceptible to Binding Principle A. Once again, the outcome of such a loss would be that patients should have similar responses for The boy sprayed him. and The boy sprayed himself . because Binding Principle A would apply to both.

From Analysis 2, however, we have evidence that The boy sprayed him. is clearly more difficult for aphasic patients to interpret than The boy sprayed himself. It appears that while loss of grammatical competence can account for

the random behavior of severely impaired patients, it cannot account for why less severely impaired aphasics interpret him as himself.

In light of this, we are going to examine the other reason that was cited for WHY sentences containing a pronominal are most often mistakenly interpreted as sentences containing an anaphor. In the next analysis we will explore the possibility that a default mechanism exists, and that this mechanism comes into play when, for whatever reason, one cannot get through all the steps that are necessary in order to completely comprehend a particular sentence.

5.3.2 Analysis 5

The aim of this analysis is to examine the possibility of there being a default mechanism as explained in the preceding section. To do this , we will examine which pictures patients chose for the following sentences:

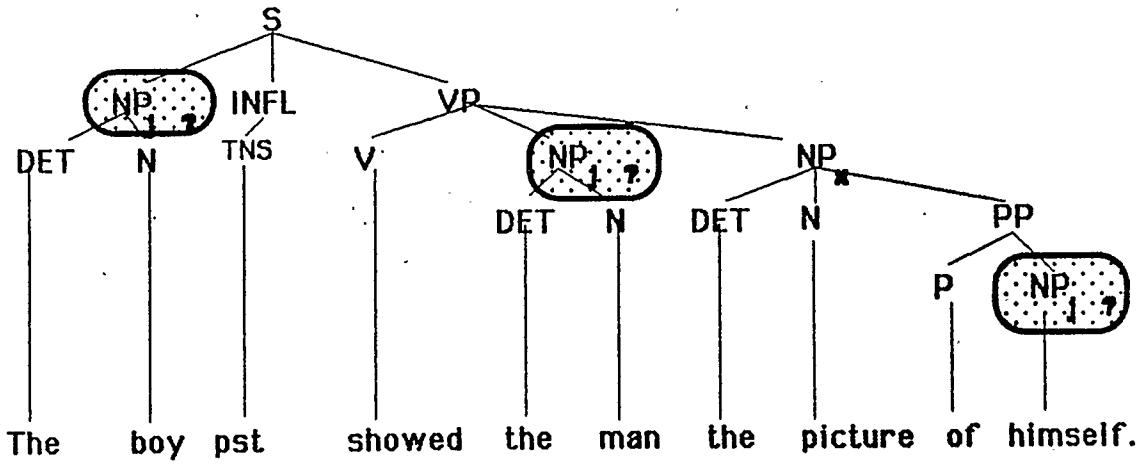
Sentence 11 : The boy showed the man the picture of him.

Sentence 12 : The boy showed the man the picture of himself.

Note that in sentence 12 there are two possible clausemate antecedents for the anaphor himself as Figure 15 illustrates. According to GB Theory , both the boy and the man are potential binders of himself. However, the theoretical framework does not specify which of the NP's himself will be bound to.

Figure 15.

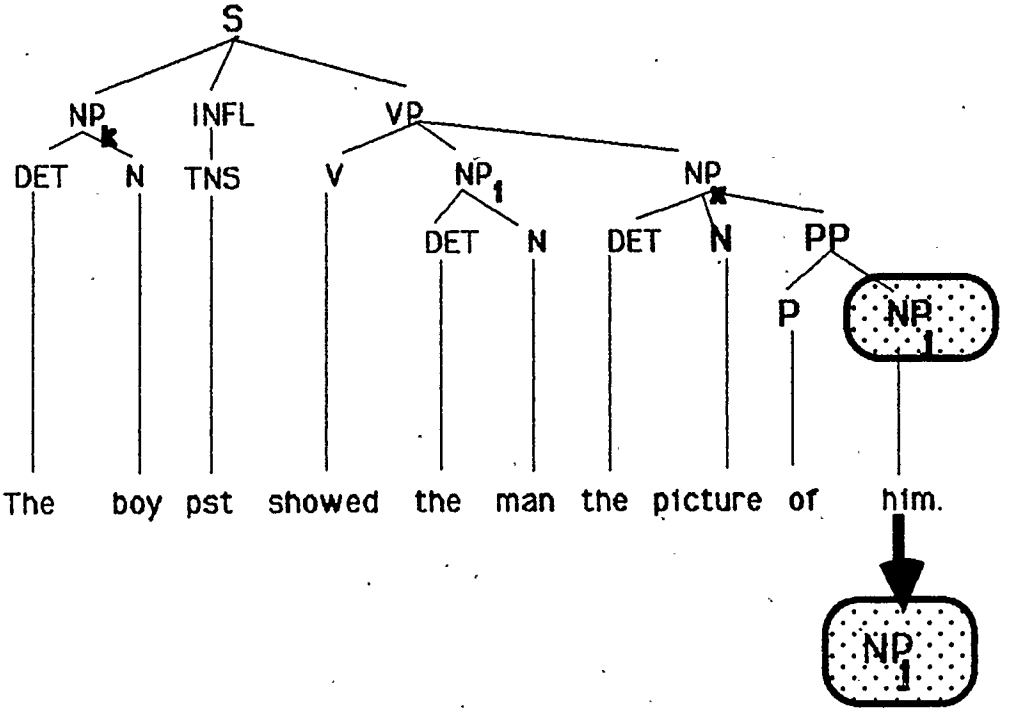
12. The boy showed the man the picture of himself.



As illustrated in Figure 16 , sentence 11 contains a pronominal which must be free in its Governing Category, which is the entire S according to the version of the framework employed here.

Figure 16.

11. The boy showed the man the picture of him.



For the sake of convenience, at this point, we are going to propose a mechanism called THE BINDING DEFAULT and formalize it as follows:

THE BINDING DEFAULT

If , at a particular step in the comprehension process you cannot go on , or if you make a mistake , then bind .

The notion of a 'DEFAULT' mechanism is meant to be suggestive of an automatic fall-back device that assists in the interpretation a sentence. THE BINDING DEFAULT implies that one does not merely stay inside the sentence and randomly select any NP as the antecedent of him . It suggests that one

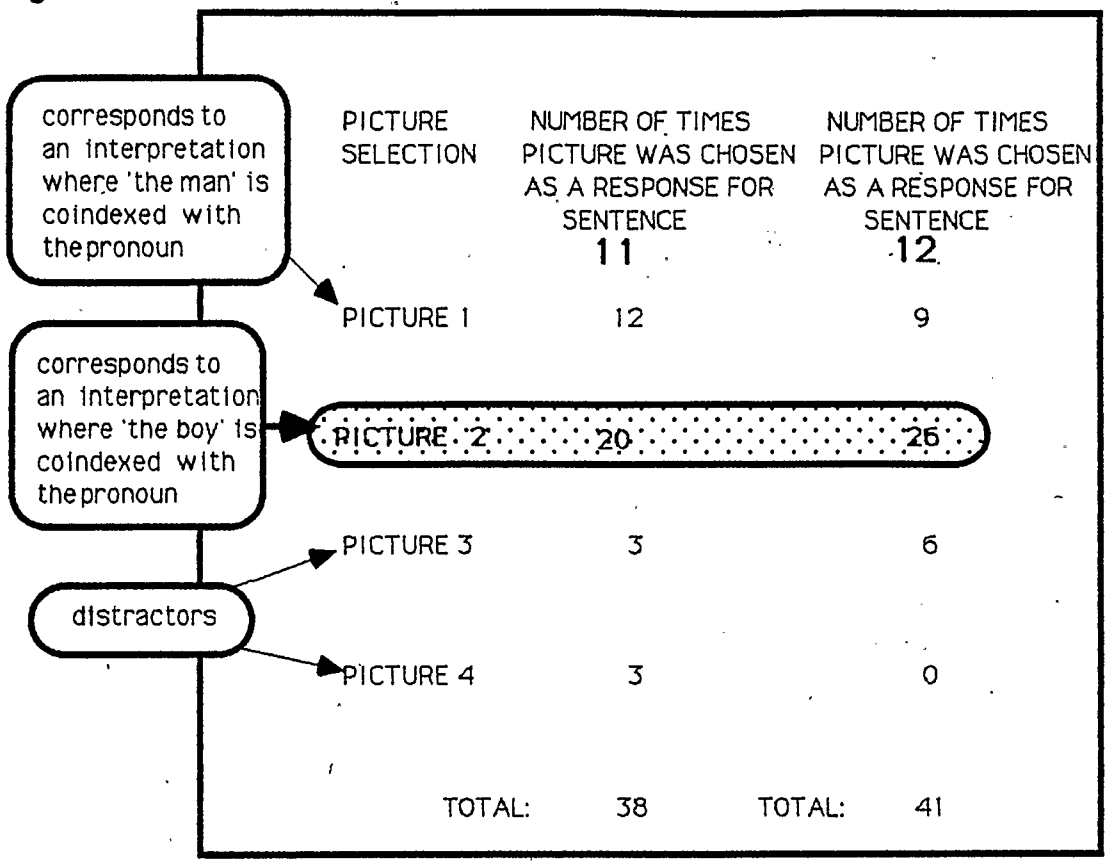
stays inside the sentence and takes, as the antecedent of him, the same NP that would serve as an antecedent of himself. So, for example, if one is unable to correctly interpret The boy sprayed him, we predict according to the THE BINDING DEFAULT, that the sentence would be interpreted as if it were The boy sprayed himself.

If there is a mechanism that is employed to assist in interpreting sentences like 11, then we would predict that according to the THE BINDING DEFAULT the pronominal (i.e., him) would have the same antecedent as the anaphor (i.e., himself).

If we examine the pictures that patients selected for sentence 12, with the aim of determining which NP patients most frequently took to be the antecedent of himself, then according to THE BINDING DEFAULT the NP chosen as the antecedent for him in sentence 11, should be the same NP as that chosen for himself in sentence 12.

Figure 17 provides a summary of the frequency of picture selection for both sentence 11 and sentence 12. Recall that since there are two possible clausemate antecedents for sentence 12, both Picture 1 and Picture 2 can be considered correct selections..

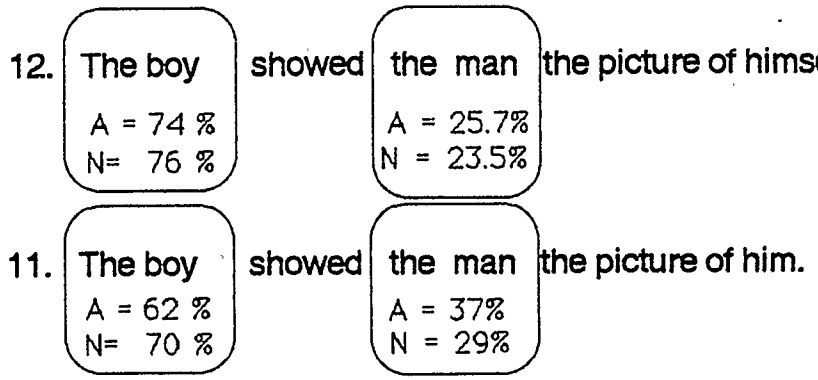
Figure 17. Picture selection for sentences 11 and 12.



The percentage of times a patient selected either picture 1 or 2 , for sentences 11 and 12, is presented in Figure 18. In addition, Figure 18 , presents similar information about choice of antecedents which normal subjects made for each of these sentences.

Figure 18. Aphasic Patients and Normal Subjects

Percentage of time a particular NP was chosen as an antecedent.



A = aphasic patient N = normalsubject

Chi-squared analyses on the data in Figure 18, indicated that aphasic patients and normal subjects chose the the boy as antecedent of both him and himself significantly more often than they chose the man. For aphasic patients on sentence 12, χ^2 (1 , n = 16) = 23.0 , p<.05, and on sentence 11 , χ^2 (1 , n = 16) = 6.26 , p<.05. For normal subjects on sentence 12, χ^2 (1 , n = 17) = 28.0 , p<.05, and on sentence 11 , χ^2 (1 , n = 17) = 16.82 , p<.05.

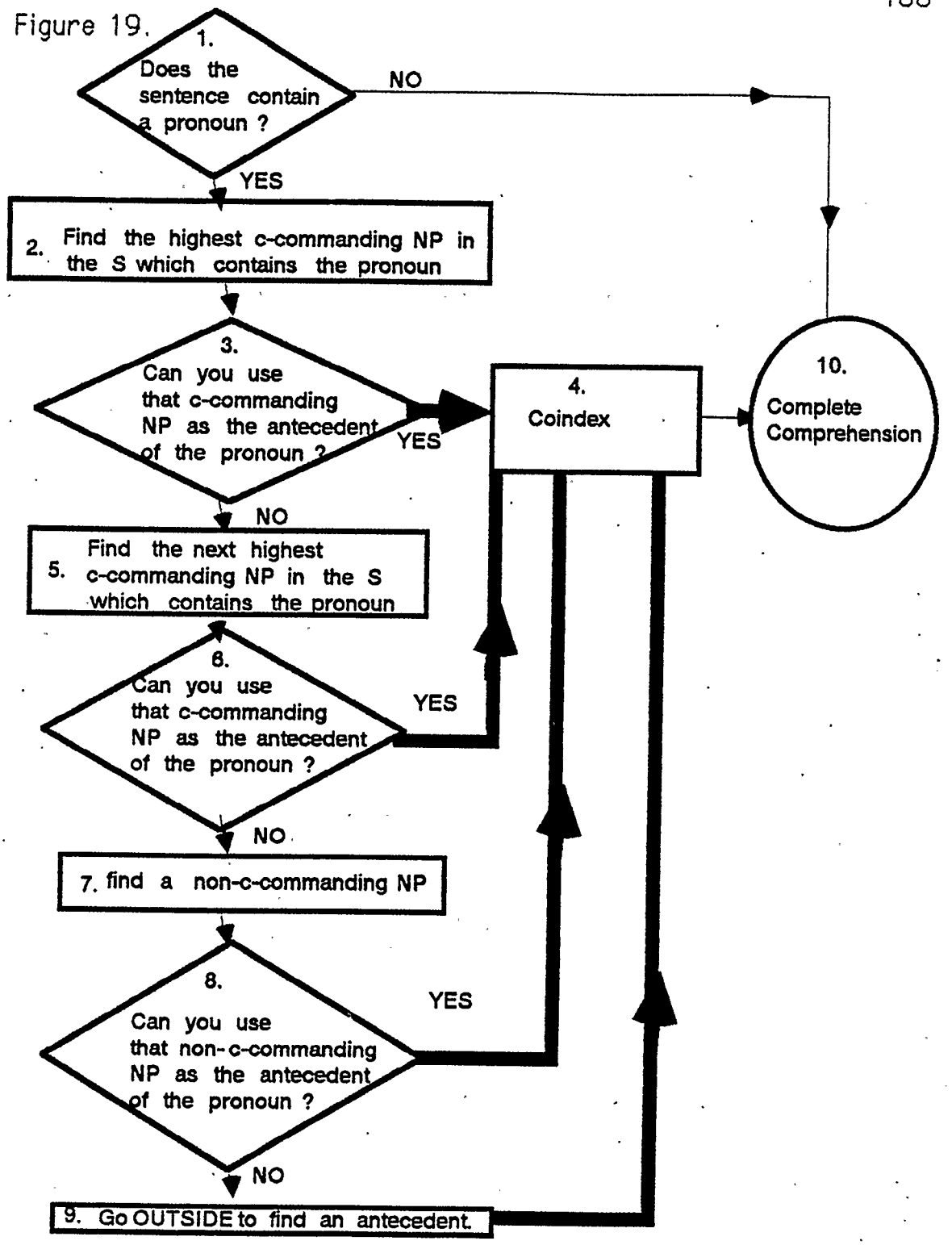
These findings illustrate three crucial points. First, in reference to sentence 12, the subject of the sentence (which is the highest NP in S), is chosen significantly more often as the antecedent of himself than is the direct object NP. This suggests that there is a preference for the subject NP to be antecedent to the pronoun . Second, it is clearly the case that , in keeping with THE BINDING DEFAULT , the NP which was chosen as the antecedent of him in sentence 11, is the same NP that was chosen as the antecedent of himself in sentence 12.

Third, both aphasic patients and normal subjects followed the same pattern in reference to the selection of antecedents in sentences 11 and 12. This implies that is there a qualitative overlap between aphasic language and normal language and, more importantly, it implies that what we have been describing all along actually is a type of processing model for normal comprehension.

It is significant to note that loss of grammatical competence cannot explain why sentences containing him often get interpreted as sentences containing himself. We have suggested, that sentences containing pronominals involve more steps before complete comprehension can occur. If this is what makes these sentences more difficult, then the likelihood of making a mistake on these sentences is greater , and so is the possibility that at some point comprehension may simply breakdown. It appears that a default mechanism comes in to assist in the interpretation of more difficult sentences, and that this default mechanism is available for both normal subjects and aphasic patients.

In light of the findings from Analysis 5, we can further expand the steps involved in the comprehension process and examine at what point THE BINDING DEFAULT might come into play. Consider the revised flowchart in Figure 19.

Figure 19.


1. Does the sentence contain a pronoun ?
NO
YES
2. Find the highest c-commanding NP in the S which contains the pronoun
3. Can you use that c-commanding NP as the antecedent of the pronoun ?
YES
4. Coindex
10. Complete Comprehension
NO
5. Find the next highest c-commanding NP in the S which contains the pronoun
6. Can you use that c-commanding NP as the antecedent of the pronoun ?
YES
NO
7. find a non-c-commanding NP
8. Can you use that non-c-commanding NP as the antecedent of the pronoun ?
YES
NO
9. Go OUTSIDE to find an antecedent.

What the bold lines in Figure 19 suggest, is that at any point in the comprehension process when a decision must be made about a possible antecedent for a pronoun, it is possible for the BINDING DEFAULT to apply. Thus, it is implied that rather than being an isolable subcomponent or actual mechanism per se, THE BINDING DEFAULT simply represents a preference to bind or coindex which is, in effect, a short cut to complete comprehension, even though its application may result in the wrong interpretation of a sentence.

One of the most significant aspects of the model Figure 19 , is that it is empirically motivated. The creation of the initial model, and every proposed expansion of that model, was motivated by findings that arose from the empirical study. In all probability, with the addition of further information (e.g., information concerning how normals and aphasics comprehend biclausal structures which contain pronominals and anaphors), this model would need to be expanded and modified.

Chapter 6

Summary

6.0.0. Introduction

This chapter contains two sections. In Section 6.1.0 the three research questions from Chapter 1 are restated. For each of these questions a related finding from Chapter 5 is presented and then followed by a discussion. Section 6.2.0 provides concluding comments.

6.1.0 Findings Related to the Original Research Questions

6.1.1 Research Question 1:

Are there differences in aphasics' interpretation of pronominals and anaphors ?

(i) Related Finding

Sentences containing a pronominal are more difficult to interpret than the corresponding sentences containing an anaphor.

(ii) Discussion

The following is a proposal for why sentences which contain a pronominal are more difficult to interpret than sentences which contain an anaphor. If it is the case that a sentence containing a pronominal does not have a sentence internal NP which can serve as an antecedent then one must go OUTSIDE the sentence in search of referential information. This implies that one leaves the sentence with an incomplete mental image about the meaning of the

sentence. Until the appropriate referential information is found, complete comprehension of the sentence cannot occur.

In terms of the empirical task, OUTSIDE implies that the patient must go to the test pictures and perform a searching operation . The goal of this operation is to determine which one of the test pictures contains the correct referential information. This is relatively difficult operation to perform because the patient does not know exactly who him refers to.

In contrast, sentences containing anaphors have all the information (including referential information)INSIDE the sentence. Such sentences are highly picturable, in the sense that it is relatively easy to form a complete mental image of what the sentence means solely on the basis of sentential information. All one must do, when presented with the test pictures, is perform an operation to match an already existing mental image with the appropriate target picture. This is a relatively easy operation to perform because the patient knows exactly who himself refers to.

For the most part, notions from Government and Binding Theory could be used to account for the finding stated in 6.1.1. We saw however, that GB Theory only gives an explicit characterization for which NP's can serve as antecedents for anaphors but does not give explicit principles or guidelines for determining antecedents for pronominals. It is implied that a pronominal can take a non-c-commanding NP as its antecedent. However, a non-c-commanding antecedent can be either outside the sentence, as in the case of

The boy sprayed him, or possibly inside the sentence as in the case of The boy's father sprayed him.

As explained in Chapter 5, it was necessary to employ the notions of OUTSIDE and INSIDE because: 1) The notions of free and bound do not take into account what the patient must do order to select the target picture, 2) The notions of free and bound, even though they may not be incompatible with theories of performance, are in essence concepts which refer primarily to linguistic competence .

In essence then, GB Theory can account for what occurs at the sentence level. However, once one leaves the sentence (i.e., in search of referential information) then additional notions of OUTSIDE and INSIDE are useful in helping to characterize how one finds the additional information that is necessary for complete comprehension. Thus, notions from the theoretical framework were supplemented with OUTSIDE and INSIDE in an attempt to characterize the steps that one goes through in comprehending both sentences which contain an anaphor and those which contain a pronominal. In Chapter 5, it became apparent that the complete comprehension of a sentence which contains a pronominal involves more steps than are involved in the complete comprehension of a sentence which contains an anaphor. The fact that one must go through more steps in order to completely comprehend a sentence containing a pronominal is, in part, what makes these sentences more difficult to interpret.

The observation that sentences which contain a pronominal are more difficult to comprehend, is probably NOT limited or unique to the task which was involved in this investigation. If one considers context of normal discourse, it is often the case that correct interpretation of sentences containing pronominals is reliant upon referential information which is disclosed somewhere in the conversation.

6.1.2 Research Question 2

If there are differences in aphasics' interpretations of pronominals and anaphors, what is the appropriate characterization of these differences?

(i) Related Finding

The observations that pronominals are more difficult to interpret than anaphors and that pronominals are often interpreted as anaphors cannot necessarily be characterized as a loss of linguistic competence. One characterization that is consonant with these observations is that the processing of pronominals involves more steps before complete comprehension can occur. Thus, there are more chances for mistakes to occur or for the interpretation process to breakdown. If either of these situations occurs, the BINDING DEFAULT applies.

(ii) Discussion

A purely theoretical account for why pronominals are interpreted as anaphors might claim the loss of Binding Principle B. If one had only Binding Principle

A available, then it is possible that both pronominals and anaphors would be susceptible to being bound. For example, loss of Binding Principle B might imply that The boy sprayed him. and The boy sprayed himself. would both be interpreted as The boy sprayed himself. If both sentences were being interpreted as The boy sprayed himself. , then we would predict that patients would give them identical interpretation. This was definitely NOT the case, however.

In addition, if it was a simple case of losing a particular Binding Principle, then we would expect that there should be a clear division between those patients who had lost Binding Principle B and those who had not. Those who had lost Binding Principle B should always make an error that corresponds to him being interpreted as himself . Those who had not lost Binding Principle B should interpret him as a pronominal and himself as an anaphor. However, patient performance defies this type of characterization. It is not the case that all patients make errors which indicate that they either have or do not have Binding Principle B .

Moreover, the only errors that normals made were errors where sentences containing him were interpreted as if they were the corresponding himself sentences. This could not possibly be explained in terms of a loss of Binding Principle B, since we assume that as part of a complete endowment of linguistic competence, normals have both Binding Principles .

There may also be another reason for why aphasics often interpret a sentence containing a pronominal as if it were a sentence containing an anaphor. It may be the case that the storage of lexical information is somehow impaired such that one loses the lexical markers that normally indicate which lexical entries are pronominals . One of the possible consequences of this might be that pronominals are no longer marked as being pronominals and they become included in the set of forms which are marked as being anaphors. Once again, however, since we assume that lexical information in normals is intact, this explanation cannot account for the fact that normals also err in such a way that a sentence containing a pronominal is sometimes misinterpreted as a sentence containing an anaphor .

It is NOT being claimed that Binding Principle B or other linguistic elements and principles cannot be lost. In cases of global brain damage one would expect that linguistic competence would be severely compromised or lost completely. It is , however, being suggested that loss of a specific category or principle cannot adequately characterize the performance of the majority of less severely impaired aphasic patients involved in this investigation.

Rather than it being a case of losing Binding Principle B, it appears as though there is something about the nature of pronominals themselves which make them more difficult to interpret. Specifically, finding antecedents for pronominals often involves going OUTSIDE to find referential information, and as we have discussed in previous sections, going OUTSIDE involves more steps for complete comprehension to occur.

It is not surprising then, that if one cannot get OUTSIDE (i.e., access or use Binding Principle B) or, if one makes a mistake along the pathway to getting OUTSIDE (i.e., at the points in the flowchart where one must make a decision), then one stays INSIDE even though there may be no correct antecedent there. Regardless of whether there is correct referential information INSIDE the sentence, if the goal is ultimately to comprehend the sentence, it is suggested that perhaps there is a default mechanism , such as THE BINDING DEFAULT, which predicts that when subjects err on sentences containing a pronominal it should be an error that corresponds to a situation where the pronominal is interpreted as if it were an anaphor.

6.1.3 Research Question 3

What is the relationship between aphasic's interpretation of sentences containing a pronominal or anaphor, and normals' interpretation of sentences containing a pronominal or anaphor.

(i) Related Finding

The characterization that has been constructed using aphasic data is, in essence, a characterization of normal language comprehension.

(ii) Discussion

In Chapter 5, as we progressed through each analysis we obtained more and more information concerning the way in which aphasic patients were interpreting various groups of sentences. We were able to use this information to assemble increasingly more detailed flowcharts which characterized

possible sequences of steps that aphasic patients went through in order to completely comprehend a specific sentence.

However, it was apparent at the end of Chapter 5 that, in essence, what we were describing in the flowcharts was a step by step characterization of normal comprehension. This became particularly clear in the final analysis in Chapter 5, where it was demonstrated that both normal subjects and aphasic patients tended to 1) choose the same antecedent for the anaphor in the sentence, The boy showed the man the picture of himself., and 2) employed the same default mechanism to assist in the interpretation of the sentence The boy showed the man the picture of him.

Thus, there is evidence which suggests that both normals and aphasics proceed through the same series of steps in order to comprehend a sentence. Because normals make few mistakes and because their responses are much faster than those of aphasics, it is difficult, if not impossible, to determine precisely what these steps are. Thus, the performance of aphasics can provide valuable insight into what these steps might be and how they might be ordered.

6.2.0. Concluding Remarks

Early in Chapter 1 it was established that the current study was motivated by two general questions. The first of these questions was: How can theories of normal linguistic competence assist in characterizing how sentence comprehension is impaired in aphasia? In response to this question, it has

been demonstrated that linguistic theory has the potential to make two significant contributions to neurolinguistic investigations. The first of these is concerned with the rich and detailed nature with which linguistic theory has the potential to characterize language loss in aphasia. The second contribution pertains to the increase in control that one has when using a constrained theory of linguistic competence.

If one of the ultimate goals of neurolinguistics is to fully characterize and understand what language comprehension and production consists of and how it is disturbed in aphasia , then a theory of linguistic competence plays an essential role in the fulfillment of those goals. Specifically, one cannot fully characterize aspects of language loss in aphasia without linguistic theory. However, this investigation has also demonstrated that one needs more than linguistic theory to fully characterize aspects of language loss in aphasia. Since Government and Binding Theory is a theory of syntactic competence, the phenomena it is capable of accounting for exists primarily at the sentence level. Yet to fully account for aphasic performance we need concepts that will also account for the processing of language. These concepts must take into account phenomena beyond the sentence level.

The second general question that was addressed in Chapter 1 was: How can information from language breakdown in aphasia shed light on how normal individuals comprehend sentences? This investigation has illustrated that aphasic data provides valuable information concerning the nature of normal comprehension. Specifically, during the course of this investigation we have

had the opportunity to make two important observations about what it means to comprehend a sentence. First, there are various degrees of comprehension. Second, there are are various ways in which comprehension can occur .

Most likely, each of those ways involves an ordered sequence of steps. In reference to sentences which contain a pronominal or anaphor, complete comprehension can only occur once one has information about the individual components of a sentence, an understanding of how those components relate to one another syntactically, and knowledge of where one must go to get necessary referential information.

Ultimately, the way in which comprehension occurs is dependent on both the nature of the stimuli and the context of the task. If the stimuli consist of sentences containing either an anaphor or a pronominal, we now know that comprehension of these two types of sentences may involve quite different operations. It is possible for one to completely comprehend a sentence which contains an anaphor, entirely on the basis of sentential information. It is often the case, however, that in order to comprehend a sentence which contains a pronominal, one must look external to the sentence for additional referential information before complete comprehension can take place.

If one has to look external to a sentence to find referential information, <u>where</u> one looks is based largely on the context one finds oneself in. During this investigation, when patients went outside a sentence to find referential information, they had no other choice but to go to the test pictures. The test

pictures represented a concrete destination where the correct referential information was always available. During normal discourse, however, referential information could exist in any number of places outside of the sentence. If a patient has difficulty establishing referential information when the destination is specified and concrete, it is understandable that difficulties might arise in normal conversation where securing referential information is often dependent on an abstract body of shared knowledge.

Even though it is beyond the scope of the current investigation to delve into how aphasic patients might secure referential information during normal discourse, the current investigation at least provides insight into the different steps that one might possibly go through when attempting to comprehend sentences which involve some type of referential relationship .

As we have seen, it is possible that in spite of a great deal of individual patient variability, there are certain generalizations that can be made concerning the performance of a group of aphasic patients. In addition, there are important areas of overlap between the performance of aphasic patients and the performance of normal subjects.

Linguistic theory and the field of aphasiology have the potential to develop a secure symbiotic relationship in which linguistic theory can offer detailed and precise characterization of language breakdown. Aphasic data, in turn, can provide a testing ground and means of constraining linguistic theory and theories of normal language processing. The findings of this investigation are

ultimately seen as a small yet significant contribution to the ever growing body of data that bears on the study of language and the mind.

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