AN INVESTIGATION OF THE EFFECTIVENESS OF LANGUAGE RETRAINING METHODS WITH APHASIC STROKE PATIENTS.

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ABSTRACT

Four main experiments were conducted to investigate the effectiveness of language treatment methods with aphasic stroke patients. Experiment 1 was designed to compare an operant speech training procedure devised by Goodkin (1966) with speech therapy and with an attention placebo treatment. Twenty-four patients with moderate aphasia (35 to 65 %ile on the PICA) received four weeks of speech therapy and four weeks of either operant training, or non-specific treatment. Results indicated no significant differences between the treatments. Patients showed significant improvement in language abilities but this was unrelated to age, months post onset or handedness.

Experiment 2, was a preliniary investigation of speech therapy with eighteen severe aphasics (below 35 %ile on the PICA). Patients showed significant improvement in language abilities but this was unrelated to age, months post onset or amount of speech therapy received. In Experiment 3 operant training and an attention placebo were each given for 4 weeks, in addition to speech therapy, to twelve severe aphasics. No significant differences occurred between treatments and patients showed significant change which was unrelated to age or months post onset.

Experiment 4 compared the treated patients in Experiments 1 and 2 with a no treatment control group. Results indicated no significant differences between the groups over a four week interval.

Three subsidiary experiments were carried out to assess the reliability of some assessment procedures used, the Token Test shortened version, the Object Naming test and the Speech Questionnaire.

Language retraining methods, as used at Rivermead Rehabilitation Centre, were shown not to improve language abilities more than attention placebo treatments or no treatment. Patients'language abilities improved, but this was unrelated to biographical variables, such as age, months post onset and handedness.

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CHAPTER 1

INTRODUCTION

The rehabilitation of language disorders has been carried out for many years by speech therapists and to a much lesser extent by occupational therapists. These treatments have developed from theoretical ideas on aphasia as well as what has clinically been found to be useful. Practice in those skills in which a patient has been found to be deficient has been assumed to be therapeutic. This basic assumption has recently been questioned by Hopkins (1975) and there have been various suggestions that the recovery of function observed occurs spontaneously and independently of any therapeutic intervention. There are many problems in determining whether this is in fact so (Darley 1972), but certainly there is a general consensus of opinion that a certain amount of improvement occurs spontaneously in the early stages following a stroke. Whether speech therapy enhances this recovery has still not been adequately evaluated. There is therefore a need for an evaluation of speech therapy as a treatment regime.

Recently, alternative procedures have been developed for retraining language in dysphasic stroke patients. Programmed instruction and verbal conditioning procedures are becoming more extensively used, yet the efficacy of either of these has not been determined.

The present study was set up to evaluate some of the treatment procedures being used at Rivermead Rehabilitation Centre, Oxford, in the rehabilitation of dysphasic stroke patients. The main treatment used for these patients is speech therapy, but an operant conditioning procedure (Goodkin 1966) has also been occasionally used. It was considered appropriate that both these should be evaluated, though the main interest was in the application of operant techniques. The reason for this is that various procedures based on learning principles have been developed elsewhere which could be used in rehabilitation units, yet none seem to be widely used or generally accepted. Speech therapists are in short supply (Hopkins 1975) so in many instances they cannot provide as full a treatment service as they would wish. The operant conditioning techniques have the advantage that they could be carried out by an occupational therapist or relative or some could even be self-administered. These might be used as an adjunct to speech therapy or if found to be more effective than speech therapy they could be used as an alternative. It may be that some procedures are appropriate for certain groups of patients and so an attempt to determine how most effectively to rehabilitate aphasic patients is required.

The present study is designed to look at selected treatment regimes involving operant techniques and to determine what contribution they have to make. The aim is to evaluate treatments which are widely applicable and given in intensity and frequency typical of most NHS hospitals. They are intended to represent current clinical practice and not an ideal treatment programme. The reason for this is that no treatment, however effective, will be adopted unless it is practical within the settings in which it is to be applied.

CHAPTER 2

THE ASSESSMENT OF APHASIA

2.1 Definition of Aphasia

Aphasia has been defined as an impairment of language functioning of persons who have incurred localized cerebral damage that results in reduced likelihood that an individual involved in a communication situation will understand or produce appropriate verbal formulations (Eisenson 1971).

The first important feature of this is that it involves impairment of language functioning. Disorders of articulation, dysarthrias, are therefore not included nor is dysphonia, loss of voice. These are often fairly straightforward to differentiate from aphasia in that the content of spoken and written speech is normal, but the execution of spoken speech is impaired. This may be to the extent that it is totally uncomprehensible or it may be merely distorted. These may both result from impaired central nervous system functioning, e.g. head injury, multiple sclerosis. A more difficult distinction is to differentiate between aphasia and dyspraxia. Oral dyspraxia is the inability to produce the appropriate combination of movements of the lips, tongue and larynx to produce intended sounds. Each component movement may be successfully performed but the co-ordinated combination of these movements may not be achieved. Written expression may be affected due to dyspraxia of hand movements. However, in dyspraxia comprehension is usually intact.

The second important feature is that aphasia is a result of localized cerebral damage. This may be a cerebral vascular accident, a subarachnoid haemorrhage or a head injury. In all cases there is damage to the brain cells. This distinguishes aphasias from loss of language due to psychiatric conditions, such as schizophrenia or hysteria, though the content of the disorder may not be very different (Critchley 1970).

Distinctions have been made between aphasia as total loss of language and dysphasia as a partial loss of language. In practice total language loss virtually only occurs when an individual is unconscious. In any conscious state there is usually some understanding of gesture, such as head nods and smiling, which can be considered to be a basic communication system. Verbal comprehension is usually retained even if only at a very simple level of yes and no. Calling those patients with total language loss aphasic would lead to almost all patients with language problems being classified as dysphasic, because almost all retain some language function. It is therefore not a practically useful distinction if used in this manner.

In clinical situations aphasia is used for a severe language loss and dysphasia for a milder one. The dividing line between the two is an arbitrary one and varies from clincian to clinician. It therefore does not provide a reliable classification system. Since no consensus of opinion has been reached, published articles use both terms. As there is no practical advantage in separating the two, in the present thesis the terms have been used interchangeably. Where possible the terms used in the articles quoted have been adhered to. No distinction between aphasia and dysphasia has been considered, and no conclusions can be drawn on the basis of the particular term used.

2.2 Causes of Aphasia

Aphasia results from any lesion in the speech areas of the brain. The most common causes are cerebral vascular disorders, intracranial tumours, cerebral abscess and brain injuries. In addition, aphasia may occur as a transitory phenomenon in migraine or as the aura of a focal epileptic attack.

Cerebral vascular disorders account for the majority of aphasics seen and present the most severe rehabilitation problems. All the patients seen in the present study were aphasic as a result of a cerebral vascular accident or 'stroke'.

A stroke is a catastrophic or potentially serious disorder of brain function due to interference with the circulation. The three main causes are cerebral haemorrhage, infarction and transient ischaemic attacks.

Cerebral haemorrhage results from rupture of the wall of a blood vessel so that blood escapes from the circulation, either into the subarachnoid space, the substance of the brain (intracerebral), or into the ventricle. The blood may clot to form a haematoma. Cerebral haemorrhages are caused by changes in the arterial wall due to atheroma or arteriosclerosis which make it likely to rupture and this may be aggravated by high blood pressure, which is commonly associated with arterial degenerative disease. They are also caused by aneurysms, a dilation of the artery due to congenital weakness; and angiomas, congenital malformations consisting of a mass of abnormal blood vessels. Head injuries may cause haemorrhage, with bleeding into the subarachnoid space or into the extradural or subdural spaces forming localised clots and a consequent rise in intracranial pressure. In addition, cerebral haemorrhages may result from diseases in which there is a general disorder of clotting of the blood. Haemorrhages may be detected by lumbar puncture, EMI scan and arteriography.

Infarction is death of tissue due to impairment of the blood supply (ischaemia). The extent of the infarction will depend on which blood vessel is obstructed and on the capacity of the neighbouring arteries to supplement the deficient blood supply. Ischaemia sufficient to produce infarction may result from a thrombosis, which is an intravascular clot which develops within the intra- or extra-cranial parts of the carotid and vertebral arteries; or from an embolism which is a clot or other substance such as fat which is carried in the circulation from one part of the body and obstructs a blood vessel elsewhere.

The third type of stroke occurs when the ischaemia is insufficient to produce infarction, but produces relatively minor short lived disturbances of cerebral function. These are sometimes called 'little strokes' and a series of them may preceed a major stroke.

Strokes are very common causes of admission to hospital, particularly among the elderly. Of these twice as many are thought to be due to infarction as to cerebral haemorrhage (Hutchinson 1976) though other estimates reported by Hutchinson are higher. However, it seems that haemorrhages are more common than was once thought. The refinement of X-ray techniques using the EMI scan has meant it is now possible to detect much smaller areas of cerebral haemorrhage. It seems that whereas previously infarctions were assumed on the basis of no evidence of cerebral haemorrhage in many cases this was due to inability to detect the very small haemorrhages and the incidence of haemorrhage was probably considerably higher than studies indicated.

2.3. Classification of Aphasia

Various classification systems have been used to subdivide aphasics into distinct groups. These have been developed and changed over many years but as yet there is no generally accepted means of classifying different types of aphasia.

The existence of such a system would have the advantage that it would reduce the amount of information needed to give an accurate description of a patients' language abilities. However, the categories need to be mutually exclusive with no overlap, so that the attributes of a patients' language are known, rather than a category indicating a patient may have one of several attributes which resulted in his allocation to that category.

Categories, to be of practical value, also need to have predictive significance. If, from a classification one can predict a patient's progress with time, then it can be used in planning treatment and evaluating progress. For this reason categories must be independent of severity. If each category does not cover the full range of severity, then it may merely represent the degree of impairment and not the nature of impairment.

Some authors, such as Schuell, have argued against classifying aphasics into different sub-groups but propose that aphasia is a unitary dimension of language impairment. They classify patients according to the impairments which occur concommitant with aphasia, which just seems to move the classifcatory problem to one side.

According to Bay (1967), a logical classification system is only possible if it is based on a theory of underlying relations, such as a theory of aphasia. At present there is no available theory of underlying relations in aphasia which is entirely satisfactory. Most classifications based on unsatisfactory theories are retained for convenience, rather than because of any adherence to the theory from which they were derived.

Bay puts forward two conditions which he considers necessary for a reliable, generally acceptable classification system. First, it must be possible reliably and clearly to distinguish between classes. If classes become too numerous it becomes impossible to make discriminations between performances of patients with sufficient accuracy for them to be reliably classified. The second condition is that each constituent of a classification system must be defined on the basis of a single unequivocal property of pattern, for example, fluent or non-fluent. If several properties are used, confusion results if they are independently variable, for example, reception and expression. One variable may indicate classification into one sub-group and the other variable a different group. Bay therefore proposes the qualitative basis should be the presence or absence of a specific symptom and not a 'more or less' distinction. These should be retained as indicators of severity within the sub-groups. Bay considered that, at that time, aphasia should be considered as a unitary category because no sub-groups could be unequivocally defined.

2.3.1 Sensory-Motor-Conduction Aphasias

This system is based on neurological findings linking the area of brain affected and the observed language impairment in aphasic patients. Motor aphasia resulted from damage to Broca's area, the third frontal convolution, and was said to be characterised by loss of speech in the absence of impairment of comprehension or loss of intelligence. Sensory aphasia was described by Wernicke as resulting from temporal lobe lesions and consisting of loss of understanding of speech with learning and articulation intact. Interruption of the fibre tracts connecting these two areas would lead to conduction aphasia, the chief symptoms being paraphasias, errors of commission modifying the individual words, and word subsitutions in speech or writing. Although now of little status, these conceptual models laid the foundation stones of modern aphasiology. Few physiologists ever believed completely in the motor-sensory dichotomy, which persisted for many years, and it is now established that cerebral processes are infinitely more complex and dynamic than this scheme suggests.

The classification system became unacceptable as it did not accord with clinical observations and it also had to be extended to account for other 'types' of aphasia which could not be incorporated into the system. For example, total aphasia was introduced to account for the deficits observed, when both Broca's and Wernicke's area were damaged.

Some recent work has been done which lends support to the traditional classification system. Goodglass and Kaplan (1972) report on two factor analyses of results from the Boston Diagnostic Aphasia Test (BDAT), which provide factors which separate all the major aphasic syndromes. However, even though these traditional types may be identified from the score profiles on the BDAT, in the early stages there is considerable overlap between groups. There is also no evidence presented that the patients classified have the corresponding localized lesion to produce the observed impairment.

Kertesz and Phipps (1977) performed a similar analysis on the Western Aphasia Battery. They obtained clusters which corresponded closely with clinically recognised groups. However, they do point out that the balance between specificity and objectivity, clinical relevance and mathematical abstraction is yet to be worked out.

Therefore, there is some support for the use of individual categories, such as Broca's, Wernicke's and conduction aphasias, but there are serious limitations in this being extended to classify all aphasics.

2.3.2 Receptive-Expressive Aphasias

This system, which is probably the most widely used clinically, was developed by Weisenberg and McBride (1935). It consists of four categories of aphasics, predominantly expressive, predominantly receptive, expressive-receptive and amnesic. Much of the initial support for the system came because it fitted with clinical experience. However, more carefully structured examinations indicated that a central language disturbance in which reception is more impaired than expression probably cannot exist. Schuell, Jenkins and Jiminez Pabon (1954) point out that since all subjects have impairment of both reception and expression these terms are meaningless in relation to aphasia.

2.3.3 Semantic-Syntactic-Pragmatic Aphasias

Wepman (1951) subdivided aphasics according to errors made in free speech samples. Fillenbaum, Jones and Wepman (1961) found that aphasics differed from normal controls in grammatical form classes, sequential dependencies in form class usage and stereotypy of vocabulary. Consistencies among aphasics in these led to their classification into semantic aphasics, characterised by word finding difficulty; syntactic aphasics, with grammatical errors; and pragmatic aphasics, with lack of meaningful speech. They also considered admixtures of these types could occur, which renders the whole classification system meaningless, since no distinct types may be discerned.

Wepman and Jones (1964) expound this three type classification without further linguistic data. They also added two further types, jargon aphasia, where speech is unintelligible, and global aphasia, where little or no speech is available. They draw a parallel between the five types and stages of language development in aphasia, postulating that recovery should follow these stages. This suggests that Wepman does not consider these as distinct types but as gradings of severity of aphasia.

2.3.4 Afferent-Efferent Aphasias

Luria (1964, 1966, Luria and Hutton 1977) developed a classification system in which patients were classified according to underlying or primary disturbed function and related defect in speech or language. The six categories: sensory aphasia, acoustic amnesic aphasia, afferent (kinaesthetic) motor aphasia, efferent (kinetic) motor aphasia, semantic aphasia, and dynamic aphasia, are little used clinically and seem to have gained little acceptance outside the USSR. They are based on a theoretical model without adequate experimental support.

2.3.5 Fluent-Non-fluent aphasias

This classification derived from the work on the analysis of free speech of aphasic patients by Howes and Geschwind (1964). They investigated the distribution of word frequencies in aphasia and found it to be no different from that of normal subjects, except that it is shifted in the direction of reduced variety. Aphasic patients tend to use fewer different words than normal subjects, but can use any word that a normal subject uses if one listens to a large enough sample of speech. When rate of production was considered, it was found that aphasics produce a wide variation in their rate of word production, yet the rate for a given patient is stable. The average rate at which a patient produces speech was found to divide the population into two distinct groups. Type A patients had a decreased rate of producing words and an increase in immediate repetitions of words. Type B patients had an increased rate of producing words, which increased with severity, and the proportion of immediate repetitions was essentially normal. These two types are therefore distinguished on the basis of rate of speech and this is independent of severity.

These types are more conveniently labelled as non-fluent and fluent. Benson (1967) outlines ten criteria for classifying patients into the two categories. These are rate of speaking, prosody, pronounciation, phrase length, effort, pauses, press of speech perseveration, word use and paraphasia. A more recent study by Wagenaar, Snow and Prins (1975) suggests that the classification could be made on the basis of two variables, speech tempo and mean length of utterance.

The fluency non-fluency dimension has the advantage that it incorporates the perspectives and findings of research in anatomy, linguistics and psychology. The fluent non-fluent dimension has important neurological correlates and therefore incorporates the more traditional models. Geschwind (1971) outlines the relation between the classical types and the fluent non-fluent dimension. Non-fluent aphasias are generally associated with a hemiparesis and result from damage to Broca's area. Fluent aphasias are not generally associated with a hemiparesis and result from damage to the tempero-parietal area.

Support for the anatomical relations with the fluent non-fluent dimension comes from cranial computed tomography. Hayward, Naesser and Zatz (1977) were able to separate non-fluent and fluent aphasics into pre- and post-rolandic lesions. Benson (1967) obtained consistent results using data from radioisotope brain scans. He found that patients with lesions anterior to the rolandic fissure were almost without exception non-fluent aphasics, while those with posterior lesions, were generally fluent aphasics.

This model is probably the best classification system available at present. It has a sound empirical basis and produces distinct categories which are discernible over time. However, it is little used clinically. This may be because the identifying characteristics of the two types are not generally determinable on the basis of standard clinical assessment procedures, though Geschwind (1971) suggests this should be possible. If a quick, easy distinction between the two groups becomes incorporated into clinical examination procedures, then it is more likely to attain wider clinical acceptance. The introduction of the Boston Diagnostic Aphasia Test (Goodglass and Kaplan 1972) with its ratings of speech characteristics may achieve this aim. At present this test is not widely used, but as it becomes better known, the use of the fluent non-fluent classification system may develop.

2.3.6. Aphasia as a Unidimensional Language Disorder

Schuell, Jenkins and Jiminez-Pabon (1964) consider aphasia as a general language deficit which may or may not be accompanied by other sequelae of brain damage, such as impairment of auditory, visual or sensorimotor processes. All aphasics show impairment of vocabulary and verbal retention span, and a proportionate amount of difficulty in formulating and responding to messages at some level of complexity.

Factor analysis of scores on the Minnesota Test for the Differential Diagnosis of Aphasia (MTDDA) yielded initially five groups with different diagnostic criteria and accompanying prognosis (Schuell and Jenkins 1959, Schuell, Jenkins and Carroll 1962). These five groups were later extended to seven. The groups are based on impairment concommitant with aphasia, and therefore not a classification of patients with language disorders. Schuell considers that the aphasia is a unidimensional language deficit.

Powell, Clark and Bailey (1979) also point out that these types were based on visual inspection of test profiles and clinical experience and there is no evidence that they are the 'best' categories that can be formulated. Although Schuell (1965) states that language deficit is a unitary trait, but with seven types of concommitant cognitive dysfunction, she refers in her writing to types of aphasia and categories of aphasia. According to Powell et al, towards the end of her life Schuell was considering changing her typology to a severity based model. She began to cluster her groups into three mild, one moderate and three severe categories. Powell et al present evidence to suggest that this would have been appropriate. They analysed MTDDA results from 86 aphasics, and obtained four groups which aligned along a dimension of severity. These bore a loose but systematic relation to Schuell's groups. They suggest that this typology is probably applicable to aphasic patients in general, though it gives too broad a description of level of functioning to relate to the fluent non-fluent dichotomy.

There is further experimental support for the view that aphasia is a unidimensional impairment. Smith et al (1972) present data on 126 stroke and 36 traumatic aphasics on the MTDDA. They found that all four language components, comprehension, speech, reading and writing were affected and that, as severity decreased in one component it correspondingly decreased in the other three components. Similar results were obtained by Duffy and Ulrich (1976) using ratings of functional communication. They found that each of the four modalities were simultaneously impaired to about the same level of severity. However, as Duffy and Ulrich themselves point out, their population was skewed towards the severe end of the continum of impairment. In order to get a more accurate description of the differences that can exist between the various language modalities, Goodglass and Kaplan (1972) advocate using more selectively impaired subjects.

The selection of assessment procedure also influences the results obtained. Studies using measures designed to assess degree of impairment usually report uniform impairment, whereas those recording characteristics of free speech, such as phrase length, produce profiles which correspond to the various aphasic syndromes.

A recent study by Crockett (1977) incorporated both a language measure of the degree of impairment, the Neurosensory Centre Comprehensive Aphasia Examination, and rating scales of natural language samples. They obtained four groups, one with a general language disorder, one corresponding to Howes' fluent aphasics, one to non-fluent aphasics and the fourth group was characterised by memory impairment. This, therefore, suggests that a minimum of four groups should be used to categorize aphasia.

2.3.7. Conclusions

Classification systems are widely used in clinical work with aphasic patients. This is because they condense information into a useable form and they facilitate communication about aphasic patients. However, this condensation of information adds little to the description of patients since the categories used are rarely mutually exclusive and there is little agreement about what criteria have to be met for a patient to be assigned to a particular category.

None of the present systems has adequate descriptive or prognostic data and so no advantage may be gained by using them. At present, the fluent non-fluent distinction seems the most promising. This has a sound experimental basis, shows consistency over time and ties up with neurological findings. However, it is little used clinically, possibly because the characteristics for determining to which category a patient belongs are difficult to judge for an untrained observer.

In many ways the classification systems used are quite closely related. They differ according to whether they are based on anatomical, physiological, psychological or linguistic analysis.

It is, however, necessary to be able to incorporate all the manifestations of a disorder into a single coherent system, in order adequately to classify the patients with the disorder.

Until a satisfactory classification system is available, it is probably most convenient to consider aphasia as a unidimensional language deficit. For the purposes of the present study, no attempt has been made to classify aphasics into different types. Aphasia is therefore being treated as a general language disturbance. Whether it should be regarded as such, or whether classification is necessary is not at present clear.

2.4 The Assessment of Aphasic Patients

The assessment of aphasia is a specific example of assessing brain damage and therefore will involve considerations relevant to both brain damage in general and aphasia in particular.

The basic function of tests is to measure differences between individuals or between the reaction of the same patient on different occasions. In clinical practice assessment of aphasic patients is usually in order to describe the nature and severity of the language impairment or less often to determine whether a patient is or is not aphasic. Diagnostic tests, which provide a comprehensive description of a patient's language capabilities, are designed for the former purpose. Screening tests, which are often shortened forms of diagnostic tests, are used for the latter purpose.

In order adequately to assess patients, various principles of testing have to be adhered to. Tests are objective, standardised samples of behaviour. This implies uniformity in administration, scoring and interpretation so that differences in results may not be attributed to differences in the way in which a test was given. For example, the 'imprecise' conditions for administering and scoring the Eisenson Examination for Aphasia (1954) make results from this test difficult to interpret. The extent to which this uniformity is achieved may influence the conclusions that may be drawn from the test results.

Tests are objective in so far as they are independent of the subjective judgement of individual examiners. So, for example, the conditions for acceptance of verbal and non-verbal responses when answering 'yes' or 'no' questions have to be delineated, as occurs in the Porch Index of Communicative Ability (PICA).

Standardization has to be carried out on an appropriate population, so that it represents a sample of the population from which the patient tested will be drawn. Screening tests therefore need to be standardized on a sample of aphasic and non-aphasic patients in equivalent proportions to the population from which the patients to be assessed will be drawn. Diagnostic tests will also need to be standardized on a population of aphasics with appropriate proportions of different types and severity levels.

Reliability, over time, between assessors and between different forms of the test, needs to be high, particularly if change in performance with recovery is to be assessed. Validity of aphasia tests is generally determined by comparison of the test with clinical judgement.

These aspects of testing are of relevance to the design of any test. Testing aphasic patients has the additional problem that many, in addition to their language problems, have physical disabilities. This is usually a hemiplegia and may affect a patient's ability to write because he will be likely to have to use his non-dominant hand. It may also affect speed of performing timed non-verbal tasks. Tests standardized on aphasics will include a proportion of patients with hemiplegia and so for group data this may not distort results. However, when considering an individual patient's score this may be of relevance.

Brain damaged patients may be very distractible, with short attention span, anxious and easily fatigued. Lezak (1976) suggests that the administration of tests needs flexibility so that a patient's optimal performance may be obtained, yet still retaining standardization sufficient for interpretation of results. The PICA has a very rigid administration procedure which does not allow the examiner the flexibility Lezak suggests, whereas the MTDDA is relatively flexible, but consequently may not have sufficient standardization for interpretation of results.

The interpretation of test results will be influenced by the availability of appropriate data on the test. However, in practice a lot of subjective information is gathered during testing, which is used in the diagnosis and treatment of patients and therefore may be of value to the clinician involved, though of no relevance to others.

Aphasia tests, in order to be used for research purposes, need to meet the criteria specified. In addition, screening tests need to be short and provide a decision making criterion for classifying patients as aphasic or not. Diagnostic tests need to cover a wide range of language abilities. Scores are usually presented on a profile and indicate which performances are normal and which are impaired. The descriptions produced from the profile are generally based on clinical judgement rather than strictly psychometric method. In addition to aphasia batteries, separate tests of different abilities, often included in the aphasia batteries, may be given. Specific tests of naming, auditory memory span, fluency, spelling and sentence learning may be used independently of a battery of language tasks.

When assessing an aphasic patient it may also be necessary to know about other intellectual abilities, which would not be included in the language assessment. Tests of non-verbal abilities, intelligence and memory might be included to determine whether other intellectual functions are well retained.

2.4.1 Aphasia Batteries

There are several aphasia batteries in current clinical use which were considered as possible assessment procedures for the evaluation of treatment.

2.4.1.1 Eisenson Examining for Aphasia (1954)

This test is based on the Weisenberg and McBride Classification System (Section 2.3.2). It is designed to provide the clinican with a guided approach for evaluating possible language disturbances and other disturbances closely related to language function. It is divided into receptive abilities (five subtests) and expressive abilities (eleven subtests). Each subtest contains a variable number of items which were taken directly or adapted from various educational achievement tests.

The test is unsuitable for research work as it is not standardised in administration or scoring. Therefore, comparison of one patient with another or the same patient at different times is not possible. Eisenson felt that it was unlikely that a standardised test for aphasia could be produced which would permit a clinician to measure percentage of loss as a whole or even to estimate accurately percentage of loss within a given area of language function. The lack of a satisfactory scoring system means that considerable information is lost or is not put in a quantifiable form. Eisenson considered that aphasics are characteristically too inconsistent in their responses to permit formal scoring standards to be developed and meaningfully applied. The scoring system used in the test is on a + or - basis, but additional symbols are used to record qualitative aspects of performance. Estimates of a patient's degree of difficulty are made in terms of whether the dysfunction appears to be complete, severe, moderate, little or none. No overall index of severity may be obtained. The clinician has to obtain an overall impression of a patient's abilities and disabilities by subjective judgement.

The advantage of the test is that it covers a wide range of difficulty. Easy items such as colour matching can be performed by most patients, difficult items, such as silent reading comprehension, may be failed by even mildly impaired patients. Wallace (1964) criticises the test for having too much material at the same level of difficulty. This is probably true for the easier items but seems to apply to a lesser extent at higher levels of difficulty.

There are no norms for either an aphasic population or a normal population. Therefore, no comparisons can be made between subtests

There is also no reliability or validity data due to the lack of standardization and scoring.

It is based on a classification system which lacks any real support for its use. Tests are designed to evaluate receptive and expressive abilities, but since most patients have difficulty on both types of task they would all be classified as receptive-expressive aphasics.

The test, despite the fact it has been widely used in clinical work with dysphasic patients, is therefore not suitable for research evaluating the effectiveness of therapy.

2.4.1.2 Wepman and Jones Language Modalities Test for Aphasia (LMTA) (1961)

This test consists of film strips as visual stimuli and the voice of the examiner as an auditory stimulus. Some items use a combination of visual and auditory stimuli. Items are classified according to input modality, auditory or visual; output modality, oral, graphic or gestural and by symbol systems within input modalities, pictures, geometric forms, numbers, letters and words. However, the test does not cover a wide range of linguistic abilities. For example, there is little testing of auditory comprehension as evidenced by the subject designating a variety of objects named by the examiner or by following vocally administered instructions. The range of difficulty of items is also insufficient to detect minimal language defects.

Scoring of oral and graphic responses is on a 6 point scale. This scale is based on types of errors, i.e. 1 correct response, 2 phonetic errors, 3 grammatical and syntactical errors, 4 semantic errors, 5 jargon errors and 6 no response. These categories have distinct characteristics which differ in kind from adjacent categories. This has the advantage over other category scales, such as that used for the Functional Communication Profile (FCP), in that it has better potential for scorer agreement. However, this 6 point scale is not used for all items. The Tell-a-Story items have a different scale and the matching items and the entire screening section are scored on a plus or minus basis. This means that the total on one section cannot be compared with the total on another section. It also limits the amount of information available from the matching and screening sections.

There is a separate 8 level self correction and recovery scale as Wepman (1958) considered self corrections to be important indicators of prognosis. This scale ranges from level 1, where a patient fails to recognize errors in any modality and cannot recognize errors when pointed out and so cannot correct them, to level 8, where a patient recognizes errors in both speech and writing and corrects them easily without assistance.

Wepman and Jones (1961) found that the test had adequate test-retest and inter-rater reliability. Spiegel (1965) has provided some evidence that the LMTA is a valid indicator of language abilities. However, no norms are available for either normal or dysphasic patients.

Therefore, although this test is an improvement on the Eisenson test in that it does attempt at scoring aphasic responses,it is still not adequate for makihg fine enough discriminations in performance reliably to detect changes in ability.

2.4.1.3 Schuell Minnesota Test for the Differential Diagnosis of Aphasia (MTDDA) (1965)

This test is probably the most widely used of all aphasia batteries. It consists of an evaluation of five major language processes, auditory (9 subtests), visual and reading (9 subtests), speech and language (15 subtests), visuomotor and writing (10 subtests) and numerical relations (4 subtests). Each subtest contains a number of items which vary in complexity. Most tests are scored on correct or incorrect basis but some are scored on a 6 point rating scale from no impairment to total impairment. The scores provide a classification of patients into sub-groups.

The test covers a wide range of language abilities and also includes a variety of non-language tasks. The latter are included so that complex processes underlying language events, which cannot be observed, can be inferred from relevant kinds of discriminating behaviour. Wallace (1964) criticises the MTDDA for having too many tests at one level of difficulty. Thompson (1978) reported a study which indicated that many of the MTDDA subtests could be excluded without loss of information on patients' abilities.

The scoring is on a correct or incorrect basis, although Schuell suggests the use of supplemental scales and notations to reduce the loss of information inherent in the correct or incorrect method. Although such scales do add to the qualitative value of the test, they are not reflected in test scores. A patient may get the same score on two occasions even though he has improved markedly in terms of slowness, slurring and hesitations. As a result, test scores may not be sensitive to change.

Some items require a 'yes' or 'no' response. This is difficult to score with aphasics who may say 'no' when they mean 'yes' and vice versa while nodding their heads in the appropriate manner, (Critchley 1970).

Some tests require lengthy instructions by the examiner and patients with poor auditory comprehension may fail for this reason. For example, this may apply to the writing a paragraph and reading comprehension subtests. The use of gestures to accompany verbal instructions also is not specified.

The MTDDA is long, taking about 3 hours to administer. Schuell (1957) describes a shorter version of the test which consists of those subtests with highest diagnostic and prognostic value. The short version takes about 30 minutes to administer, but in a re-evaluation of the scale Schuell (1966) concluded that it did not provide an adequate sample of language behaviour for reliable diagnosis over the whole range of aphasic disabilities. As an alternative she proposed the use of scaled tests which permits the examiner to select an appropriate range of tests for each patient. Testing time is shortened by obtaining a basal and ceiling score for each patient on each test section.

A diagnostic scale was developed to summarize the critical information from twelve functional categories and present an overall pattern of impairment. Ratings are 0, no information and from 1, no impairment, to 4, severe impairment. The scale is based on subjective interpretations of clinical observations. A severity scale which indicates severity of deficit in each language modality, is used to compliment the diagnostic scale. It has been used to evaluate changes in ability with recovery or regression. Correlations between severity ratings and number of errors were significantly high for all modalities, thus indicating it is a valid measure of ability. However, the inter-rater reliability and test-retest reliability of the scale are not presented, which limits interpretation of results.

The standardization of the MTDDA was carried out with various sizes of groups of both aphasic and non-aphasic subjects. However, Schuell rejects standard scores as meaningless when dealing with aphasic populations as they are so heterogeneous.

Although the Schuell test is widely used in clinical practice and is used in research to evaluate treatment (Enderby and David 1976), it is not sensitive enough to changes of a qualitative nature to be used for evaluation of short term treatment. It is also very long in its standard form and the reliability is questionable.

2.4.1.4 Goodglass and Kaplan, Boston Diagnostic Aphasia Test (BDAT) (1972)

This test was designed to be used to diagnose the presence and type of an aphasic syndrome, to measure the level of performance over a wide range of abilities, to provide both a baseline measure and assessment of change and to give a comprehensive evaluation of the assets and disabilities of a patient in all language areas as a guide to therapy.

It consists of 49 subtests, 38 of which are language tasks and 11 are supplementary non-language tasks. These cover a large variety of abilities: naming (4), fluency (4), oral reading (2), repetition (3), paraphasias (4), automatic speech (2), music (2), auditory comprehension (5), writing (7) and a severity rating. The supplementary tests cover defects associated with aphasia; constructional abilities (3), finger agnosia (5), acalculia (2) and right-left confusion (1). The test is therefore appropriate for a large proportion of aphasic patients.

Scoring of some subtests is by ratings. These are subjective and likely to be influenced by the examiners experience with aphasic patients. For example, the evaluation of the mechanics of writing, paraphasias, recitation, rhythms and narrative writing are all scored by ratings. Some items require yes or no answers which may be difficult if the patient says one thing indicating the reverse by his head nodding (Critchley 1970). For example, this applies for questions on complex ideational material such as 'will a board sink in water?' and 'is one pound of flour heavier than two?'. Some items are scored on a coarse scale and so may not be sensitive enough to detect changes in ability, for example, written confrontation naming, oral sentence reading and singing. Also aspects of performance, such as delayed responding or self correction, which occur on many subtests are not recorded.

The test is relatively long. Goodglass and Kaplan do not indicate how long it takes but Brookshire (1973) considers it takes between one and four hours.

It was standardized on a sample of 207 patients who were admitted to hospital and stayed for rehabilitation. Although this may not truly represent the entire aphasic population, it is probably representative of the aphasic population for which the test is likely to be used. The range, mean and standard deviation of these patients provide an external reference point of degree of severity in each area tested. This frees the examiner from impressionistic judgement about the patient's relative impairment in one area as compared to another.

Scores on some subtests, such as fluency and paraphasia, do not cover the full range of severity but the range is sufficient adequately to assess the majority of patients. Within each group of abilities there is adequate discrimination at both extremes of severity. This means that subtests are likely adequately to discriminate change in ability. However, evidence of this is not available for all subtests.

Inter-rater reliability of the rating scales was determined by three judges independently rating the same tape recorded conversation for 99 patients. Correlations of the two most disparate items indicated adequate inter-rater reliability for these scales. Test -retest reliability data had not been collected when the test was published.

The test has not yet been widely used in this country but is rapidly gaining popularity. Results obtained with the test would be of less practical value to therapists than results obtained from a test with which they were familiar. The relative recency of development of the test made it unsuitable for present research purposes rather than any serious inadequacies.

2.4.1.5 Porch Index of Communicative Ability (PICA) (1967)

This consists of a battery of 18 subtests sampling gestural, verbal and graphic abilities at various levels of difficulty. Each subtest uses the same ten common objects which are placed before the patient. This permits comparison between subtest responses and reduces the variation due to introducing new stimulus items on each task. The 18 tasks were chosen to sample various input and output modalities. Since the battery is intended to sample basic communication ability, the complexity of the tasks is not demanding in terms of intelligence, education or experience. The tests are ordered from the most difficult to the least difficult so that the patient receives the least possible information about answers on succeeding subtests, since the same objects are used throughout the battery. The progression is maintained through the verbal and gestural subtests and then through the graphic tests separately. Ordering the tasks in this manner reduces the effect of immediate recall and encourages the patient, since though he may fail on one type of task he soon has the opportunity to succeed on another type, as the modalities being sampled are changed frequently. In addition, using tests in decreasing order of difficulty progressively increases the chances of the patient being motivated by a successful performance as he does successive tests. The 18 subtests, in order of administration are:

I Verbal - describing the function of objects

II Gestural - demonstrating the function of objects

III Gestural - demonstrating the function of objects handed to patient

IV Verbal - naming objects

V Gestural - reading cards describing the function of objects

VI Gestural - pointing to objects designated by function

VII Gestural - reading cards of object names

VIII Gestural - matching pictures with objects

IX Verbal - completing sentences with object names

X Gestural - pointing to objects designated by name

XI Verbal - imitating object names

A Graphic - writing sentences describing the function of objects

B Graphic - writing object names

C Graphic - writing object names to dictation

D Graphic - writing object names given the spelling

E Graphic - copying object names

F Graphic - copying geometric forms.

The tests are administered under standard conditions, and with standard procedure, which is specified in detail. Scoring is on a 16 point multidimensional scale. This scoring system is based on five dimensions of describing a response: accuracy, the correctness of the response; responsiveness, according to the amount of stimulation or information the communicative system requires before it can respond accurately; completeness, the omission of certain aspects of performance which though relevant and recognizeable is not entirely adequate; promptness, delay in responding and efficiency, the facility with which the response is produced. Ideally each response should be judged in terms of all these dimensions but this becomes too cumbersome since it provides redundant and irrelevant information. Porch therefore devised a 16 point scoring system which involves the five dimensions at a workable level. The 16 categories are:

16 Complex - accurate, responsive, complex, prompt, efficient

15 Complete - accurate, responsive, complete, prompt, efficient

14 Distorted - accurate, responsive, complex or complete, prompt, distorted

13 Complete Delayed - accurate, responsible, complex or complete, delayed

12 Incomplete - accurate, responsive, incomplete, prompt

11 Incomplete Delayed - accurate, responsive, incomplete, delayed

10 Corrected - accurate, self corrected

9 Repeated - accurate after instructions are repeated

8 Cued - accurate after cue is given

7 Related - inaccurate, almost accurate

6 Error - inaccurate attempt at task item

5 Intelligible - comprehensible but not an attempt at task item
4 Unintelligible - incomprehensible but differentiated
3 Minimal - incomprehensible and undifferentiated
2 Attention - no response but patient attends to tester
1 No response - no response, no awareness of task.

The 16 point scale has the advantage that it has enough steps to describe relatively small changes in responses, yet is not too numerous to overtax the raters. The ordering of the 16 categories was based on a binary choice system, revolving round the five selected dimensions, and on the observed patterns of severity of communicative involvement from clinical experience. The appropriateness of this order was tested using 12 judges who obtained a high co-efficient of concordance, when ranking definitions of the 16 categories. However, McNeill, Prescott and Chang (1975) obtained rankings of videotaped responses which would receive scores between 1 and 15 on the scale. By this method they found that the rank of observed behaviour did not accord with the ranks given in the PICA classification system. Martin (1977), in discussing this data, concludes that if the behaviours subsumed under the PICA categories are not ordinal, the entire rationale for the statistical treatment of scores collapses.

Another problem which relates to the statistical analysis of scores has been put forward by Silverman (1974). He states that the mean of a patient's scores on a particular subtest is not the most frequent response to items on that subtest and may even designate a response which did not occur. For example, a patient giving distorted, score 14, and related, score 7, answers on test IV, naming objects, may obtain a mean score of 10.5 yet none of his answers were self corrections which score 10. For this reason Silverman suggests the use of the mode as a summary of subtest performance. This requires less computation and is more defensible as a measure of central tendency, since the PICA scoring system had only been demonstrated to have ordinal properties. In reply to this Porch (1974) defends use of the mean because he wanted a stable and consistent measure which is useable statistically. He argues that the mode can change dramatically depending on the type of measure and the status of the patient at the time of testing. The interpretation of test profiles would become impossible on subtests which produced bimodal or multimodal responses. Porch considers that it is more productive to treat the PICA scoring as an interval scale and therefore use more powerful statistics but with conservative interpretation of results. The problem then arises as to how conservative it is necessary to be.

Martin (1977) criticises Porch's multidimensional scoring system to the extent that he considers it invalid. Porch's claim that the nature of responses are specified using the 16 point scale is questioned. Martin presents an example of a patient producing six categories of responses when asked to name a pen. While this is a feasible situation, in practice it is a very rare occurence and patients' responses usually only fall into one and at most two categories. Porch accepts the last response as the recorded response. However, as Martin indicates, the category 5, an intelligible response, probably is a poor category in the sense that it is over-inclusive and does not accurately describe the nature of a response.

Further criticisms, levelled by Martin, in relation to the construction of the test are that the instructions are difficult for aphasics to understand, and that the lack of feedback to the patient when answers are not correct is upsetting for the patient. Also the terminology is considered misleading. For example, the term 'gesture' encompasses so many types of behaviour, including pantomime, reading and pointing to objects. Categories of responses are considered ambiguous since various types of behaviour are subsumed under the same category. For example, incomplete responses, 12, include: improper pluralisations, such as pens for naming a pen; placing a card by the right object but in the wrong position and handing correct objects to the tester when asked to point.

Therefore the PICA scoring system, though initially considered a breakthrough in terms of specifying the nature of responses and providing quantifiable data, has met with heavy criticism. However, in practice the system is easily used to describe performance, not necessarily in the context of the test itself. Some speech therapists (personal communication) use the PICA score categories to describe patient responses on the MTDDA as a convenient shorthand which provides more information than a simple correct or incorrect record. However, it does seem that further investigation of the PICA scoring system is needed in order for results from the test to be satisfactorily interpreted.

Despite the questionable validity of the scoring there is normative data available. Data on 380 patients, 280 with left hemisphere and 100 with bilateral damage, provides percentiles for the subscales, which may then be compared with each other. The range of task difficulty was found to be wide enough so that even patients with mild involvement experienced some difficulty on some subtests and those with severe involvement had at least some success on easier items. However, there is a loss of discrimination at the higher levels of ability. For this reason a new extension of the PICA has been produced for dysphasics with only mild impairment. This module A advanced version consists of nine additional tests involving verbal, gestural and graphic tasks.

Scorer agreement was investigated with three scorers, trained in scoring for 40 hours each. They each scored thirty patients and differences between scores for subtests were found to be small and agreement was highly significant (Porch 1967). Reliability coefficients were 0.93 or better for subtests and 0.97 or better for response levels, which seem to be satisfactorily high.

Test -retest reliability was determined by forty patients being assessed on two occasions. There were patients with recent as well as long standing involvement, since the former group are likely to show inconsistencies due to spontaneous recovery and treatment effects. The patients were selected from the original sample of 380 and were retested two weeks later. The battery reliability was found to be high. There was a slight tendency for patients who were longer post-onset to have smaller test -retest differences but this was only significant for test F at the 5% level of significance.

The PICA is quite lengthy to administer, taking between an hour and an hour and a half, but is shorter than several of the alternative tests available. Di Simioni et al (1975) suggested that the PICA could be shortened by exclusion of some subtests or some items. Stepwise regression procedures performed on 222 PICA profiles indicated that 4 subtests, I, VII, D and VI could predict PICA Overall Score with a correlation of 0.98. Alternatively, using five test objects would give equivalent results to using all ten objects. Phillips and Halpin (1978) also found that the PICA could be shortened by using half the items, with only slightly lower reliability and practically identical means and standard deviations for subtest, modality and overall scores, as compared with the full version.

The relation between PICA and Functional Communication profile (FCP) scores was investigated by Helmick, Watamori and Palmer (1976). The FCP was given by both a speech therapist and the patient's spouse. The latter was negatively correlated with the PICA scores ($p < 0.05$) and that of the therapist was positively correlated with the PICA scores ($p < 0.01$). Comparison of FCP by spouse and therapist indicated significant differences, which was interpreted as indicating that the spouses were not understanding the patient's problems. However, Martin argues the possibility that the patients were more effective at communicating with their spouse than with their therapist. These results suggest that, as Martin claims, the PICA does not measure communication ability, but it is a measure of language ability.

The PICA despite the problems and limitations of its scoring system has advantages over alternative tests as an assessment of aphasia for research purposes. The standardization and reliability are good and it is sensitive to small changes in ability over time. Analysis of results may need to take into account the doubts about whether the 16 category scale should be treated as an interval, ordinal or nominal scale.

2.4.1.5 Taylor. Functional Communication Profile (FCP) (1953)

The FCP was based on Taylor's work in 1953 and was subsequently developed in 1969 (Sarno 1969). The scale attempts to measure functional dimensions of language performance that are not accounted for in clinical testing. Functional performance is distinguished from clinical performance by the conditions under which the language sample is obtained, test or task oriented, and by the conditions which simulate the natural use of language. Clinical tests of aphasia show nothing of what a patient does in his everyday and non-verbal attempts to circumvent his language impairment. Many tests do not take account of gestural signals as a means of communicating, accurate but inconsistent responding, time to respond orally and the specificity of a task.

The FCP consists of 46 integrated communication behaviours considered common language functions of everyday life, such as saying greetings, handling money and signing one's name. Ratings of each behaviour are made on an eight point scale on the basis of informal inter action with a patient in a conversational situation. The rating of 'normal' represents the patient's estimated premorbid level of language proficiency estimated according to known social, educational and personality factors in his history. The other ratings can only be defined in relation to this level, which will depend largely on the clinician's reference framework. Variations between testers is likely to be high and so renders the interpretation of scores difficult. Sarno (1969) reports that the inter-rater reliability of the overall score for the scale is high, i.e. 0.95 with a range of 0.87 to 0.95 for different sections. However, this may depend very largely on the experience of the raters in using the scale.

The test -retest reliability of the scale is also reported to be high, with a correlation of 0.97 quoted for a one week interval. However, again it may be influenced by the experience of the raters.

Each rating is assigned a weighted score which is converted into percentages in each of the five modalities, movement, speaking , understanding, reading and writing and calculation. The sum of these gives an overall score which can be used as a single measure of an individual's communication effectiveness in everyday life. Correlation of FCP scores with MTDDA is 0.94 indicating that the FCP is a valid assessment of language ability. These results are consistent with those comparing FCP and PICA scores (Helmick et al 1976) and therefore may only apply when the FCP is given by a speech therapist.

The problems with the FCP for research purposes are the lengthy understandardized administration and the poorly defined grading of scores. These mean that the experience of the raters is likely to have a highly significant effect on the results obtained.

2.4.2 Tests of Specific Language Abilities

2.4.2.1 Receptive Ability

Two tests are available as separate measures of language comprehension.

2.4.2.1.1 Sequencing Test (Albert 1972a)

This test was designed to evaluate the capacity to maintain and utilize the sequential aspects of an acoustic input. It consists of twenty objects placed in front of the patient. The patient is asked to identify the objects in the order specified in the command. For example, 'Point to the key and the hammer in that order'. Starting with two objects, the number of objects in each command is increased until the patient fails three times at a given number of objects. The score is the highest number of objects pointed to in correct sequence.

Left hemisphere damaged patients perform significantly worse than right hemisphere damaged who perform significantly worse than non-brain damaged controls. Aphasic left hemisphere damaged patients perform significantly worse than non-aphasic left hemisphere damaged patients (Albert 1972b). The test has been shown to have greater sensitivity to defects of comprehension of spoken language than the Token Test (Albert 1972b). However, additional analyses have indicated that impaired performance on this test may be due to a more general disturbance of linguistic function.

2.4.2.1.2 The Token Test (TT)(De Renzi and Vignolo 1962)

This test of receptive abilities is designed to reveal slight disturbances in speech without challenging other intellectual functions. In its original form it consists of 20 tokens of two shapes, rectangles and circles, two sizes, large and small, and five colours, red, white, blue, yellow and green. The patient is given a series of oral commands which are expressed in progressively more complex forms, for example, 'Pick up the yellow rectangle and a large green circle'. The patient has to perform a simple manual task in response to the commands, such as, show, pick up and touch. In the original form 62 commands were used.

Validation studies have shown that the TT scores of aphasics are significantly different from non-aphasic brain damaged and non-brain damged patients (Boller and Vignolo 1966, Orgass and Poeck 1966, Coupar 1976). On the basis of Orgass and Poeck study a cut-off point of 11 was suggested for discriminating aphasic from non-aphasic patients. Using this cut off Van Dongen and van Harskamp (1972) reported that the TT gave 80% correct classification, 4% of aphasics and 15% of non-aphasics being misclassified. Hartje, Kerschensteiner, Poeck and Orgass (1973) suggested raising the cut off from 11 to 23 which reduced the misclassification of non-aphasics in his study from 22% to 5% but the correct identification of aphasics was then reduced from 93% to 91%. However, with either cut off the TT has high discriminating power. Shortened and modified versions of the TT have been developed and their ability to discriminate between aphasics and non-aphasics has been investigated. Spellacy and Spreen (1972) used squares rather than rectangles, added seven easy items specifying only shape and colour and shortened the test to 39 items. From this they developed a 16 item version which had adequate discriminating power and reliability compared with the 39 item version. Van Harskamp and Van Dongen (1977) constructed a 16 item and a 10 item version and considered using only part V of the TT. These initially seemed to be adequate for classifying patients and the 16 and 10 item versions had adequate reliability. However, repetition of the study with a further group of aphasic and non-aphasic patients indicated that the shortening reduced the discriminating power and they concluded it was necessary to administer the full TT for detection of patients with slight receptive disorder. De Renzi and Faglioni(1978) obtained favourable results with a 36 item version, which also used squares rather than rectangles, and black rather than blue tokens.

Further modifications of the original test have been to give a repetition of instructions in order to reduce the effects of poor motivation and inattention (Boller and Vignolo 1966), to use only parts of the full TT (Swisher and Sarno 1969, Coupar 1976) and to use black and white concrete objects (Martino, Pizzamiglio and Razzano 1976).

Despite the variations in test format the results seem to consistently show that the TT has high discriminating power between aphasics and non-aphasics. This makes it particularly useful as a screening test for aphasia.

The test results are independent of the type of aphasia. No differences have been found between sensory and motor aphasics (De Renzi and Vignolo 1962) or fluent and non-fluent aphasics, (Poeck 1972), De Renzi and Faglioni 1978).

The relation between TT scores and other tests of language ability has been investigated by Coupar (1976). He correlated TT scores with Wepman's auditory discrimination test, Eisenson's oral sentences, MTDDA following directions, English Picture Vocabulary Test and three Italian tests of aphasia measuring phonetic, semantic and syntactic aspects of comprehension. The correlations obtained were high, indicating that most tests were significantly related. Coupar suggests that the TT might be useful for monitoring the effects of speech therapy or natural recovery of language function as well as the detection of aphasia.

For a test to be used as an indicator of change it needs to have high test -retest reliability. This was investigated by Spellacy and Spreen (1969) and found to be high for both a pass or fail scoring system and using weighted scores according to the complexity of the command.

Age has been found in some studies to have no effect on scores (Swisher and Sarno 1969) and in others to have a moderate influence (Hartje et al 1973). Intelligence has been consistently shown to affect scores. Van Dongen and Van Harskamp (1972) and Coupar (1976) using Raven's Progressive Matrices and Hartje et al (1973) using Performance IQ have all found some effect of intelligence on TT scores. It may therefore be necessary to correct for this factor in the interpretation of test scores.

The Token Test is therefore a reliable, highly discriminating test of aphasia, which can give a measure of severity of receptive language disturbance and covers a wide range of performance from mild to severe impairment. It has the advantage over alternative tests of auditory comprehension, that it is applicable to the identification of aphasics, as it has relatively few items which non-aphasic brain damaged and intelligent normals fail. It can also be used to assess level of impairment and changes in this over time.

2.4.2.2 Naming

Naming tests are included in most aphasia batteries. There is, however, a test available which has been found to be clinically useful, which was designed specifically to test object naming. This is the Oldfield-Wingfield Object Naming Test (1965).

It consists of a set of 36 outline pictures of objects (26 used for the test and 10 for practice). The objects were chosen as being unambiguously presentable and identifiable by simple outline drawings, having only one name when represented and having name frequencies spread throughout the Thorndike-Lorge range. The pictures are presented in one of three previously arranged random orders. These orders were randomised within the constraints that the 10 practice cards came first and the final three cards were relatively easy to name. The latency of naming is timed and items are correct if the name is given in a clearly recognizeable form.

The test covers a wide range of naming ability and so will detect milder disturbances than some of the naming tests in aphasia batteries, such as the PICA. This means that if patients improve markedly, differences in naming ability may be detected, which would not be detected with the PICA due to a ceiling effect.

Practice effects appear to be slight. Oldfield and Wingfield using the test with normal individuals found that practice produced a decrease of 27% in latency between first and second trials and 16% between second and third trials. Newcombe, Oldfield and Wingfield (1965) used the test with men with penetrating gunshot wounds and hospital controls. They found that lower intelligence and greater age produced an increase in latency of naming, as compared with university students. Any brain lesion produced a further increase and lesions which produced dysphasia showed the greatest increase in latency.

Oxbury, Campbell and Oxbury (1974) found that left hemisphere damaged stroke patients were significantly impaired relative to right hemisphere and brain stem stroke patients. Data from retesting the right hemisphere damaged patients, who were not impaired on the test, suggests that it has high test -retest reliability, as scores were not significantly different between assessment at three weeks and six months post stroke. (Campbell and Oxbury 1976).

2.4.2.3. Fluency

Tests of fluency are included in some of the standard aphasia batteries, such as the Multilingual Aphasia Examination (Benton 1969). They require the patient to give as many items as possible that are in a given category, such as, animals, objects in the street or words beginning with a specific letter. Various response times are allowed but usually a minute. Birbaumer, Gloning and Hift (1972) used a ten minute response time but found that most responses are given within the first 200 seconds so a one or two minute interval would seem likely to be sufficient.

The localization of damage producing impaired word fluency has been questioned. Borkowski, Benton and Spreen (1967) first established that brain damaged patients perform significantly worse than controls. This was most marked for patients of high intelligence, over 100 IQ, on difficult letters, such as J and U, and for patients of low intelligence under 90 IQ, on easy letters, such as F, S, P and T. Although disorders in both hemispheres produced a verbal fluency deficit, left hemisphere damaged patients had more difficulty on difficult letters than right hemisphere damaged.

Further support for differences between right and left hemisphere damage comes from Perret (1974). Patients with circumscribed left hemisphere lesions produced significantly fewer words beginning with a particular letter than patients with circumscribed right hemisphere lesions and non-brain damaged controls. Differences also occurred according to localization of the lesion within the hemisphere, patients with frontal lesions producing significantly fewer words than those with temporal or posterior lesions. Left frontal lesions therefore performed worse, which is consistent with previious findings by Milner (1964) and Benton (1968). These results are in conflict with Newcombe (1969) who found no word fluency deficit specific to left frontal lesions.However, her patients had relatively small lesions and the task was to produce items in particular categories, such as animals. This may involve well established associative habits of word finding and so avoid conflict between habitual and unusual categorization of words.

Benton (1967) considered types of aphasia and presents illustrative profiles of the different types, some of which show relative impairment on the word fluency test. For example, expressive, jargon and global aphasics have poor word fluency. Birbaumer et al compared fluent and non-fluent aphasics and found that the lattergroup produced fewer words. The curves of number of associations within a ten minute period are parallel, suggesting that the differences between the groups are quantitative rather than qualitative. These findings are consistent with two characteristics of non-fluent aphasics, slow rate of speech (Howes 1964)and long pauses (Benson 1967).

Borkowski et al found that practice and fatigue effects were low, which suggests high reliability. They also found that overall level of intellectual functioning influenced scores. For this reason, Cauthen (1978) collected normative data on the test for different IQ groups. Differences occurred between different IQ groups only for patients over 60 years of age. Age was found by Schaie and Strother (1968) to produce a decline in verbal fluency. Cauthen found this was only important if patients were over 60 years.

2.4.3 Related Aspects of Intellectual Functioning

2.4.3.1 Handedness

There have been suggestions that handedness relates to recovery from aphasia (Zangwill 1960, 1964, Luria 1970) (section 3.2.6) and therefore an assessment of handedness is relevant to the study of aphasia.

Assessment of handedness, in quantitative terms, has been by two main approaches. One consists of having subjects perform various standard unimanual tasks, such as the Purdue pegboard, with both right and left hand. Performance can be scored according to time or errors or both and an index of handedness calculated. Oldfield (1971) reports that the differences between hands, obtained by such methods, are relatively small and they do not correspond to the gross disparity between the two hands which is manifest on well established tasks. Additional disadvantages are that performance measures are time consuming and may not be independent of sex, age and culture. However, the main advantage is that these measures are free from the unreliability of subjective report.

Benton, Meyers and Polder (1962) noted that results from manual dexterity tests are discrepant with subjects self reports. Many self classified left handers showed a striking superiority of the right hand on a manual co-ordination test. Similar results were obtained by Satz, Achenbach and Fennel (1967) who found that self classified left handers showed variable lateral preferences on manual and auditory tasks. By contrast verbal reports of right handers correlated highly with performance on manual tasks.

The test -retest reliability of motor performance tasks was shown by Provins and Cunliffe (1972) to be satisfactory for tasks performed with the preferred hand but less so for tasks performed with the non-preferred hand. When the difference in performance of the two hands (Preferred - Non-Preferred) was considered only two of seven tasks yielded significant correlations between performance on the first and second occasions. It was only on speed of writing and tapping tasks that subjects who obtained a large difference in performance between the two hands also obtained a large difference in performance on the second occasion. Therefore, they suggest that satisfactory performance measures of handedness are only those which reliably yield performance differences between the two hands.

The second approach consists of asking a series of questions about a subject's use of his right or left hand for various habitual everyday tasks. Conformity to the practice of the majority of the population is regarded as the norm and an index of handedness is calculated. Inventories of this type have the advantage that they are short to administer and provide a larger distinction between right and left handed individuals. However, Satz et al also showed that the questionnaire items do not correspond with self reports of handedness. Only 50% of self classified left handers endorsed the left hand as the primary hand on at least seven of ten questionnaire items. This lack of concordance indicates that reliance on verbal reports may be misleading.

Pickersgill and Pank (1970) combined these approaches by using the performance of questionnaire items to assess handedness. This is likely to produce a greater discrepancy between right and left than performance of simple but little practiced unimanual tasks.

In a dysphasic stroke population both methods have additional disadvantages. Behavioural measures are likely to be limited by presence of a hemiplegia in a large proportion of patients. Even when a hemiplegia is not present, weakness on one side may occur which in itself might be sufficient to account for differences in the performance of the two hands. The use of inventories is dependent on verbal comprehension, verbal report and in some cases reading ability, any of which may be impaired in a dysphasic patient, rendering them unable to complete the inventory. It seems likely that severely dysphasic patients would be unable to attempt the task, but if gestural responses are allowed then probably most moderate and mild aphasics could complete the task.

Alternative procedures,such as dichotic listening and Wada Sodium amytal test, may be used to indicate speech laterality within the brain but this is not generally considered to be very directly related to handedness (Zuffery 1978).

Two questionnaire tests of handedness in general clinical use were available for consideration.

2.4.3.1.1 The Handedness Inventory of the Multilingual Aphasia Examination. (Benton 1969)

This consists of ten questions about hand preference in various activities, which are presented orally to the patient or when this is not possible to a reliable informant. Certain items are culture related, such as using a baseball bat, and others relate more to a particular sex, such as using a sewing needle and a screwdriver. The remaining items are similar to those in the Edinburgh Handedness Inventory (EHI), for example, writing, using scissors and throwing.

2.4.3.1.2 Edinburgh Handedness Inventory (Oldfield 1971)

This consits of ten items which were selected to be, as far as possible, independent of national, cultural and socio-economic background and of sex differences. Decile values are available for right and left handed sections of the population, but these are provisional as a larger population, particularly of left handers, is needed.

Raczkowski, Kalat and Nebes (1974) conducted a reliability and validity study on some handedness questionnaire items. College students filled out a handedness questionnaire, then one month later were required to perform each task and then repeat the questionnaire. Twenty three items were scaled for reliability, validity and frequency of right handed preference by predominantly left handed people. On these bases certain items were recommended for inclusion in future handedness questionnaires. Of those suggested, six are included in the EHI, i.e. writing, drawing, throwing, scissors, toothbrush and foot used for kicking.

Bryden (1977) further investigated the use of handedness questionnaires. He gave 620 men and 487 women the Crovitz Zener test and the EHI. In addition, subjects were asked whether they considered themselves right or left handed and about the handedness of their immediate family. The five items in common to the Crovitz Zener test and the EHI provided a measure of reliability. Factor analysis yielded three distinct factors, one which related to handedness and the other two appeared to be idiosyncratic to the wording of the questions. Bryden therefore recommended that the five items loading most heavily on the first factor, which were also in common to both questionnaires and had been found by Raczkowski et al to have high reliability, to be used as shortened versions of both tests. A score based on these five items, writing, throwing, drawing, scissors and toothbrush, correlates highly with professed handedness and with familial history of handedness.

It therefore, seems that the EHI provides a reliable, valid measure of handedness, though shortening to five items is possible if considered desirable.

2.4.3.2. Intelligence

A measure of intelligence is often included in the assessment of aphasia as it is sometimes considered that impairment of non-verbal intellectual abilities occurs concommitant with aphasia. This has implications both for natural recovery and for treatment.

There has been considerable controversy about whether aphasia is always accompanied by intellectual deficits. The early clinical work suggested that aphasics always show intellectual deficits (Marie 1906, Head 1926) but it was suggested that intelligence only suffers in so far as language processes necessary to carry out intelligent behaviour are affected (Weisenberg and McBride 1935).

The investigations on the question have involved two main aspects. One is the extent to which non-verbal abilities of aphasics are affected and the other is the new learning ability of aphasics.

The studies on non-verbal intelligence in aphasia have been partly influenced by the concept of intelligence employed. If intelligence is envisaged as a general superordinate ability which enters into every intellectual performance, then investigations have compared brain damaged with non-brain damaged patients. Any lesion is expected to produce an intellectual deficit, the severity depending on the size not the locus of the lesion. Some studies comparing aphasics with non-brain damaged controls have found normal performance by aphasics (Zangwill 1964), Edwards, Ellams and Thompson 1976), others have found the aphasics in common with right hemisphere damaged patients were impaired (Costa and Vaughn 1962).

The alternative approach to intelligence is that it consists of distinct primary mental abilities, which have different cortical localizations. Injury to different areas will result in the derangement of different intellectual performances. According to Basso, De Renzi, Faglioni, Scotti and Spinnler (1973) any attempt to compare groups with differently localized lesions would be meaningless. However, certain abilities are to some extent localized and may affect ability to perform intelligence tests and, therefore, defective performance may simply indicate the presence of apraxia, none of which can be taken as direct evidence of intellectual deterioration.

Comparisons of right and left hemisphere damaged patients have supported this view. Basso et al (1973) found that on the coloured Progressive Matrices (RCPM) right hemisphere brain damaged patients with field defects failed because of inattention or impairment of visual perception. The presence of a field defect alone did not affect performance, since left hemisphere damaged with and without field defects were no different from each other. It therefore only seems to be when field defects are associated with right hemisphere damage that they affect RCPM performance. Similarly left hemisphere damaged patients perform no differently from right hemisphere damaged, but those with aphasia perform worse than those without. Basso et al considered this was not due to the aphasia as virtually no correlation was found between RCPM score and either the Token Test or naming ability. Support for right hemisphere damaged patients performing poorly on RCPM comes from Costa (1976) and Ganiotti, Caltagirone and Miceli (1977) but these two studies did not find the left hemisphere groups to be impaired. The interpretation of results when comparing right and left hemisphere groups is difficult due to the deficits associated with right hemisphere damage, as well as the presence or absence of aphasia. Some studies have, therefore, compared aphasic and non-aphasic left hemisphere damaged patients on intelligence tests.

There are discrepancies of findings when aphasic and non-aphasic left hemisphere damaged patients are compared. Some studies have shown no differences between the groups on non-verbal tasks (Archibald, Wepman and Jones 1967, Ettlinger and Moffett 1970, Kertesz and McCabe 1975). Others indicate that aphasics are impaired on intellectual tasks when compared with non-aphasics, (Orgass and Poeck 1969).

An alternative to comparing aphasics with various control groups is to consider changes with time. Culton (1969) included the RCPM in his study of spontaneous recovery and found that recent aphasics showed significant improvement but stable aphasics did not. This suggests intellectual problems occur concomittant with aphasia and decrease as the aphasia improves. There are two possible explanations for this. One is that comprehension defects produce the failure to complete certain non-verbal tasks and as they improve so will the apparent non-verbal deficits. The other explanation is that some aphasics have involvement of the non-dominant hemisphere, which produces an impairment on non-verbal tasks. This may improve over time in the same way that aphasia improves.

Generally the studies on non-verbal abilities indicate that aphasics may show impaired performance. The results will depend to a certain extent on the comparison group used. The difficulties with matching patients for severity of lesion make even comparisons of aphasic and non-aphasic left hemisphere damaged patients difficult to interpret. However, generally it seems that brain damaged patients have some lowering of intellectual abilities, with differences between right and left hemisphere depending on the nature of the task. Aphasics are more likely to have intellectual impairment because they are more likely to have more extensive brain damage. Similarly, the more severe the aphasia, the greater the likelihood of impairment on non-verbal intellectual tasks.

The alternative to considering the non-verbal abilities of aphasics is to consider their learning ability. There is generally more consensus in the results of this type of study than those on cognitive non-verbal tasks.

The rate of learning of aphasics has been found to be slower than non-aphasics, but given appropriate conditions they can learn, (Tikofsky and Reynolds 1962, 1963, Carson, Carson and Tikofsky 1968, Tikofsky 1971 and Emlinger and Moffett 1970). The learning of non-verbal tasks has been used by Brookshire (1968, 1969, 1971) to throw further light on the learning of aphasics. These studies demonstrated that aphasics are sensitive to the reinforcement contingencies and so clinicians must be careful when dispensing reinforcers that adventitous reinforcement of responses, other than those desired by the clinician, does not occur, as it might interfere with the acquisition of those responses that the clinician wishes the patient to acquire.

He also demonstrated that aphasics alter their behaviour in accordance with reinforcement schedules indicating that behaviour shaping procedures can be effective. However, severe aphasics tend to be particularly sensitive to delay between their responses and the consequences for those responses.

Therefore, given that verbal learning is impaired as part of aphasia and that non-verbal learning while initially affected can be improved to initial levels of performance, it should be possible to use this non-verbal learning ability as part of a treatment regime. Glass, Gazzaniga and Premack (1973) trained seven aphasics to use an artificial language system, which consisted of cut out paper symbols for words. Various levels of competence were attained by the patients ranging from expression of relations between objects (same-different) to simple statements of action. This suggests that patients can use non-verbal learning abilities to serve certain language functions.

The assessment of intellectual abilities in aphasics generally involves the administration of non-verbal cognitive tasks rather than learning ability. The two most commonly used are the performance scale of the Wechster Adult Intelligence Scale (WAIS) (Wechsler 1955) and Ravens Progressive Matrices (Raven 1958).

2.4.3.2.1 WAIS Performance Scale (Wechsler 1955)

Although primarily a non-verbal scale the use of this assessment is limited when patients are aphasic or have a physical disability. Certain items of the test, such as picture completion, require a verbal response and although pointing to the correct part is permissible, it is often difficult for the examiner to determine exactly what the patient is pointing to if they can give no verbal indication. The digit symbol subtest requires writing which may be impaired due to aphasia or due to the patient being forced to write with his non-dominant hand as he has a hemiplegia of his dominant side. Manual dexterity is required on the block design and object assembly subtests and so performance on these may be affected by a hemiplegia or hemiparesis.

2.4.3.2.2. Progressive Matrices (Raven 1958)

This test has the advantage that it can be administered entirely non-verbally and only requires the patient to be able to point to his answer. The standard version consists of 60 patterns, each with a segment missing. The patient has to select the portion, out of six or eight alternatives, that will complete the pattern. The test is designed to measure a person's capacity for intellectual activity.

It is easy and quick to administer, though with aphasic patients individual administration is often necessary so the examiner can record the answers for the patient. Normative data is available for ages 8 to 65 years and, though the original norms (Raven 1958) provide only grades of intellectual capacity, percentiles are available (Peck 1970).

The reliability varies with age but generally is about 0.80 (Burke 1958). Scores correlate highly with full scale intelligence as measured on the WAIS (Shaw 1967). Some studies have suggested that it fails to test general intellectual ability but does assess reasoning in the visuospatial modality (Archibald et al 1967, Colonna and Faglioni 1966).

Despite its limitations, it is one of the most widely used assessment procedures for evaluating intellectual impairment in aphasics.

CHAPTER 3

THE PATTERN OF RECOVERY

3.1 Spontaneous Recovery

3.1.1 Theoretical basis of Spontaneous Recovery

Clinical observations have indicated that patients who experience mild to severe brain damage and who show at the onset serious behavioural deficits usually recover some, if not all, of the lost function. There have been several attempts to understand this recovery process. This has been both at an experimental level, in which structural or functional alteration of the central nervous system (C.N.S.) is deliberately induced and its behavioural outcome noted, and at a clinical level, in which behavioural consequences of the lesions produced by disease are observed.

The experimental approach has the advantages that the experimenter can exercise some control over the size and locus of the lesion he produces according to the surgical technology and understanding of structural characteristics of the brain available at the time. He can also control the genetic characteristics, life history and age of his experimental animals. On the other hand, the clinical approach has the advantages that the subjects are humans, who can be asked to do specific tasks and can report on their experiences. Their cognitive capacities are also infinitely greater, which means that abilities can be studied which could not be attempted with animals, for example, language. Thus, the two approaches should compliment each other and each contribute to understanding of recovery from brain damage.

Various explanations have been put forward to account for recovery and these are briefly summarized below.

3.1.1.1 Structural explanations of recovery

Structural explanations are based on conceptions relating to the anatomical organisation of the intact brain. These generally relate more to sparing, the failure to detect any loss of behavioural efficiency even immediately after neuronal damage, than to recovery. They relate to the process constructs (see 3.1.1.2) in order to account for recovery.

1. Redundancy

This refers to the possibility that part of a neural system may adequately mediate a function normally subserved by the system as a whole, so that, when part of an area is destroyed, there may be enough of the area remaining to carry out the behaviour in a manner indistinguishable from normal. This is closely related to Lashley's concept of equipotentiality (1929) though, according to Rosner (1970), redundancy is more localized. The problem with studing an absence of defect is that there is always the possibility that the analysis was not refined enough to detect a significant loss in the quality of performance. At a physiological level, Wall (1976) has proposed that already existing, but relatively inefficient pathways may be able to mediate neural function when primary sensory afferentation is eliminated. However, it has not yet been determined experimentally whether the presence of relatively ineffective synapses can mediate functional restitution after brain damage.

2. Multiple Control

A specific function is conceived as being controlled by more than one centre. Damage to one governing substructure leaves the other intact. This is a static concept and cannot by itself account for the process of initial deficit followed by a gradual return to normal. There is, however, evidence that multiple control may provide a basis on which a recovery process may operate. Commisurotomized patients show evidence of some speech comprehension in the right hemisphere, indicating that the right hemisphere has some influence over language activities (Gazzaniga and Sperry 1967) as well as the left hemisphere. Similarly there is some control of movements of the hand by the ipsilateral hemisphere (Gazzaniga, Bogen and Sperry 1967). So, alternative areas of the brain are available for the control of certain functions. However, multiple control cannot account for differential effects with simultaneous and sequential lesions of different structures. Sequential operative removal of cortex in animals has been demonstrated to have less effect than simultaneous removal (Rosen, Stein and Butters 1971) but, since the same tissue is destroyed under both conditions, according to the multiple control theory one would expect the same effects.

3.1.1.2 Process approaches to recovery

Recovery of function occurs over time and therefore constructs which emphasize events after the lesion have advantage over static constructs such as redundancy and multiple control.

1. Functional substitution

This is a similar concept to multiple control, but involves one subsystem taking over the functions of another, in the event of neural damage to the latter. The replacement subsystem may not perform the function in a manner identical to the 'normal' subsystem, but it performs the same duties.

Functional substitution may be involved in the transfer of language functions from left to right hemisphere in the recovery from aphasia. Kinsbourne (1974) suggests that if the left hemisphere alone controls verbal behaviour, then left hemisphere inactivation in aphasics would increase the language deficit, whereas inactivation of the right hemisphere would not impair speech more frequently than would occur in the general population. However, he presents results of two studies to indicate that this does not occur and suggests that the right hemisphere can at times compensate for left hemisphere damage. The first study is by Nielson (1946) who reported a few patients, who, after recovering partially or completely from aphasia preciptated by left hemisphere damage, were rendered aphasic by subsequent lesions to the right hemisphere. In the second study, Kinsbourne (1974, 1971) anaesthetized the left hemisphere of six aphasic patients using the Wada technique and in four patients their speech was unaffected during the injection. On three of these patients right sided Wada testing was also performed and in each case the patients' speech was affected. Therefore, Kinsbourne suggests that these patients were using their right (previously minor) hemisphere to programme speech output. Since, in two patients, anaesthetizing the left hemisphere produced a further speech deficit, not all aphasic speech is programmed by the minor hemisphere. However, the small number of cases precludes any estimation of the frequency with which the right hemisphere compensates for left hemisphere language impairment.

Functional substitution can also account for differences between simultaneous and sequential lesions of different structures. The effect of sequential lesions on language would be less marked because the right hemisphere would take over language functions and subsequent lesions would not be expected to affect language abilities.

The time at which the brain damage occurs is likely to relate to the amount of functional substitution that occurs. Kinsbourne presents the theory that both hemispheres are preprogrammed for language processes, but in most the left hemisphere is differentially stimulated and, therefore, shows a more impressive evoked response to speech sounds

The attentional ascendancy of the left hemisphere produces a cumulative suppression of the right hemisphere. Support for these ideas comesfrom studies on children with left hemisphere damage. In children under five years damage to either hemisphere produces a disruption of speech, mostly on the output side, which recovers (Basser 1962, Alajouanine and Lhermitte 1965). After the age of five right hemisphere damage no longer affects speaking except in a small proportion of cases, but lesions of left hemisphere produce aphasia, which tends to be milder and more transitory than equivalent lesions in a mature adult (Basser 1962, Kinsbourne 1974). This could be due to the right hemisphere acquiring speech or the right hemisphere may have learned initially but became suppressed by the left hemisphere. The rate of recovery is incompatible with new learning of language and the knowledge shown indicates some preservation of vocabulary and memory, which together support the latter hypothesis.

There is, therefore, evidence to suggest that functional substitution may account for some recovery. In relation to language, the right hemisphere appears in some cases to perform language functions previously performed by the left hemisphere following damage of the latter.

2. Plasticity and reorganisation

These involve global changes in neuronal organisation, which take place in response to injury. This reorganisation is usually considered at a physiological level, where a change in substructure is produced though the function may remain the same. The physiological processes which may be involved are diaschisis, regenerative and collateral sprouting and denervation supersensitivity.

1. Diaschisis

Diaschisis was first proposed as a recovery mechanism by von Monakow (1914) and was described as an interruption of function within a neuron group which is transmitted to adjacent and related neuron groups. Recovery from diaschisis is due to regression of shock due to a struggle for the preservation of the disrupted nervous function. The mechanisms by which such recovery might occur is not clearly specified and therefore diaschisis is untenable as an explanatory process.

Subsequent interpretations of the von Monakow theory have considered the physiological recovery of spared neural tissue, the functioning of which was interfered with, but not destroyed (Braun 1978). Recovery from cerebral oedema, interruptions in vascular flow and changes in biochemical milieu are all consistent with this idea. Transient swelling and the consequent restricted blood flow can probably occur for prolonged periods of time, at levels sufficient to maintain fundamental vitality of brain tissue but insufficient to maintain the contribution of restricted tissue to the integrative activity of the brain. The progressive diminution of this pathological state could underly some relatively long term behavioural recovery.

The diaschisis hypothesis can also be extended to account for recovery of permanent appearing behavioural losses by amphetamine injections, if one regards the drug as facilitating access to relatively intact neurological systems which mediate the behaviours (Meyer 1972).

2. Regenerative and Collateral Sprouting

Regenerative sprouting refers to proximal regeneration of the axon after it has been transected and the distal portion degenerates. The newly operated axon may or may not reinnervate the denervated areas. This is generally considered of minimal relevance to mammalian recovery of function within the C.N.S. (Laurence and Stein 1978).

Collateral sprouting refers to sprouting from intact cells to a denervated region after some or all of its normal input has been destroyed. This has been demonstrated to some degree in various areas of the brains of animals, but these are mostly subcortical and this is where recovery of function following brain damage is least impressive (Johnson and Almli 1978). Johnson and Almli also noted that collateral sprouts, which may be physiologically functional, may not be adaptive for the organism. Odd behavioural changes have been demonstrated in hamsters by Schneider and Jhaveri(1974), yet most changes observed in recovery are adaptive rather than maladaptive. Braun (1978) therefore, questions the extent to which processes like sprouting can underlie adaptive appearing behaviour changes.

3. Denervation Supersensitivity

This refers to the phenomenon of increased post-synaptic responsiveness (sensitivity) to neurotransmitter substances or their agonists after input to an area has been denervated. This means that loss of input to a particular area can be compensated for by an increased sensitivity of the post synaptic membrane to a decreased amount of transmitter substance. Laurence and Stein point out that this relatively simple physiological change can explain a wide variety of complicated and apparently discrepant phenomena. However, in relation to the broad range of recovery phenomena, it is only applicable to a special combination of neuroanatomical locus and lesion parameters, destruction of input to an area with the receptive neurons intact, but in the case of recovery from damage to the motor cortex both afferents and their receptive fields are destroyed.

The physiological mechanisms that have been investigated, therefore, might account for some reorganisation processes within the C.N.S., but further research is needed before conclusions can be drawn.

3. Behavioural Strategy change

Different environmental cues, both internal and external, are used to maintain function. Clinically, this is the most widely accepted recovery process and Gazzaniga (1978) stresses this to the point of believing that recovery is almost invariably the product of an alternate behavioural strategy being brought into play. He cites experimental work on cross-cueing in commisurotomized patients and recovery in neurological patients as evidence.

Commusurotomised patients learn to name objects from a limited set held in the left hand, e.g. ball or square. Ipsilateral tracks to the left hemisphere could carry numerical information and the patients learn to deduce, by presence or absence of feeling an edge, which one it might be. Visual testing of the right hemisphere also indicated alternative strategies behind apparent recovery of the right hemisphere. A patient L.B. used a cross-cueing technique in order to name numerals presented to the right hemisphere. The left hemisphere commenced a count, which was accompanied by a slight head movement, when the number flashed corresponded to the counted number, the right hemisphere signalled the left hemisphere by stopping the head. The left hemisphere observed this and said the number. These seem to be highly speculative proposals and difficult to either prove or disprove on the basis of the clinical data presented.

Neurological patients have also been observed as switching behavioural strategies. Gazzaniga (1978) quotes examples of a patient with visuospatial problems learning to do the WAIS block design by means of a verbal strategy. He also suggests that anomic patients who are unable to name an object might, when they start to use the object, be able to describe the action because verbs are available to these patients and, on the basis of this, can obtain the relevant noun. For example, a patient can describe the action 'combing' and from this obtain the name 'comb'.

The clinical recovery observed in patients, therefore, may not reflect a recovery of function in a neurological sense, but may reflect the ingenious ability of organisms to maintain a behavioural status quo by using other mental and behavioural resources.

3.1.1.3 Conclusions

Various mechanisms have been investigated which may account for the spontaneous recovery of function observed following brain damage. Marked differences occur in the level at which the recovery process is considered, for example physiological or behavioural, and consequently discrepant findings occur. However, it seems likely that several processes at each level will together contribute to recovery and the relative importance of each will depend on the recovering function under consideration. In relation to recovery from aphasia, behavioural strategies are, therefore, likely to be a major consideration initially, as they have practical implications for the treatment of aphasic patients However, physiological processes may be of relevance, if, by physiological or biochemical means, the recovery process can be induced.

3.1.2 Studies on Spontaneous Recovery

There has been relatively little work concerned with the natural history of aphasia in the absence of treatment. However, from the studies that have been conducted, the general finding is that some recovery of function occurs spontaneously.

This was intimated by Head (1926) who also believed that observation of patients with different types of aphasia would show that some improved more than others. Later, Weisenberg and McBride (1935) also implied that spontaneous recovery was an important factor, by pointing out the need to compare it with the recovery of patients receiving language training.

Vignolo (1964) carried out the first major study to include consideration of spontaneous recovery on an experimental basis. Twenty seven non-re-educated and 42 re-educated aphasics were tested twice at a minimum interval of 40 days using a standard aphasia examination. Of the 27 non-re-educated aphasics, 15 were found to change, 14 of which improved, whereas only one deteriorated. Vignolo tested the significance of change in the direction of improvement and found this to be very high ($p = 0.0007$). The conclusions drawn were that spontaneous evolution exists and occurs in the direction of improvement and restitution of function. However, the problem with this study is that allocation of patients to the re-education or non-re-education groups was not on a random basis. Patients in the non-re-education group were those with personal, family or transportation problems, which might prevent them attending therapy sessions. These are also factors which might render these patients less likely to improve regardless of whether they received treatment or not. The effect of this would be to decrease the proportion of patients improving spontaneously and so the 14 improved out of 27 non-re-educated patients may be an underestimate of the role of spontaneous recovery.

A more systemmatic study was conducted by Culton (1969). He considered the recovery of two groups of aphasics. The first group of eleven subjects were recent aphasics, who had been aphasic less than 30 days. The second group of ten subjects had been aphasic for 11 months or more, and had received language training, though they did not receive language training during the testing period. Patients were assessed on 8 language tests and Ravens Progressive Matrices, as a measure of non-verbal intelligence, at two week intervals over a period of six weeks. A significant improvement in scores was obtained for group one between first and second assessments and over the total assessment period. This indicated that spontaneous recovery occurs in patients who have recently become aphasic and this is most marked in the first month post onset. The second group remained stable on all tasks throughout the testing period, suggesting that at a later stage spontaneous recovery no longer occurs.

A further study which may lend support to these findings is that of Newman (1972). A group of 39 patients with hemiplegia due to cerebral infarction were assessed from the time of onset for a period of 20 weeks. The process of recovery was followed with neurological and functional tests. Nineteen of the patients had a speech disorder which was assessed using a simple unspecified three point scale, and for six patients the PICA. On the three point assessment scale, 14 of 19 patients showed some recovery of speech, expression and comprehension between the first and twelfth weeks. The six patients tested with the PICA showed improvements ranging from 11% to 75% gain in initial score. Since no indication is given of how patients were selected to be tested on the PICA it is difficult to generalise from this result. The three point assessment scale was probably too crude a measure to yield results of any practical importance, though it does support the general idea of spontaneous recovery. However, it is unclear whether patients were really receiving no therapy as is implied from the discussion. These patients were attending a rehabilitation hospital and it is therefore unlikely that they received no treatment which might affect speech abilities. This study therefore contributes relatively little in terms of objective evidence for spontaneous recovery of speech.

Sarno and Levita (1971) evaluated the Communication Profiles (FCP) in 28 untreated aphasic patients. Patients were evaluated two days, three months and six months post CVA. The number of patients decreased markedly during that period from 28 to 14 at six months, as a result of deaths. From the results of those that survived, it was possible to determine that greater improvement occurred within the 0-3 month than the 3-6 month period post stroke in the absence of formal speech therapy. This underlines the important contribution of recovery processes operating during that period and provides further support for Culton's work.

Smith et al (1972) studied 15 aphasic patients who received no language therapy. Patients were initially assessed at an average of 15 months after the onset of aphasia, and reassessed on average 2 years later. A battery of tests yielded generally negligible changes in language functions. Although all patients showed some improvement in at least one language modality, they showed decline in others, and, therefore, Smith attributed the change in scores to random variability in language test performance. These results, therefore, suggest that spontaneous recovery does not occur, but in relation to previous studies this is not particularly surprising in view of the late stage post onset at which most patients were initially assessed.

A recent study on spontaneous recovery is that of Kertesz and McCabe (1977). Ninety-three aphasics who had been assessed at regular intervals on the Western Aphasia Battery were reviewed. The total group was divided into subgroups, which were considered separately. Thirty six patients who had been assessed within 45 days of onset and three months later were investigated for rate of recovery in relation to time post onset. The degree of improvement was greatest in the first interval, 1½ - 3 months post onset, but some improvement occurred in subsequent intervals, 3-6 and 6-12 or more months. However, not all patients were assessed in all intervals. The reason for decrease in numbers is specified as attrition, which makes interpretation of the results difficult. Any consistent trend, such as those who are completely recovered tend not to return for follow-up or those who have failed to improve do not return, could seriously bias the findings. During the assessment intervals some patients received treatment for varying lengths of time. Although there was no significant difference in recovery between those treated and untreated, the basis for selection for treatment was not specified. If patients were given treatment when they were showing relatively little spontaneous recovery and this produced an improvement in performance, no differences would be apparent between treated and untreated groups, but the effect of spontaneous recovery would be exaggerated. Kertesz and McCabe were not able to control the selection, amount, duration or quality of therapy, but they accept that it is possible for patients making poor recovery to receive treatment longer, as these are the patients who stay in the rehabilitation setting where speech therapy is readily available.

The general conclusion from the studies on spontaneous recovery is that it occurs. It is most marked in the three months post onset, but minimal changes may continue for longer.

In view of the occurence of spontaneous recovery, it is necessary to consider the factors that determine the extent to which it occurs. These factors will then provide prognostic indicators for recovery.

3.2 Prognostic Indicators of Recovery

Research into prognostic indicators of response to therapy has been more extensive than consideration of prognostic indicators of spontaneous recovery. However, since the two are so closely interlinked, the same factors could predict both. In view of recent doubts that therapy has any influence on recovery (Hopkins 1975) it may be that the two are synonymous.

3.2.1 Aetiology and extent of lesion

The aetiology of aphasia has implications for recovery in that generally traumatic cases improve more than those of cerebral-vascular origin.

Butfield and Zangwill (1946), in considering the re-education of 70 dysphasic patients, concluded that the most favourable outcome occurred in traumatic cases. Eisenson (1949) supported these conclusions on the basis of his observations of 100 aphasic patients.

More objective recording of performance yields similar results. Kertesz and McCabe (1977) studied 74 aphasics with infarcts and intracerebral haemorrhages, 12 with subarachnoid haemorrhages and 7 with trauma. Recovery graphs of performance on the Western Aphasia battery indicated that traumatic aphasia had a better over-all prognosis than that of vascular disease.

However, the problem with comparing traumatic and vascular origin aphasics is that the latter group tend to be older and age alone may have a significant effect on recovery (see 3.2.3).

Within these broad diagnostic categories differences have also been found associated with aetiology. Luria (1970) considered only traumatic aphasics and found that non-penetrating injuries had a better prognosis than penetrating injuries. Twice as many of the former group had recovered completely within 4 months as in the latter group.

The site and extent of lesion may be difficult to determine but some broad generalisations concerning its influence on recovery may be possible. Russell and Espir (1961) report better prognosis if one rather than both hemispheres is involved. Eisenson (1964) found that a single lesion improved more than recurrent lesions and, of these single lesions, those which did not involve the temporoparietal region did better.

In addition to aetiology affecting the rate of recovery, there has been a suggestion that it also influences the pattern of recovery. Porch (1971b) reported on serial administrations of the PICA to patients with aphasia of different aetiologies. Those with vascular aphasia show an ascending recovery curve that levels out at about 6 months post onset, whereas traumatic aphasics show a stair step recovery that continues to improve beyond 6 months.

3.2.2 Severity and Nature of Aphasia

The general expectation is that the more severe the aphasia at its onset, the less likely the patient is to recovery. This has received considerable experimental support. Butfield and Zangwill (1946) reported marked improvement in 40% of their cases rated severe, 56% rated moderate and 58% rated mild. Thirty-four percent of the severe group remained unchanged, compared with 6% of the moderate group and 0% of the mild group.

Sands, Sarno and Shankweiler (1969) reporting on 30 patients, stated that their data indicated a higher intake FCP score predicts a higher outcome FCP score. Conversely, if the intake FCP score is low the prognosis for recovery is poor. In the high gain in FCP score group, the intake FCP was 38.3%, whereas for the low gain group it was 17.2%. From this they concluded that severity of language impairment at initial evaluation is a good indicator of the amount of recovery that might be expected.

Kertesz and McCabe (1977) selected a subgroup of 30 aphasics with CVA, whose initial test was within 45 days of onset and had one year or longer follow ups, from their total group of 93 aphasics, to correlate initial severity with outcome. This correlation was significant ($p<0.01$), indicating that severely affected aphasics recovered to a lesser extent and reached a lower level of speech function than mildly affected ones.

The study by Kertesz and McCabe also included consideration of the differences in recovery rates between the various types of aphasia. They found a significant difference in improvement scores during the first three months ($p<0.01$) indicating that untreated global and anomic aphasics improved significantly less than Broca's and conduction aphasics. The lack of improvement in the anomic group might be a ceiling effect since the mean aphasia quotient at initial testing is 76.9 and, therefore, leaves little scope for improvement. The lack of improvement in global aphasics may be a reflection of the severity of aphasia rather than the type, especially in view of the lack of evidence for types of aphasia being independent of a severity dimension (see Section 2.3).

The lack of difference in recovery between Broca's and Wernicke's aphasics supports an earlier report by Basso, Faglioni and Vignolo (1975) who found no significant difference between Wernicke's and Broca's aphasics' recovery. This lack of difference occurred for both re-educated and non-re-educated patients and at various stages in recovery.

However, Brust, Shafer, Richter and Brunn (1976) found that 74% of fluent aphasics improved between 4 and 12 weeks post stroke compared with 52% of non-fluent aphasics. Recovery was complete in 44% fluent aphasics as compared with 13% non-fluent aphasics.

The presence or absence of specific language features may also have prognostic significance. Wepman (1958) initially suggested that the ability to correct errors was of importance, but subsequently revised this idea and suggested that the speed with which a person passes through various stages of self-correction is a better prognostic indicator than the degree of loss of the capacity at any one time.

Another feature which may be of relevance is anarthria. Vignolo (1964) suggested that this had a significant retarding effect on recovery of expression. However, this was not demonstrated adequately in his study as anarthria could not be separated from the influence of time post onset. Schuell et al (1964) found that perceptual, sensorimotor and dysarthric components meant that prognosis was worse than if these components were absent. Culton (1969) found that recovery was poor when subjects initially were unable to point to pictures of named objects and when a few weeks after onset they were unable to write words to dictation, whereas the prognosis was better for those who exhibited large amounts of spontaneous recovery on oral encoding tasks, naming and answering questions, and ability to write words to dictation. Many of these specific features may merely reflect overall severity and consequently extent of brain damage rather than specifically poor prognositic indicators.

Generally, therefore, it seems that severity at onset provides some indication of likely progress. This may well be a result of relating closely to the extent of brain damage involved. However, Smith (1971, 1972) found that initial severity of language deficit increased with age and so the relatively poorer prognosis of severe aphasics may reflect the tendency of these patients to be older.

3.2.3 Age

Age was pinpointed as an important factor in predicting recovery by both Eisenson (1949) and Wepman (1951) in their early work. Eisenson reviewed the notes of 21 patients and divided them into those who made a good recovery and those who made a poor recovery. The mean age of the former group was 24 years, range 20 to 32 years, whereas, the mean for the poor recovery group was 31 years, range 22 to 47 years. Wepman obtained similar results in that those who were reported to have made good progress in therapy ranged in age from 19 to 38 (mean 25.8) years, whereas those with lowest level of achievement were the global aphasics who were also the oldest group (mean 29.5 years).

Vignolo (1964) found age to be important in his group. While more than 70% of young patients under 40 years old improved and 40% reached a functional communication level, only 22% of old patients over 40 years improved and only 11% reached a functional communication level.

Sands, Sarno and Shankweiler (1969) reported that age appeared to be the most potent variable influencing recovery in a group of 30 patients whose mean age was 56.5 years. The one sixth who improved most proved to be the youngest in the series with a mean age of 47 years, whereas the sixth that improved least averaged 61 years. On the other hand Sarno, Silverman and Levita (1970) working with an elderly group of 31 patients (median age 65 range 46 to 80 years) found no difference between those over 65 and those under 65 years, inchange in language ability. This would suggest that age is less important than had previously been supposed, at least for those over 47 years. However, the wide range in interval between assessments - 4to 36 weeks, with no indication of the basis on which the reassessment time was chosen limits the interpretation of these results. Any systemmatic trend, such as testing those who improve most earlier, could bias the results.

Further support for the lack of prognostic value of age comes from Keenan and Brassel (1974). They reviewed the clinical records of 39 aphasic patients, and correlated factors noted on initial examination with patients progress in communication performance. Patients were divided into 10 year age groups to compare terminal speech performance, rated as good, fair or poor, in the different age groups. The distribution in different decades did not indicate that age was of any prognostic value. However, the classification of terminal speech performance may have used too broad categories to reflect any underlying trends.

Smith (1971) presents some more objective data which fails to support age as an important prognostic indicator. He compared the performance of 19 patients who were 19 to40 years with 27 patients from 51 to66 years and found relatively slight differences in gains in the two groups.

One of the problems in evaluating the different studies concerned with comparing groups of different ages is that different criteria for young and old are used in each, so that while there may be no difference between age groups 19 to40 and 51 to66, there may be a difference between those under and over 65 years. However, the studies reviewed above seem to cover the full age range and positive and negative findings do not seem to relate the age groups of patients involved in the particular studies. An alternative approach to comparing young and old is to calculate the correlation between change in ability and age. Kertesz and McCabe correlated age with recovery rates in the first 3 months and found no statistically significant relation.

Age, therefore, seems to be of relatively minor importance, though the data is in no way conclusive.

3.2.4 Psychosocial variables

Various psychosocial variables have been put forward to account for differences in rates of recovery from aphasia, but there is generally a lack of experimental evidence to support the views and that which does exist is mostly contradictory.

Eisenson (1949) suggested that certain personality characteristics were associated with better prognosis,such as outgoing rather than withdrawn and introspective, a modest rather than very high or very low level of aspiration and independent rather than over dependent, and prognosis was poor if the person was euphoric, rigid or concrete. However, he presents no experimental evidence to support these observations. Bouquet (1972) attempted to rectify this by using various personality scales with 26 patients and found there was no significant relation between premorbid personality, coping ability and stroke rehabilitation.

Educational level was postulated by Eisenson to produce a less favourable recovery if it was high, but Sarno and Levita (1971) found that both educational and occupational level were unrelated to progress. Health during recovery was also suggested by Eisenson, but this failed to find support from Keenan and Brassel (1974). General health was rated on the basis of information from each patient's medical history and was found not to relate to whether terminal speech performance was poor, fair or good. Intelligence was suggested by Wepman (1951) as important, but the experimental evidence also fails to support this suggestion (Sarno and Levita 1971, Smith 1971).

It is difficult to draw definite conclusions from the above studies as there are so few which adequately test the hypothesis presented. However, it does seem that the more objective studies have failed to provide support for the suggestions of Eisenson and Wepman and so it seems unlikely that psychosocial variables are of importance as prognostic indicators. However, Darley (1975) in his review of the factors influencing the outcome of therapy, considers that these factors do partly influence the degree of language recovery.

3.2.5 Time between Onset and Therapy

The importance of early language therapy as a prognostic indicator of recovery has been put forward in studies attempting to demonstrate the effectiveness of therapy. If therapy is ineffective, the point at which it is commenced should have no decisive influence on the course of recovery.

Butfield and Zangwill (1946) divided their 70 patients into two groups, one which received re-education less than six months post-onset and one which received re-education more than six months post-onset of aphasia. Their data indicates significantly more improvement in the group re-educated earlier. However, it is impossible to separate the effect of spontaneous recovery from that of re-education since the basis for selection of patients re-educated more than six months post stroke is not specified.

Bein and Stoliavova (1968) considered that the time of commencement of therapy has an important effect on the achievement of recovery in patients who are aphasic due to cerebral haemorrhage but in patients with ischaemic injury the condition of the collateral circulation is the determining factor.

Sands, Sarno and Shankweiler (1969) compared 13 patients whose treatment began no later than 2 months post stroke with 12 whose treatment began 4 months after and found greater improvement in the earlier group. However, in this earlier group spontaneous recovery may be of relevance, as well as the early onset of treatment. Sarno, Silverman and Levita (1970) on the other hand, found no difference between those initially assessed less than 19 months post stroke and those assessed more than 19 months post stroke. However, as all patients were so long post stroke, differences might no longer be expeeted.

Smith et al (1972) also considered relatively long intervals before the onset of therapy, though these were shorter than those of Sarno et al (1970). They compared changes in the language function of 25 patients, who began therapy 3 to 5 months post onset of aphasia with 22 patients who began therapy after 21 to 114 months. Larger gains were obtained by the early treatment group, though 10 patients treated late made marked gains in language function.

Early therapy is, therefore, likely to be more beneficial than late, though in the early stages the effects need to be carefully distinguished from those of spontaneous recovery.

3.2.6 Handedness

Handedness has been related to recovery, in that left handers are expected to make a better recovery than right handers.

Subirana (1958) reviewed 250 stroke patients, of which 161 had unilateral hemisphere lesions and of these 108 were aphasic. The incidence of aphasia in left handers was slightly higher than in right handers. Of the right handers, 66% were aphasic, whereas 75% of left handers were aphasic. However, this latter finding only represents six out of eight left handed patients. When aphasic patients alone are considered, about 5% are left handed.

Smith (1971), on the basis of one left hander in 78 chronic aphasics, suggests that left handers are less likely to sustain chronic aphasia. This is contradictory to the conclusion reached by Subirana, yet the proportion of left handers in the aphasic group appears to be similar. This similarity persisted when Smith (1972) increased his sample to 126 chronic aphasics, 4 of which were left handed. The interpretation of results is limited by the small number of left handed aphasics, 5% in Subirana's study, 2% and 3% in Smith's two studies.

The results are also likely to be influenced by the stage in recovery at which patients are assessed. This is not clear from Subirana's paper, but Smith's patients were all chronic aphasics. If left handed aphasics recover better the proportion found in chronic aphasic groups is likely to be less than the proportion in groups of recent aphasics. Brown and Simondson (1957) reviewed 100 aphasic patients relatively early in their recovery and found that 11% of aphasics were left handed or ambidextrous. It is, however, impossible to determine how Brown and Simondson's ambidextrous patients would have been classified using the criteria adopted by Smith.

It is, therefore, not clear whether left handers are more or less likely to become aphasic as a result of a stroke. The interpretation of results is very limited by the small numbers of left handed aphasics. There is, however, more support for the suggestion that left handers improve more than right handers when they become aphasic.

Subirana found that the proportion of patients in which aphasia was transitory despite the persistence of a hemiplegia was ten times higher in patients who were right handed, but with left lateral tendencies or a family history of left handedness, as compared with right handers.

Smith supports this view by advocating that aphasia tends to be less severe in left handers. His patients were all chronic aphasics and so the data would reflect the effects of recovery. Data does not seem to be available to indicate whether initially post stroke the aphasia of left and right handers is equally severe.

Luria (1973) when considering factors determining the success of restoration of function after brain injury, includes the degree of preservation of the unaffected hemisphere and the readiness of other areas of the brain to take over functions of a damaged area. He suggests that, if there is a marked dominance of the left hemisphere, take over by the right hemisphere may be difficult. It would, therefore, be expected that recovery from aphasia by left handers, with less marked cerebral dominance, would be easier than by right handers.

Some indirect evidence related to this aspect of recovery comes from Kertesz and McCabe (1977). McGlone (1977) considered the incidence and degree of aphasia in right handed males and females with left hemisphere damage. Three times more males than females were aphasic, which led him to suggest that females as a group show a more heterogeneous pattern of cerebral speech representation than males. If this is the case, one might expect females to show better recovery than males. However, Kertesz and McCabe comparing recovery patterns in aphasics, found no significant difference between male and female patients. Although they recorded handedness in their aphasic patients and obtained 3 left handers in their sample of 93 patients, the progress of these three was variable. One recovered well, one improved moderately and one remained significantly disabled after a year. Although these numbers are too small to analyse statistically, they do not suggest any particular superiority in the recovery of the left handers.

Handedness, therefore, possibly has prognostic significance for recovery, but the conclusions are limited by the small number of left handed aphasics available for study. It is also very hard to show whether the frequency of right and left handers becoming aphasic after a stroke is significantly different without a strict measure of handedness (see Section 2.4.3.1).

3.2.7 Conclusions

Generally, certain factors do seem to relate to prognosis. Age and aetiology have been the most thoroughly investigated but, even for these, the data is not conclusive. Many factors are so closely inter-related that it is difficult to determine which are of primary significance. However, it seems likely that the nature of the lesion and the general condition of the brain during recovery will have major significance for recovery and other factors, such as therapy and environmental variables, a minor contribution. Any studies into the recovery process will need to allow for the contribution that any of these variables may make.

Even though these generalizations may hold true for aphasics as a group, there are many exceptional cases quoted in the literature and it is this great variability in recovery which makes predicting the progress of any one individual virtually impossible.

CHAPTER 4

LANGUAGE TREATMENT METHODS

Various treatment procedures are used in the rehabilitation of aphasia. Historically speech therapy is the best established but recently techniques based on learning principles, for example, programmed instruction and verbal operant conditioning, have been introduced. Initially the two could be relatively easily separated but they are now being used in conjunction with each other and techniques from both areas incorporated into treatment programmes. The two main language treatment methods, speech therapy and operant training, will be considered separately but the division is in some instances arbitrary as there is considerable overlap between the two methods.

4.1 Speech Therapy

Speech therapy as a treatment regime for aphasics has developed from clinical work with patients rather than from any theoretical formulation. Despite the diversity of its development several basic principles have emerged which are common to many authors.

4.1.1 Basic Principles

4.1.1.1 Stimulation

Treatment procedures are based on two main concepts of the recovery process. One is put forward by Schuell Jenkins and Jiminez-Pabon (1964) who hypothesize that a process of reorganisation occurs within the brain. This involves a retrieval of what a patient already knows, and is achieved by stimulation. The role of the clinician is as a stimulator and to control circumstances by reducing environmental 'noise' such that the likelihood of comprehension and production of linguistic behaviour is enhanced.

Theoretical explanations for the use of stimulation have varied. West, Kennedy and Carr (1947) used stimulation to develop associations by direct or indirect pathways between different cortical centres. Aphasics were classified according to whether sensory or motor channels needed strengthening and, in each, strengthening was achieved by repetition and reinforcement through different channels. Thus gesture, painting, drawing and dramatising might be used to strengthen motor speech patterns. They considered that learning through the method of correlated activities was better, though they produce no experimental evidence to support this claim.

Wepman (1953) considered stimulation as one of the three processes essential to recovery. The other two are facilitation, a physiological process which lowers the impedance against organized cortical activity, and motivation, a psychological state of readiness which has to exist before maximal learning of the formation of new operative neural integrations is possible. The therapist provides stimulative material in the area of the patient's greatest need, at a time when the patient is capable of utilizing it, for the facilitation of cortical integrations which ultimately produce language performance. Wepman emphasizes general verbal stimulation with little or no specification regarding the content, although he did suggest that language therapy takes into account a patient's interest and premorbid personality. Wepman considers that if a patient is left without therapy, his performance remains at the same level and secondary reactions such as withdrawal, anxiety and dependence may develop.

Schuell et al (1964) emphasize multi-modal stimulation and, in particular, controlled intensive auditory stimulation. This is used to stimulate language processes so that they begin to function. Auditory stimulation is stressed since Schuell considers language to be most dependent on this perceptual system, because it was through this system that language patterns were organised in the brain. Schuell points out that patients are continuously receiving verbal stimulation from their environment, yet this is not expected to produce the same recovery effects, because it is presented too fast or in a too complex manner. The effectiveness of stimulation is increased by presenting material slowly, slightly louder than usual, and by repeating it many times if necessary. The material is presented in meaningful language units, which in many cases involves only common everyday words, and the length of stimulus is controlled. These methods of increasing the effectiveness of stimulation increase the chances that a patient will be able to respond. This is consistent with Wepman's idea that the nervous system has to be able to deal with the material presented.

Schuell (1974) has more recently suggested that combined auditory and visual stimulation might be used to elicit language on progressive levels of complexity. This combination of stimulation is used so that each modality reinforces the other, and is continued until the patient can respond to each modality alone or at any given level. Although Schuell advocates the use of multi-modal stimulation, her emphasis is on the use of auditory stimulation, with other in-puts in a secondary role, or being added at a later state of progress.

Eisenson (1973) supports this concept of the importance of stimulation but in contrast with Schuell does not stress the auditory pathway. He suggests that the sensory or motor pathways which are relatively intact should be used for input and expression. This means that if it is the visual system that is relatively unimpaired, then visual input and graphic expression may be used as a starting point in therapy.

4.1.1.2 Transfer of Function

Stimulation is therefore an important aspect of therapy if a reorganization process is seen as the basis of recovery. However, an alternative assumption is available. Luria (1963) suggests that resumption of function can be accomplished more effectively by by-passing defective systems and establishing new circuits. His treatment procedures are based on the transfer of functions to other structures or other functional systems. Initially Luria's procedures were not widely adopted outside the Soviet Union, whereas Schuell's ideas were accepted and generally used as a basis for therapy in many western countries. Leche (1972) indicates that treatment often incorporates both theoretical frameworks according to the problem that presents, and it seems that Luria's techniques are becoming quite widely used, and Schuell's more rigid programme is less widely used.

4.1.1.3 Expression

In conjunction with multi-modal stimulation Schuell (1974) has suggested that multi-modal expression can also be used. All modes of expression are built together, as well as all modes of stimulation. In this way they too may reinforce each other.

Eisenson (1973) illustrates the use of multi-modal expression for patients with word finding difficulties. He suggests that the function of an object should be demonstrated, the object named by the therapist, and if possible repeated by the patient, and also written or copied by the patient.

4.1.1.4 Learning

The role of learning in this stimulation process is a source of variation between different theories of treatment. Schuell and Wepman both see stimulation of language processes as something other than learning. Stimulation of language processes causes them to function, and recovery involves the re-establishment of language usage, not the patient learning how to talk. Wepman is particularly emphatic on this point, but he also claims that recovery from aphasia is the expanded use of previously learned behaviour. This is supposed to be incompatible with considering recovery as a learning process, but, if learning is considered as increasing the probability that a particular response will occur following particular stimuli, then his description of recovery is exactly a learning process. Learning in this case would have a major role, and not as Wepman suggests "only a very minor role, if any role at all" (Wepman 1970).

Other speech therapists have accepted the importance of learning in the therapy situation to a far greater extent. Eisenson conceptualises speech therapy largely in terms of learning techniques and the basic principles that he presents are very similar to those of Schuell and Wepman despite the discrepancy in theoretical background.

Various features of speech therapy show consistency with a learning theory framework, which indicates some acceptance of learning being involved. The most notable feature, in this respect, is the policy of beginning with easy items and building up progressively to more difficult tasks. If it were just a question of stimulating the appropriate ability, then there would be no basis for a graded sequence of tasks to shape up particular goal behaviours. Brookshire (1973) suggests that treatment should be structured so that performance is slightly deficient, but not erroneous. These are tasks on which performance is just beginning to show impairment, the responses are correct but response latencies are appreciable, or responses are initially incorrect but are subsequently corrected by the patient without prompting. This is similar to the ideas of Porch (1973) who emphasized that clincians should work on 10 to 13 scores on his multidimensional scoring system. This, Porch considers, ensures that the patient is working on tasks that are not beyond the capacity of his processing system, but are at a level of difficulty which forces him to use his system to near its capacity.

Another reason for beginning with easy items is the effect of errors on subsequent performance. Brookshire (1972) has shown that when an aphasic makes an error in a task the occurence of the error response tends to generate additional errors. It therefore appears advisable that clinicians aim to ensure that few errors occur.

4.1.1.5 Orientation of Treatment

The areas to which speech therapy is directed are also of relevance. Wepman suggests that working with the area of the patients' greatest need at that time. This may present problems if the patient's impression of his greatest need and the opinion of the therapist do not coincide. For example, a patient, due to impaired comprehension, may not see the importance of singing, copying or matching tasks and may only focus on demands for purely verbal tasks. Brookshire (1973) supports this idea of directing treatment to key areas of deficit, since by treating these it may be possible to produce improvement in a number of related areas. He considers auditory abilities may be such a key area when language comprehension problems are present. Kushner and Winitz (1977) investigated this experimentally. They gave extended comprehension practice to a patient who was aphasic after a head injury one month previously. Practice was given on comprehension and not on production for a month, followed by one month with no treatment, followed by a further month's treatment. Assessment after this 3 month interval indicated that improvement had occurred in both comprehension and production. This was probably not due to spontaneous recovery since no increase in ability was observed in the no treatment interval. However, Scott (1977) questions the attribution of improvement on production, i.e. confrontation naming, to the comprehension training. This is largely because of the lack of consistency between the comprehension and production improvement patterns over the 4 month interval. However, he does not suggest why the improvement in production occurred if it were not due to the comprehension training. Working on tasks that a patient is successful at already is generally considered unnecessary. However, it may serve a motivating function and indicate to the patient that there are tasks which he can do, as well as tasks on which he has difficulty.

4.1.1.6 Patient response

Another feature of Schuell's approach is that the patient should be required to respond. This can be in any of a variety of ways, for example pointing, writing or verbal responses, and should be continuous throughout the session. This permits the clinician to determine whether a stimulus was adequate and also serves a feedback function, according to the response made. Schuell finds that a patient first points and then almost unconsciously begins to repeat when repetition becomes easy. The clinician can usually then elicit a response by supplying a frame for it, for example "you live in a ...." or, at a later stage, "what do you live in?". This cueing gradually becomes unnecessary, as the patient can elicit a response spontaneously.

The importance of giving a response receives considerable support from the literature on general learning principles, which indicates that learning is facilitated by requiring the learner to respond often throughout the learning situation. Brookshire reports that he has consistently found that procedures which require large numbers of responses from the patient are superior to those which require few responses.

Cueing is a technique suggested by Schuell which may be used to elicit responses. Schuell considers that this idea of producing or eliciting a response should be emphasized rather than letting patients struggle for a response or correcting erroneous responses. Cueing is one means of doing this. Love and Webb (1977) investigated the efficiency of cueing techniques with 20 Broca's aphasics. Cueing was found to be most effective if the initial syllable was used, then sentence completion and least effective was the printed word. Support for this comes from Pease and Goodglass (1978) who found first sounds were the most effective, followed by sentence completion, and these were both more effective than location, rhyme, superordinate and function cues. They also found that this effectiveness was independent of the type of aphasia. Cues, therefore, are effective in producing words from the patient, but whether they facilitate naming on subsequent occasions seems not to have been investigated.

4.1.1.7 Encouragement

Another feature in common to many speech therapists is that in order to develop a patient's morale a lot of encouragement is given. West et al (1947) consider this as an important factor in treatment, as it has a determining effect on a patient's motivation and therefore his prognosis. Eisenson conceptualizes this more in terms of reinforcement through reward. This is contingent on performance and therefore less freely available than West et al would recommend. Brookshire (1973), supporting this view of Eisenson's considers that treatment programmes should routinely provide for feedback to the patient regarding the accuracy and adequacy of his responses. Feedback will vary in form according to the patient, and may be very minimal for mildly impaired patients, whereas it may have to be more intense, simple in terms of information content and follow every response, for the severely impaired patient. Brookshire suggests one means for doing this is to present graphs of test and treatment performance to indicate progress to patients.

4.1.1.8 Non-specific features of speech therapy

Other aspects of speech therapy are often mentioned yet are not direct treatment procedures in themselves. Patients often cannot be treated as often as a therapist considers necessary and so treatment within the home is recommended. Schuell (1964) suggests that teaching machines might be useful in this situation, or, alternatively, assignments may be set for the relatives to complete with the patient. Wepman (1970) is, however, strongly opposed to the use of teaching machines. Although his particular objection is that they destroy the patient-therapist relationship, his general theoretical framework would also indicate an opposition to the use of a teaching machine by the relatives as well as by the therapist.

Treatment schemes in the home have been tried using untrained volunteers. Griffths (1975) reports on a pilot scheme in which volunteers worked with dysphasic patients with speech therapists available for advice. Improvement in speech was reported by G.P's for 21 of 31 patients seen, and 17 of 19 patients assessed by a speech therapist improved. However, the extent to which spontaneous recovery contributed to these changes cannot be determined. The main advantages of the scheme were found to be that volunteers provided support to the family and encouraged independence and filled gaps in professional help. A similar project was carried out by Lesser and Watt (1978). They found no significant evidence of improvement on objective language tests in 16 patients. However, ratings of functional speech and social skills did show improvement, which suggests that the benefits from such schemes are social rather than linguistic.

4.1.2 Specific Procedures

4.1.2.1 Group Therapy

Present considerations have related to the individual treatment of aphasic patients. Many speech therapists also include group therapy in their rehabilitation programmes. Group therapy is not generally recommended as the main component of a treatment regime. However, it is often offered as an adjunct to individual therapy.

Group therapy has only occasionally been reported in the literature and little attempt has been made to evaluate its effectiveness. It is mainly directed towards the social function of speech, rather than being task orientated. Leche (1972) points out that the group setting provides an opportunity for the therapist to observe the patient's speech at a functional level, and the patient has a valuable socializing experience.

Some groups have been more task orientated in their approach. Corbin (1951) emphasized training in verbal skills, although he saw the advantage of the group situation as the stimulation and challenge of competition as a motivating factor. Gordon (1969) assessed a group therapy programme and considered task orientated aspects. She found that dysphasic patients showed some improvement after training and tended to correct more phonemic errors. Improvement in voluntary naming was also noted.

Psychotherapeutic aspects are also considered important in the group setting. Aaronson, Shatin and Cook (1956) orientated their group work towards emotional difficulties, although the group activities involved, such as singing, stories, puppets and discussion, were all likely to improve speech performance. Godfrey and Douglass (1959) report on a group run by two minimally trained occupational therapists. Although language functions showed no improvement, gains were made in the patients' acceptance of the limitations of their disability and their ability to relate to others, and they acquired relatively objective unemotional attitudes. Leche (1972) advocates that another advantage of group therapy is the psychological support given by other patients and recommends relatives' discussion groups in addition to those for patients. These give the therapist an opportunity to tackle some of the difficult problems of how the relatives should treat the patient.

The general impression gained from the few reports available in the literature is that psychotherapeutic aspects are as much involved as direct attempts to improve communication behaviour. It may be that opportunities provided for socialization, for motivation from peers, for observing techniques of other patients in getting themselves understood, for responding to more than one manner of speech and language usage, and for ventilating and airing grievances are the most valuable features of group therapy. However, as Eisenson (1973) points out, group therapy has its shortcomings. It is difficult for withdrawn patients, it may provoke discussion of personal problems before the patient is ready and the rate of the group is slower than the best member and faster than the worst. However, careful selection of members, together with the use of groups as an adjunct to individual treatment rather than instead of individual treatment, should minimize these shortcomings.

4.1.2.2 Melodic Intonation Therapy (M.I.T.)

This therapeutic method has recently been developed by Albert, Sparks and Helm (1973, 1974). It involves the sung intonation of propositional sentences, such that the intoned pattern is similar to the natural prosodic pattern of the sentence when spoken, in order to develop propositional speech. Sparks and Holland (1976) present a series of stages, through which the patient will gradually progress, which increase in length of units, diminish dependency on the clinician and diminish reliance on intonation. The programme is designed for patients with paucity of verbal output, but their studies have shown that improvement with M.I.T. is also associated with only mild to moderate impairment of auditory comprehension. Some preliminary data on the effectiveness of M.I.T. has been obtained. Sparks, Helm and Albert (1974) treated eight severely impaired right handed aphasics with left hemisphere damage from a C.V.A., who had shown no improvement in verbal expression over 6 months. Recovery of some propositional language was reported in 6 of the 8 patients. Sparks and Holland (1976) found gains in 11 of 16 patients who had received language therapy once or twice daily for 6 months without improving in quality or quantity of verbal output.

The reason postulated for the effectiveness of M.I.T. is that dominance for music, particularly recall and production of melody, is in the right hemisphere. The non-dominant hemisphere, through this musical function, together with the less developed language area of the right hemisphere may support the left hemisphere, which continues to be language dominant. Sparks et al (1974) suggest that M.I.T. serves to stimulate the latent language capacity of the non-dominant hemisphere. Berlin (1976) further elaborates on a possible physiological mechanism to account for the effectiveness of M.I.T. He suggests that damage to Broca's area and the arcuate fasciculus of the left hemisphere means that auditory input cannot reach Broca's area. However, posterior to anterior interaction may occur through an indirect route, i.e. transcallosal communication, at Wernicke's area with its homologue on the right side via the arcuate fasciculus of the right hemisphere to the homologue of Broca's area on the right side. From here information can be re-routed cross-callosally to the pre-rolandic areas of the left hemisphere, or the right hemisphere can attempt to control some of the motor gestures being made.

These preliminary hypotheses will need further examination, but the general approach of seeking alternate modalities or combinations of access routes in the treatment of aphasia seems to be of importance. Similarly studies to evaluate its effectiveness by comparison with no treatment or alternative procedures are needed before any conclusions can be drawn.

4.1.2.3 Visual Communication Therapy

Another recently developed procedure is visual communication therapy (Gardner, Zurif, Berry and Baker 1976). It is based on a system of communication using symbols to represent words. Patients are taught to recognise symbols and then to manipulate them so as to respond to a command, answer a question relative to the present moment and circumstances, describe actions at that moment and to express needs, wishes or other emotions of the moment. A large vocabulary is impossible, because of the large number of cards with symbols on which the patient would need to have available, the number and complexity of items that can be represented and the fact that many aphasics may have cognitive and perceptual impairments. Eight patients have been studied, five were able to carry out commands, answer questions and describe actions. Two were also able to use the system propositionally. As yet, this system of therapy has not been fully developed and so it is difficult to tell whether or not it will prove useful, though the evidence so far suggests that some severely aphasic patients can master the basics of an alternative symbol system.

4.1.2.4 Linguistically based treatment

Linguistic approaches have also been used as a basis for treatment with individual patients.

Ulatowska and Richardson (1974) investigated a deblocking technique to reintegrate the mechanisms for correlating sound and meaning. A 62 year old right handed man, dysphasic following a C.V.A., was seen three times a week for traditional language therapy. No major improvement occurred and so a deblocking technique was tried. The affected stimulus to be deblocked was the phonemic structure of words, by reorganization of the system via the visual recognition of words. Words and sequences of words were presented which the patient had to match to a picture, point to appropriate phrase or command, point to component of word on command, point to picture on command, listen to phrase read by clinican and answer simple questions. No expressive demands were placed on the patient. The authors conclude that the observed improvement in the patient, through stages explicable as the recovery of well-defined heirarchically dependent subcomponents of linguistic organization, supports the viability of the theoretical constructs of linguistics. It is however, difficult to differentiate the procedure used from that which might be used in speech therapy. The main differences seem to be in the basis for selecting material used in the treatment.

Another programme based on linguistic principles is that of Davies and Grunwell (1975). They treated a man who was dysphasic following two C.V.As and had received two years intensive traditional speech therapy. Four months further treatment produced no significant gain in ability on the Schuell MTDDA. Therefore a structured treatment programme was introduced. Substitution drills based on a linguistic assessment produced improvement in the availability and productivity of spontaneous language. Improvement occurred only on those areas on which therapy had been concentrated, with little or no recovery in other areas. The authors suggest this structured approach may be appropriate with certain selected patients, but again further investigations are needed.

4.1.3 Effectiveness of Speech Therapy

The various speech therapy techniques which have been developed need to be evaluated. Evaluation needs to cover the total treatment packages as well as the component parts which characterise various therapeutic approaches. It is necessary to determine whether speech therapy produces changes in patients other than those which may be produced by spontaneous recovery (see section 3.1).

Considering that speech therapy has been used in a clinical setting for many years, there have been relatively few attempts to evaluate its effectiveness as a treatment procedure. Of those that have been carried out there are serious weaknesses in experimental design, so that few conclusions can be drawn from these studies as a whole. However, the data that is available needs to be considered despite its inadequacies so that better evaluative studies may be designed.

4.1.3.1 Retrospective Studies

Butfield and Zangwill (1946) considered the problem of re-education in 70 aphasics. They reviewed the treatment effect of 63 cases of aphasia. These were divided into 2 groups, in one group re-education was begun less than 6 months after the onset of the disorder, and in the other more than 6 months post-onset. This latter group was intended to supply some measure of control for the influence of spontaneous recovery. This comparison was however, limited by the smaller number of patients in the control group, and the unspecified basis for beginning treatment later post-onset. Patients were assessed on the basis of careful individual examination and testing. Re-training was carried out by a speech therapist, who terminated treatment at a point when little or no practical disability remained or the language condition appeared stationary despite prolonged re-education. At this point psychological examination was repeated and ratings were also obtained from clinical staff and work in the speech therapy department. Over half of the re-education group were judged much improved and nearly one third of the control group judged much improved. Of the total group of aphasics, 46% were judged much improved, 31% improved and 23% unimproved. They suggested that the most favourable outcome was obtained with traumatic cases, those with relatively mild symptoms and predominantly executive symptoms. These results were obtained from a selected sample of patients, who represent 75% of the total number of cases referred for re-education. 25% were excluded on the basis of poor prognosis, gross defects of comprehension or complicating psychiatric symptoms. The exclusion of these patients would therefore have raised the proportion of patients improving over what might have been obtained with a random sample of patients.

Marks, Taylor and Rusk (1957) report on the effects of language therapy with 205 aphasic patients. Of these 94% had aphasia of non-traumatic aetiology and 64% were over 50 years of age. A 4 point rating scale indicated that improvement was excellent in 7%, good in 22%, fair in 21% and poor in 50%. This is lower than the Butfield and Zangwill study but these patients were mostly non-traumatic cases and as a group were older. The ratings were based on changes in functional level and diagnostic level determined by 3 speech therapists. The general conclusion reached from the study was that language retraining is often of significant functional value to the patient, despite the fact that 50% made poor improvement.

Speech therapy has also been used as a preventative procedure. Beyn and Shokhov-Trotskaya (1966) used speech therapy to prevent the development of telegraphic speech at a stage where speech was absent. The basic idea was that therapy should lay the foundations for the reconstruction of patients' inner speech. This was carried out with 25 patients who had motor aphasia as a result of a C.V.A. Telegraphic speech did not emerge in any of the patients treated, although agrammatisms occurred in 16 of the 25 patients. Beyn and Shokhov-Trotskaya consider that the development of telegraphic style was inevitable with these patients, and so speech therapy had prevented its development. However, there is no evidence to indicate that this was inevitable, or any control group against which the results obtained can be compared. This means that few conclusions on the effectiveness of therapy can be drawn from this study.

The above studies, apart from that of Butfield and Zangwill, have used little objective recording of language performance nor adequate control groups. A study which attempted to deal with these previous inadequacies was that of Vignolo (1964). He carried out a retrospective study on 69 patients who were tested at least twice on a standard examination for aphasia. Forty-two patients had received language rehabilitation, consisting of at least 20 sessions over 40 days with at least 1 session per week, and 27 patients were not re-educated. There was no significant difference between the two groups, although Vignolo reported a trend to greater improvement in the re-educated group. If those who were re-educated for more than 6 months are compared with those re-educated less than 6 months, then the frequency of improvement is significantly greater in the former group. This seems to indicate that training extending over at least 6 months is effective. Re-education was also found to be more effective if begun 2 to 6 months post-onset. However, the major problem with this study is the lack of random allocation to treatment or no treatment groups.

This study has been extended by Basso, Faglioni and Vignolo (1975) who have reviewed 185 aphasics, 91 re-educated and 94 not re-educated. These patients were assessed at least 6 months after initial assessment and the effect of various factors in improvement determined. Comparison of patients less than 2 months, 2 to 6 months and more than 6 months post-onset showed a significant negative effect on improvement, so that those initially assessed latest improved least. This can presumably be attributed at least in part to the effects of spontaneous recovery. The presence of re-education was found to have a significant positive effect on improvement in oral expression. However, the allocation to re-education or not was not on a random basis but on the basis of social and geographic factors. It should also be noted that the non-reeducated group were significantly older than the re-educated group and this alone might account for differences found between the two groups. Even if there are significant differences between the re-educated and non re-educated groups, the proportion of patients improving with treatment is still relatively small. Thirty four re-educated aphasics improved, whereas 36 did not, despite treatment 3 or 4 times per week.

Thus the major problem with Vignolo's study (1964), lack of random allocation to groups, has been repeated in his subsequent (1975) study and so the problem with interpretation of the results remains. Also the basis for stopping re-education was not specified. If re-education continued until patients stopped im proving, then it is not surprising that those who received longer treatment did better since these would have been selected on the basis of improving most.

4.1.3.2 Control Group Studies

The first major study to use a control group was that of Sarno, Silverman and Sands (1970). Thirty one post-stroke patients who were severely aphasic were randomly assigned to three treatment groups: programmed instruction, non-programmed speech therapy and no treatment. Results indicated that there were no significant differences between the groups at termination of treatment and one month later (for details see section 4.2.2.1.4). Although this study provides no support for speech therapy as effective, a selected group of patients was used, severe aphasics who have a generally poor prognosis.

Smith et al (1972) compared the progress of 80 treated aphasics with 15 aphasics who received no formal treatment. The untreated group was not randomly allocated but received no formal treatment because of poor health, dementia or evidence of diffuse bilateral damage (5 patients) or for personal and financial reasons (10 patients). The control group also had a higher mean age, lower mean education and more severe impairment of language and non-language functions than the treated group. He considered that the efficacy of therapy was reflected in a marked contrast between negligible changes in the mean language test scores of the untreated patients over a mean period of 23 months and marked improvement in all language functions of the patients who received therapy. He considered these results contradicted those obtained by Sarno et al (1970). However, since the control group was so biased towards non improvement, they provide no contra-indication at all. Darley (1972) in reviewing studies conducted, pointed out the lack of consistency in the data and suggested reasons why this should occur. The main problem is that there is so much variation between the populations sampled that it is impossible to make generalisations about aphasics as a group. Differences also occurred in studies in the nature of language disorders treated; the stage in the recovery process at which treatment was given; the measures of change used and the nature, intensity and duration of the treatment. These factors all need to be controlled in any adequate study to evaluate the effectiveness of speech therapy. Darley presented other variables which need to be considered: age of patient at onset of aphasia; educational level, social status and prior language status; health during recovery; social milieu of patient; intelligence; aetiology, site and extent of lesion; time between onset of aphasia and institution of therapy; severity and character of the aphasia and non-language behaviour characteristics.

Hagen (1973) controlled for some of these factors by taking a highly selected sample of patients. He selected 20 male stroke patients age 49 - 57 years on the basis of aetiology, handedness, severity of aphasia and time post onset. They were divided into two groups; ten received communication therapy for one year and ten patients received all hospital services except communication therapy. The communication therapy programme consisted of individual, group and programmed independent therapy. Results gave strong evidence that, for this type of patient, recovery in communication ability was a result of communication therapy rather than spontaneous recovery. Spontaneous recovery accounted for slight changes in communication abilities during the first six months post-onset. However, it did not always produce improvement to a functional level. This study provides good support that communication therapy is effective for a selected group of patients. The communication therapy received was probably more intensive than is characteristic of most hospital units and lasted for longer, that is, one year. However, it does indicate that given intensive therapy, communication abilities can be improved to a greater extent than is achieved by spontaneous recovery alone.

An alternative to using a control group to allow for the effects of spontaneous recovery is to treat patients who are long term aphasics. Broida (1977) treated 14 patients age 43 - 79 years who were 1 to 6 years post-onset of aphasia. Treatment was given for 50 minutes 3 to 5 times per week. She reports that all 14 patients improved in at least one aspect of their communication ability. The mean overall PICA percentile increased from 60 to 71% after 2 to 21 months. Four patients were included who had previously been tested and these showed no improvement before speech therapy began, but all improved markedly when treatment was resumed. The amount of treatment was not related to the amount of improvement shown over a specified period. This might have provided a more valuable indication of whether the effect was specific to speech therapy. The question also arises to how far the gains made were a result of speech therapy rather than an attention placebo effect of renewed interest in the patient and expectation of further change.

Darley reports a study by Perry (1972) who solved the control group problem by comparing aphasic difference scores on the Peabody Picture Vocabulary test for successive therapy periods, 20 to 30 days of therapy at least 3 times per week, with a theoretical rate of spontaneous recovery. Culton (1969) showed decreasing difference scores from one test to another, and so Perry reasoned that if therapy produced equal or increasing differences over two or more successive therapy periods then language therapy could be assumed to be having an effect. Of the 50 patients tested, more than half displayed patterns of successive difference scores which indicated language training had a unique influence on their spoken language comprehension.

There are obviously considerable difficulties in designing an experiment to take account of all relevant factors. Hopkins (1975) suggests that it could be done on a national basis by a large co-ordinated team of speech therapists, psychologists and physicians. However, in practical terms, this would be very difficult, if not impossible.

Enderby and David (1976) have proposed a study to evaluate speech therapy for acquired aphasia by comparing it with stimulation by untrained volunteers. Because of the large numbers of aphasics required, the study is to be carried out by 15 different centres co-ordinated by a speech therapist. If this proves practical and reliable assessment procedures are used, then further studies of this nature might be attempted.

The recent trend has therefore been for more restricted studies on selected aphasic problems with more carefully selected groups of patients. This is easier to carry out and conclusions can be drawn from the results, but these conclusions are very specific, and cannot necessarily be generalized to other aphasic problems.

4.1.3.3. Treatment of Selected Problems

Weigl-Crump and Koenigsknicht (1973) carried out a study on word retrieval deficits characteristic of amnesic aphasia. Four adult aphasic patients were drilled over 18 sessions on 20 out of 40 words that a patient failed to retrieve on a pre-therapy confrontation naming test. No work was devoted to the other 20 words. After 6 sessions the patient was tested on the 20 drilled and 20 non-drilled words. All showed improvement but this was significant on drilled words. This indicated that therapy was an effective mechanism for improving the retrieval process. This study is dealing with a selected problem and, possibly as a result of this, includes only a small number of patients. However it does offer some support that therapy does have some positive effect on word retrieval skills. The nature of the therapy is probably rather different from typical speech therapy for word retrieval skills as given by most speech therapists. More studies dealing with selected communication problems, might be a more feasible way of evaluating speech therapy in general than the type of nationwide evaluation proposed by Hopkins (1975).

Another consideration is that speech therapy is not a constant or static activity. It is being continuously modified and developed. The drilling technique of Weigl-Crump and Koenigsknicht has many features in common with speech therapy, such as multimodal stimulation and cueing, but could probably also be conceptualized in a learning theory framework.

4.1.4 Conclusions

Speech therapy is therefore not a unified system of treatment and until some standardization of procedures used has evolved, then evaluation will be difficult. The converse is also true, that development of speech therapy is likely to be based on the findings of evaluative studies. It seems that control group studies using attention placebo treatments cannot be avoided. There should be no ethical problem withholding speech therapy since there is very little evidence that it has a significant effect on recovery. Until these studies have been done the development of techniques for treating aphasics may be hampered by redundant and ineffective use of therapist time.

4.2 Operant training

The procedures included in this review as operant training are those based on operant conditioning principles. In some cases this is a very explicit application of the principles, as in the use of programmed instruction, in other examples the theoretical foundation is more implicit, as in the use of stimulus repetition by Helmick and Wipplinger (1975). However, various basic features of operant conditioning are included in all the procedures.

4.2.1 Operant Conditioning

4.2.1.1 Theoretical basis

Operant conditioning is based on the pioneering theoretical and experimental work of B.F. Skinner. It involves an experimental analysis of the ways in which behaviour emitted may be a function of environmental events. Consequences of a behaviour 'feed back' into the organism and they may change the probability that the behaviour which produced them will occur again. When a particular response is followed by a positively reinforcing consequence, it increases the likelihood that the response will be repeated on subsequent occasions. The strengthening of behaviour which results from reinforcement is termed conditioning.

Reinforcers are those events which, when made contingent on a response, change the frequency of the response. These may consist of presenting stimuli, such as food or water, or removing stimuli, such as loud noise or shock, from the situation. A survey of events which reinforce a given individual is often required in the practical application of operant conditioning.

By reinforcement of a series of successive approximations to a given response, a rare response can be brought to a very high probability. Besides producing new units of behaviour, selective reinforcement may bring about increased effectiveness of existing units of behaviour, as occurs in the learning of skills. Once a skill has been acquired, operant conditioning continues to be effective even when there is no change occurring. Behaviour continues to have consequences and these continue to be important. If these consequences are not forthcoming extinction occurs. For example, if feedback of performance is no longer available the skill may be lost.

Most operant behaviour acquires important connections with the surrounding world. Operant behaviour comes under stimulus control. Other associated stimuli may also be effective producing generalization of control, alternatively discrimination may be sharpened so that the control is very specific to certain stimuli.

Behaviour which is followed by an unpleasant stimulus produces a decrease in the probability that the behaviour will occur on subsequent occasions. This unpleasant stimulus may involve the presentation of aversive stimuli, such as shock, or the removal of a pleasant stimulus. Punishment causes suppression of behaviour when it is introduced but when punishment contingencies are removed the behaviour reappears.

These basic concepts have mainly been investigated by experimentalists with infra-human subjects. The reason is that greater control of experimental conditions, such as previous experiences of subjects and environmental variation, is possible, repetitive routines can be carried out and experimental bias and errors of detail kept to a minimum.

Once studies are extended to human subjects such conditions cannot be met. When these subjects are also hospital patients further limitations on experimental procedures also occur.

4.2.1.2 Application of operant conditioning to clinical problems

The operant paradigm has been used as a basis for many treatment programmes in the clinical field. Often, due to ethical and practical considerations, the model cannot be applied with the precision that is used in the laboratory setting (Dinsmoor 1966). Many of these discrepancies are acknowledged and considered unavoidable consequences of using this theoretical model as a basis of treatment. However, the basic principles are applied and in many cases with apparent success. Therapeutic interventions arrange contingent behavioural consequences, including rewards and punishments, in order to alter undesired behaviours or to alter behavioural deficiences.

The most commonly used contingency is that of reinforcement following a particular desired response in order to increase the probability of that response. Immediacy of reinforcement is considered important (Skinner 1953) yet in many clinical settings it is difficult to achieve. In a verbal conditioning situation a patient may complete a desired utterance and immediately follow it by a comment or hesitate in such a manner that it is not clear whether he has finished saying what he intended saying. Reinforcement may for these reasons be delayed for a few seconds. Brookshire (1971b) has shown that aphasics are sensitive to delays of reinforcement of 1 and 2 seconds and such delays may slow down the rate of learning.

Reinforcers should be demonstrated as effective for a particular patient before they can be considered as reinforcers. In many situations attention, praise or feedback of progress are assumed to act as reinforcers, but unless stable baselines can be obtained their effectiveness cannot always be demonstrated. If a patient is showing physical recovery as well as receiving attention contingent on improved performance, it is not possible to determine which factor is producing the improvement. Removal of a reinforcer may not always bring about reversal of behaviour rates to those of baseline conditions. If a patient has been trained using praise and cigarettes as reinforcers for learning to dress, it is unlikely that when the contingencies are removed, the patient will lose the skill that he has acquired. In many situations the reinforcing properties of various stimuli have to be assumed.

There is also a limit to the range of reinforcers that can be used. If a rat is deprived of food it is likely that food can then be used as a reinforcer. Such deprivation procedures are not possible when dealing with hospital patients. If access to a given reinforcer cannot be controlled then it is inappropriate to use it to train certain skills. For example, if patients can obtain cigarettes and sweets freely, then these are unlikely to be powerful enough reinforcers to effect much behaviour change. Many patients reject material reinforcements as appropriate only to children, and so great emphasis has to be placed on social reinforcement. Attention and praise are often more acceptable to patients, but may be less effective.

Social reinforcement is also only likely to be available on a partial reinforcement schedule. Social reinforcement will be given in many social situations by nurses, therapists and relatives. Much of this is likely to be on a non-contingent basis. This partial reinforcement is likely to include behaviours that are being trained as well as those incompatible with those being trained. A patient with language problems may be asked a difficult question and be reinforced when he cannot answer it. Other times he will be reinforced for providing an answer. Reinforcement will be given to the patient for struggling to find words and for asking assistance, so that these will be unlikely to extinguish. The partial reinforcement schedule therefore may slow down the process of behaviour change. However, it is hoped that once established the behaviours acquired will be more resistant to extinction. If a patient spends a high proportion of his time in situations where the desired contingencies are not operating, then he may only acquire more undesired behaviour patterns.

This can to some extent be avoided by using principles of generalisation and stimulus control. Behaviours which are required only in specific situations should be reinforced only in those situations. Using gesture to communicate may be acceptable when a patient is learning to do his own shopping in a supermarket, but may not be acceptable during a speech therapy session to improve verbal language skills. Verbal behaviours are required in interaction with everyone in the patients' environment. Reinforcement should therefore be given by a large variety of people for certain carefully specified verbal behaviours.

Shaping procedures are used to establish a variety of behaviours, for example, dressing and verbal conversation. Outside the treatment situation requirements may be increased in large steps, for instance, a patient home for the weekend may be expected by his wife to dress completely without assistance, whereas in the rehabilitation unit during the week he had been dressing with verbal prompting. Token reinforcement is often used to overcome the problem of providing immediate reinforcement and for practical convenience. This may operate as a conditioned reinforcer, as tokens are subsequently exchanged for material rewards. Alternatively, as Brookshire (1973) suggests, they may just serve a feedback rather than an incentive function. They may provide an indication of the correctness or incorrectness of a response and no exchange system may be necessary.

The use of negative reinforcement, removal of an aversive stimulus or presentation of punishment, is rarely used in clinical practice. It has not been demonstrated as a particularly effective mechanism of behaviour change and ethical considerations are involved. Therefore undesired behaviours are usually eliminated by withdrawal of positive reinforcement or reinforcement of incompatible behaviours. However, feedback functions can be used to signal incorrect responses. Head shaking,"No" and removal of tokens or presentation of 'bad' tokens can indicate the incorrectness of a response without having sufficient aversive qualities to be considered unethical.

All these contingencies are dependent on a reliable procedure for eliciting the desired responses. It can be predicted that a hungry rat in a cage will engage in exploratory behaviour and so be likely to press a lever placed on the side of the cage. In various clinical settings it may be more difficult to ensure that the desired responses are likely to occur. However, verbal prompting can be used with most patients and they can be told the contingencies that are operating. Alternatively if they are unable to understand verbal instructions, it may be possible to demonstrate the contingencies.

The experimental studies aim to use animals with no previous experience which might influence their behaviour and no special biological propensities in order to investigate the effects of reinforcement contingencies. The influence of this previous experience may have an important contribution to make and evolution may have made certain contingencies easier to learn about, more difficult to forget, and more readily generalizable. Seligman (1972) has put forward an alternative to the equipotentiality premise, that by using arbitrary contingencies, features of behaviour general to real-life instrumental learning will be obtained. He suggests that the laws of learning might vary from one class of situations to another with the preparedness of the animal. The preparedness will be produced if evolution has affected the associability of specific events. He considers that general process -learning theorists may have discovered only a subset of the laws of learning: the laws of learning about arbitrarily arranged events. The relative preparedness of an animal for learning about a contingency is defined by how degraded the input can be before that output reliably occurs which means that learning has taken place. Differences in preparedness can account for some contingencies being better learned that others. For example, rats have trouble learning to press a bar to avoid but will learn to jump up to avoid in one trial (Baun 1966), due to differences in the preparedness of the rat for the particular contingencies.

Seligman uses the preparedness concept to account for the development of phobias. He suggests that prepared learning provides a better fit with phobias than unprepared learning because the evidence suggests that it can be acquired in one trial, is selective, is resistant to extinction and may be non-cognitive. Similarly it may be that clinical populations are prepared for stimuli indicating progress towards recovery and therefore the contingencies used in training may be less rigorously defined than in animal experimental studies.

The practical application of operant conditioning to deal with clinical problems often involves rather less rigorous control of contingencies and environmental control than experimental laboratory work. However, many behaviour problems have been demonstrated to be amenable to treatment programmes based on the operant paradigm. Increased effectiveness of training may be achieved by more rigorous application of the basic principles, but this may not be practically possible. A compromise therefore has to be reached between the ideal, as determined by animal experimental work and the practically feasible, as determined by experience in clinical settings. Although often improvements can be made to clinical work as more information is gained from animal experimental work, it is unlikely that in the clinical setting the same precise contingency management will be possible. If Seligman's ideas of preparedness can be accepted then this may not be important. However, the clinical application of operant conditioning is unlikely to be a fruitless exercise if techniques can be developed and evaluated and found to be of practical benefit.

4.2.2 Operant Techniques in Language Rehabilitation

Operant principles have been applied to the speech therapy situation both in general terms and in the development of specific treatment techniques.

In general terms, behaviour modification may be applied to patient-therapist interactions; to establishing or increasing language behaviours; to promoting generalisation from the therapy situation; and to managing of behaviours, other than verbal, which may be relevant to the therapy setting. An early application of general learning principles was by Shelton, Arndt and Miller (1961). They related various principles of learning, such as motivation, imitation and insight to the teaching of speech and language in a group therapy situation. More recent papers have been specifically concerned with the application of operant conditioning (Holland 1967, Brookshire 1967 and McReynolds 1970). These papers deal with procedures to increase certain classes of behaviour, such as reinforcement and shaping, and to decrease maladaptive behaviours such as extinction, reinforcement of incompatible behaviours and presentation of aversive consequences.

The application of these learning principles to the therapy situation has led to the development of specific techniques. These are based on operant conditioning, but may take various forms according to the type of problem to which they are applied. Two main techniques have been developed for use in the rehabilitation of aphasics, programmed instruction and verbal conditioning. These have developed in parallel and may be used on their own or in combination with each other.

4.2.2.1 Programmed Instruction and Teaching Machines

The use of programmed instruction developed from its application to other clinical problems, for example training subnormal patients. It has several features which makes it particularly useful in the training of aphasic patients.

It can be designed to circumvent the necessity for explicit verbal instructions. Pretraining sessions can be used to shape up the requisite response behaviour, such as matching to sample (Filby and Edwards 1963, Rosenberg 1965). The situation is highly reliable, standardised and distractions are minimized (Rosenberg 1965). This means that the clinical situation is minimally threatening, which Filby and Edwards consider is important. Subjects' responses are recorded continuously and objectively (Rosenberg 1965) and this provides built-in guards against ineffective teaching (Costello 1977). It also provides as much repetition as is necessary and as slowly as is necessary; this infinite patience produces a great saving in terms of therapists' time. Precise reinforcement contingencies necessary for optimum learning are provided, such as immediate reinforcement, gradual progression, self-pacing and correct response before proceeding to subsequent items (Filby and Edwards 1963).

It may be used with aphasics with a wide range of impairment in both speech and general behaviour (Filby and Edwards 1963). However, the programmes have to be very carefully written, based on careful analysis of the task. Costello gives examples of programmes which have not been adequately designed and consequently are unlikely to be effective.

Various aspects of aphasics performance have been treated using programmed instruction.

4.2.2.1.1 <u>Form Discrimination training</u>

One of the first problems to be tackled with aphasics using these methods was the testing and teaching of form discrimination. Filby and Edwards (1963) used programmed instruction with 10 patients classified as aphasic by ward physicians and the Sklar test for Aphasia and who completed a pretraining on a matching to sample task. The programme consisted of random forms which had to be matched to one of two comparison stimuli. Reinforcement consisted of a display of coloured lights. No significant difference occurred between the aphasic and control groups, but both groups showed a gradual increase in errors, indicating that the programme became progressively more difficult. Filby and Edwards concluded that under the optimal learning conditions provided by the automated teaching situation, even severely damaged patients are able to perform fairly well.

Rosenberg and Edwards (1964) found differences between aphasics and controls on a perceptual discrimination task. Five aphasic patients and five non-brain damaged controls were given the same matching to sample task as used by Filby and Edwards. They were then given discrimination programmes utilizing the variables of shape, based on those necessary to form English capital letters, orientation and transition from solid form to outline figure. Results indicated that on pretests, aphasics have greater latencies and make more errors than controls on shape, orientation and line programmes. Using training programmes, it is possible to train aphasics, such that these latencies and errors are decreased and the improvement is maintained for at least a week following training. These results are interpreted as indicating that the automated training method provides a fruitful means of investigating and training perceptual discrimination. They assume that if these skills are developed there will be a concomitant improvement in reading ability.

Rosenberg (1965) followed up this work in further detail with 24 aphasics who were trained in a matching to sample task. Half the aphasics were assigned to a true training group and were trained on the two programmes on which they had most difficulty. Half were trained on the two programmes on which they had least difficulty. Training programmes were effective in improving latency of response, which was maintained for at least a week after training. The discrimination training also transferred to verbal test items. Latency was used as the dependent varible as it had shown to be a more sensitive measure than error by Rosenberg and Edwards. This finding may also account for the failure of Filby and Edwards to find differences between aphasics and controls, since they used error as their dependent variable.

In Rosenberg's study (1965) the false training group showed less improvement with training and less transfer. This finding is contrary to ideas presented by speech therapists (Schuell 1964) that treatment should begin where a patient needs it least and progress to tasks on which they have greater difficulty, need it most.

The primer programme used by Filby and Edwards and Rosenberg and Edwards to train severe aphasics to respond differentially in a reliable fashion to visual stimuli has been gradually improved, until, as reported by Edwards (1965), it has been shown to be quite effective. Edwards trained more than 100 aphasics with this programme, with only 4 or 5 failures. Those patients who failed also displayed severe organic psychoses. The programme can therefore be used as a training procedure, and may be followed by a transition programme to any programme in the field of visual discrimination.

These programmes were intended to be a preliminary stage to developing training programmes to teach verbal skills to aphasic patients. However, as far as is known the results of this work have not been reported, nor whether it was ever developed as intended. However, other workers have developed similar tenhniques based on teaching machines and used them to train aphasics in verbal skills.

4.2.2.1.2 Verbal Skills

Keenan (1966) used the Language Master to train patients to name specific pictures in speech and writing. Keenan prepared cards of pictures and printed words. These were used as stimuli for nine related tasks, graded in order of difficulty, such as identification of referrents based on spoken or printed word and recall of spoken or printed words. Keenan reports that these programmes, used with a limited number of patients, have resulted in satisfactory progress, though he presents no quantitative evidence to support this claim. He also reports that patients liked this approach and worked on tasks with little or no urging. The problem with this flexible type of programming is that its effectiveness will be largely determined by the skill of the clinician involved. It is also difficult to ensure the low error rate and gradual progression which are essential features of programmed instruction.

Both the Language Master (Bell and Howell) and the equipment used by Edwards and Rosenberg are expensive and not generally available in speech training centres. Their application is of great theoretical and potential practical importance, but until widely accepted, it is not likely to be of great practical importance in most clinical settings. Keith and Darley (1967) have developed a teachihg machine which is less sophisticated than the ones mentioned, but could be of practical use to many clinicians since it is inexpensive and easily constructed. This teaching machine is a 'specific electric board', with which pairs of stimuli may be presented for matching. Reinforcement is given by means of a light, which comes on when the responses supplied are correct. The board may be programmed with different stimulus and response cards according to the level of difficulty required and the type of material to be presented. This teaching machine presents items in a predetermined sequence, permits the patient to respond and gives immediate feedback on the correctness of the response. The rate of progresssion and the order of tasks given has to be determined by the clinician. Hence the problem of variability according to the skill of the clinician arises. No details of any attempts to evaluate the use of this procedure have been reported as yet. If this can be used as an effective training procedure then it seems to be of potential use, not only to speech therapists, but also to occupational therapists, volunteer workers and relatives. The preparation of material however, needs to be carried out by a trained clinician.

More elaborate teaching machine methods have been used with programmes written to suit individual patient requirements. Holland

and Harris (1968) have developed programmes for less severely impaired aphasics. One series was for a 23 year old dysphasic male Ph.D student. His language rehabilitation was carried out almost entirely by programmed instruction. Therapy consisted of 5 hours a week programmed instruction in the clinic, 10 hours a week at home, and 2 hours a week group therapy over a period of 8 months. Programmes were written to cover a variety of tasks, such as relations between objects, repetition, auditory memory span and spelling. Pre and post-therapy evaluations, indicated increased variety in conversational speech, with less constricted vocabulary and less stereotyped length of conversational response. Tests of the MTDDA improved and comparison of pre and post-programme tests for specific programmes also indicated improvement. From this single case study Holland and Harris conclude that programmed instruction is a potentially useful tool to aid recovery from aphasia. They consider that the important features are the step-by-step analysis of the training procedure, the excellent therapeutic climate generated by patients observing their own progress and the economy of time once the initial programmes have been developed. Holland (1970) reports using these programmes with other patients. The extent to which these are successful will probably be a more realistic appraisal of the procedure than the single case study. In this study the patient involved would have been expected to make a good recovery, since he was young, intelligent, well motivated, his aphasia was of recent onset and treatment was commenced early post-onset. There is no means of assessing how much he would have improved spontaneously or with traditional speech therapy. Therapy was also very intensive, i.e. 17 hours per week, over a period of 8 months, which is also atypical and may account for some of his marked recovery. The use of programmed instruction at home is an important aspect of this study, since, if effective, this could be used to increase the intensity of treatment without making additional demands on the therapists' time.

Therefore, although it is interesting to note that programmed instruction can be used virtually exclusively to rehabilitate an aphasic's language, it is difficult to assess from this study the factors which account for the patient's improvement. Differences in pre- and post-programme score may be directly attributable to the programme itself but difference in conversation skills and MTDDA performance could equally be due to spontaneous recovery or general language stimulation.

Programmed instruction techniques mentioned so far have been based on the use of teaching machines of various degrees of complexity.

However, these are not strictly necessary and it may be appropriate to present certain tasks in written form on cards or verbally by the therapist. The presence or absence of a therapist has been suggested by Peterson and Butt (1972) to be a crucial factor in an automated programme. If this is the case, the automation may serve to assist the therapist rather than replace the therapist.

4.2.2.1.3 Programmed Therapy

Holland (1970) has used a combination of teaching machines for some tasks and direct work with the patient for others. Programmes were planned individually according to the patients' personal requirements and designed to train skills, such as self-cueing by writing, syntax, naming, reading comprehension, numbers, prepositions and spelling. An attempt was also made to apply shaping and reinforcement procedures to direct language work in a group setting. Each patient worked to score a number of points related to his own level of competence. According to Holland the group was well attended and the subjective evaluation by both patients and clinicians was positive. However, no evaluation was made of the amount of improvement obtained by this group. The experience suggested that group work directly focussed on language was feasible and practical, though further evaluation needs to be carried out.

Another study by Holland (Holland and Sonderman 1974) investigated the effects of a programme based on the token test for teaching comprehension skills. Twenty four aphasics were assessed on the token test and 4 subtests of the MTDDA. The training procedure was based on initial TT performance and aimed to improve performance by a graded series of items based on the TT. Verbal reinforcement was given for correct performance and when 80% of each section had been completed correctly the next programme section was begun. Mild to moderate aphasics showed significant improvement, while moderate to severely aphasic patients did not. There was no transfer of language skills acquired in therapy to similar untrained tasks.

The individual programmes designed have covered a wide range of skills for patients at various levels of ability. This is a time consuming process, particularly because of the large amount of individualization necessary, though it became less time consuming once the basic techniques were established. Designing programmes for aphasics meets with various problems. One is the difficulty of obtaining an error rate as low as 10%, another is that back-up procedures following incorrect responses become confusing to aphasic patients since the sense of total forward progression tends to become lost.

Holland suggests that clinicians should design their own programmed material rather than use programmes developed by others. This is based on the need for the clinician to fully understand the principles of programming involved rather than any lack of generalization of programmes from one patient to another. Naeser (1975) developed a structured approach to teaching aphasics basic sentence types as a possible future part of programmed language rehabilitation similar to that suggested by Holland (1970). Three basic sentence types, i.e. verb form to be, verb transitive and verb in-transitive, were represented pictorially. Four aphasics were given 3 half-hour therapy sessions per week for 4 weeks. All improved significantly at post-test in production of the 3 sentence types, but PICA scores remained the same. Naeser was unable to obtain a control group and so results are difficult to evaluate. However, she does conclude that the results are encouraging.

Further developments of programmed therapy have continued. Bollinger and Stout (1976) have employed response contingent small step treatment with a variety of brain injured communication disturbed patients. It is quantitative, structured and directed by patients' responses to stimuli presented, but differs from the operant approach by emphasizing structure and manipulation of the antecedent event rather than shaping behaviour through selective reinforcement of responses. However, feedback of correctness of responses, by 'yes' 'no' or 'good', is given by the clinician as appropriate. Bollinger and Stout conceptualise this feedback as a method for increasing response awareness rather than as reinforcement. It seems difficult to separate the two since the former is likely to increase the probability of that behaviour on subsequent occasions and so would be consistent with such a definition of reinforcement. Bollinger and Stout present treatment forms illustrating their approach but no data on patients to indicate its effectiveness.

A similar programme has been developed by La Pointe (1977). This incorporates some procedures of both operant training and speech therapy. Baselines are established on the PICA and then 10 items are given for 10 sessions on tasks specified, 3 or 4 tasks being given at each session. Once performance is 90% for 3 consecutive sessions then the task is changed. La Pointe presents illustrative case histories which suggest that the technique is useful. The reasons he gives are that stimulus control is emphasized, so that tasks are defined and more clearly specified; performance is scored so that change can be noted on a session-by-session basis and this performance change can be plotted graphically and used as a reinforcer. It is also adaptable to time series designs which La Pointe advocates as a potential medium for evaluating the efficacy of therapeutic intervention.

These latter two studies suggest that programmed instruction is likely to be further developed as a rehabilitation technique with dysphasic patients. It has already been found to be useful in training aphasics in certain language skills. However, as yet there has been little evaluation of its effectiveness or comparison with alternative treatment procedures.

4.2.2.1.4 Evaluation of Programmed Instruction

One major study has been carried out to evaluate the effectiveness of programmed instruction. Taylor and Sands (1965), in a pilot study, used programmed instruction techniques for patients who did not seem to have gained any recovery of language with non-programmed speech therapy. Over a period of a year 26 different programmes were designed and administered to a group of severely impaired aphasic patients and analysis of results strongly suggested that programmed instruction facilitated language recovery in a severely impaired aphasic population.

Sarno and Sands (1970) used programmed instruction with 25 global aphasic patients who had failed in speech therapy. These patients were right handed native English speakers and had a C.V.A. producing a right hemiplegia. All were severely aphasic, scoring less than 15% on the FCP. Treatment consisted of a graded series of programmes involving imitation, visual matching, writing, auditory comprehension and speech, given 5 times per week for 30 minutes over an average period of three months. The results were that 21 of 25 patients achieved at least one of the goals of the programmes, all learned to trace and copy geometric forms and some ultimately to copy words. The general effects of the programme were to increase awareness of errors as rated by the therapists and those who received programmed instruction seemed to retain skills for longer than those treated by traditional techniques. On the basis of the success of these programmes a controlled study was developed to evaluate three treatments for severe aphasics.

Sarno, Silverman and Sands (1970) investigated whether programmed instruction enhances recovery in severe expressive-receptive aphasics. Thirty one severely aphasic patients who were more than 3 months post C.V.A. were assigned between three groups; programmed instruction, non-programmed speech therapy and an untreated control group. This was not a random allocation due to the varied location of the patients and limitations on the availability of the various clinicians concerned.

However, all groups were found to be equivalent with respect to age, symptom duration, FCP score, previous speech therapy, total time on programme and number of treatment sessions. Assessment was carried out pre-and post-treatment using the FCP and 10 tests corresponding to the experimental tasks. The programmed instruction consisted of 11 programmes given in hierarchical order of difficulty. The non-programmed instruction consisted of work directly with a speech clinician, who had been told the vocabulary to be taught in each modality and an explanation of the behaviours to be learned. The control group did not receive treatment.

The two treatment groups received 80 half-hour sessions or were treated until the programmes were completed, whichever criterion was met first. Treatment ranged from 4 to 36 weeks, the number of sessions from 13 to 91.

The results gave no significant differences between treatments at the end of treatment, for change scores on seven of the ten tests. On the three visual recognition tasks significant differences occurred. These indicated that non-programmed therapy was significantly better than no treatment for matching pictures and words and matching words, and better than programmed therapy for matching words. No significant differences occurred between the two treated groups after therapy for each terminal behaviour, or at one month after the end of therapy.

The authors concluded that there was no support for the hypotheses that aphasics can learn, or that programmed instruction is an effective means for teaching them. Sarno et al suggest that speech therapy, of either type, did not affect language recovery in this study, due to the severity of the aphasia in these patients. This supports data on prognostic indicators (see section 3.2.2.) that severe aphasic stroke patients show poor recovery,

Darley (1972) points out that in the hands of a trained clinician, the FCP provides quantification, in percentages, of the patients' ability to function in a variety of language activities of daily life. However, he suggests that the PICA might have been a better assessment as it covers a wide range of specific abilities. There is also evidence to suggest that the FCP is measuring different language behaviours from most aphasia batteries. Sarno, Sarno and Levita (1971) compared the FCP with the Neurosensory Centre Comprehension Examination for Aphasia (NCCEA) and found that as measures of change they did not correlate and there was therefore a difference in what the tests were measuring. Thus, while the ultimate goal of therapy is for a functional improvement in communication, if Sarno. Silverman and Sands (1970) had included an objective measure of communication ability, they could have assessed whether changes, though not functional, were occurring. If a functional improvement in therapy is required then functional speech should be used as the basis for therapy. However, if communication ability is being trained then it would seem reasonable to test communication ability. Any measure of functional communication following training in communication ability will be a measure of generalization of training rather than a direct assessment of how much has been learned.

Darley also suggests that measures of general intellectual functioning should be included. Intellectual functioning may have been altered by the treatment procedures used, without any noticeable gains in functional speech. Although functional speech is of ultimate importance, it may be an unrealistic goal with many patients, and an improvement in general intellectual functioning may be all that is achieved for many. It also may be an early aspect of change with recovery, and may later be followed by improvement in functional abilities.

Another factor which may account for the lack of improvement with therapy is the age of the patients. Although there were no differences in age between the groups, the inclusion of geriatric stroke patients may have reduced any group differences which might have occurred. The age range of the patients was 46 to 83 with medians of the 3 groups about 64 years. Therefore many patients were from the geriatric population, which is generally considered unlikely to benefit from speech therapy (see section 3.2.3). Many of these elderly patients may also have deteriorated due to minor disturbances in cerebral circulation or sub-clinical strokes, which would have reduced any improvement obtained. However, as Sarno points out, the majority of aphasic stroke patients are in this age group and so the study is of practical relevance because it includes these patients.

Darley stresses that it is impossible to generalize from the conclusions of this study to groups of patients different in any of several aspects. Relevant variables to be considered are age at onset of aphasia, educational level, social status, prior language status, intelligence, health during recovery, social milieu, aetiology of aphasia, site and extent of lesion, time between onset of aphasia and institution of therapy, the aphasia itself and non-language behaviour characteristics (see section 3.2).

Some of these variables were also considered important by Hopkins (1975) who criticizes the lack of attempt to match the groups for site and size of lesion, premorbid intelligence or linguistic competence, or environment after the stroke. However, since the improvements obtained were minimal, he concedes that even if this had been done, differences may not have occurred.

Some patients received very different amounts of treatment over different periods of time. Reasons are not given why these differences occurred in each case, though generally stated as being due to the number of terminal behaviours to be taught, inability of some patients to complete the series, and the number of sessions available per week. Although no differences occurred between the groups with respect to the amount of treatment received, it may have acted to limit the amount of improvement obtained. Patients who completed the programmes quickly would receive fewer treatment sessions, those who had greatest difficulty would receive the most treatment. This would act to reduce the mean improvement of the group. Refusal to continue and discharge from hospital seem more likely to occur in patients who are slightly less impaired and so would reduce the number of sessions they received, whereas death might be more likely in the more severely impaired. However, no details are given of the numbers of patients receiving less treatment and the reasons for this.

The conclusions that can be drawn from this study are that severely aphasic elderly patients do not show any evidence of ability to learn with treatment, and there is no difference between their response to programmed, non-programmed or no therapy, as measured by functional communication skills. Generalization from this group to young, or mildly or moderately aphasic patients, or recent aphasics, or traumatic aphasics is not necessarily possible. The effect of various treatments in these groups needs yet to be evaluated.

4.2.2.2 Verbal Conditioning

The verbal conditioning work has developed in parallel with programmed instruction.

Before any operant conditioning programme can be carried out effective reinforcers need to be available. This is particularly a problem when working with severe aphasics. An early study to evaluate the effectiveness of verbal reinforcement with aphasics was carried out by Stoicheff (1960). The speech behaviour of 42 aphasic subjects following 3 types of motivating instructions, encouraging, discouraging and non-evaluative was investigated. Results indicated that patients under discouraging instructions do significantly worse than those under encouraging instructions on naming and reading tasks. Stoicheff accounts for this in terms of anxiety. However, it does indicate that aphasics will respond differentially in terms of the reinforcing properties of the situation.

An early application of verbal reinforcement in therapy was by Bloom (1962). He used a group therapy situation with aphasics in which appropriate verbal behaviour in a functional situation was reinforced. For example, the greeting situation was recreated at the beginning of every session and the responses of 'hello', 'how are you' were produced contexually and rewarded by recognition and appropriate response from the audience. Therapy progressed to concepts, such as up-down, to situations, such as come in and sit down, and to conversation structured with appropriate verbal behaviour patterns, for example 'where is the book'? 'it is on the chair'. Reinforcement was continued after the appropriate verbal behaviour was acquired in order to maintain or increase the strength of response. The use of situations to strengthen verbal operants is stressed. The reported success of this approach was that many low level patients were able to show marked improvement after little or no gain through individual treatment. However, Bloom noted that a more comprehensive enquiry into this general rationale was required.

4.2.2.2.1 Production of Verbal Responses

More systematic use of verbal operant conditioning was introduced by Goodkin (1966). As part of a general study on the application of operant methodology to problems in rehabilitation, he included a programme to increase understandable and appropriate speech and decrease unintelligible and perseverative speech in a dysphasic patient. Mr. M. had a moderate to severe receptive and expressive dysphasia as a result of a C.V.A. He was making little progress in treatment and so a programme was designed to increase the frequency of understandable words and phrases that he would emit in response to relatively unstructured questions, and to decrease the frequency of both unintelligible and preseverative utterances. Each day the patient was asked a series of 10 open-ended questions, for example 'What kinds of things do you do outside classes' and 'Tell me something about New York City'. A base rate was recorded for 5 sessions, which was fairly consistent from day to day. From day 6 onwards, 5 of the questions were treated. Verbal reinforcement was given following good responses, utterances with one clearly distinguished word, and bad responses, perseverative utterances, were followed by the therapist shaking his head and not responding verbally. The remaining 5 questions received no gestural or verbal response from the experimenter. This procedure had very little effect on the patients' total performance and he did not perform differently under treated and untreated conditions. Following this, numerous other conditions were introduced on different days, for example different colour tokens being given for good and bad responses and modelling. These treatments produced an increase in good responses and a decrease in bad responses. There was no marked differentiation between responses to treated and responses to untreated questions, although bad responses to untreated questions decrease in frequency considerably later than bad responses to treated questions. This suggests that generalization of treatment effects may be operating between treated and untreated questions and that this effect is more marked for good responses than bad.

Although this study did not demonstrate that verbal conditioning alone modified an aphasic's language behaviour, it did demonstrate a potentially useful technique. The lack of treatment effect initially could have been that 7 sessions in 7 days is insufficient time for the procedure to produce consistent change. However, the addition of tokens to provide additional feedback, and the use of modelling and self-reinforcement techniques produced a change over a relatively short period of time.

Goodkin (1969) subsequently treated a 56 year old man who was dysphasic following a CVA 2 years previously. The patient, who had been dropped from his speech therapy class as he had ceased to make progress, was then seen 3 times a week for 30 minutes. In each session he was given one of 4 sets of open-ended questions, similar to those used by Goodkin (1966). Following base rate recordings, 5 questions were treated and 5 were ignored with respect to treatment. Once an improvement in one dimension of responding had stabilized and shown little change following a number of procedures, new response categories were selected and experimentally treated, for example words and phrases, sentences, unclear responses and perseverations. The procedures used included verbal reinforcement and punishment, modelling and delayed feedback. Results showed a marked overall increase in the number of words emitted, i.e. 46 to 102 average words/session, and decrease in unclear or perseverative utterances, i.e. 48 to 7 per session. Changes in the desired direction were also produced in a variety of other response categories, clear but irrelevant utterances, sentences and words not in sentences. The data suggests that some experimental treatments produced greater changes than others. The most effective treatments seemed to be self-punishment, modelling and delayed feedback. This conclusion was probably reached on the basis of observational interpretation of the results rather than a statistical analysis, but this is not clear. It is also difficult to determine which treatments are having which effect, since various combinations of treatments are used, for example modelling, self token reinforcement and punishment, delayed token reinforcement and punishment. It is also difficult to evaluate the effects of treatment combinations since many were given for as few as 3 sessions. This seems insufficient time for many treatment effects to become apparent and carry over of effects from one treatment to another are likely to occur.

One can conclude from this paper that the overall effect was to produce improvements in the target behaviours recorded, in functional communication ability, and in relatives and therapists reports. However, the contribution of each individual procedure has not been adequately evaluated.

The selection of dimensions of responding to be treatedwas based on clinical evaluation of the patients' language performance. Goodkin (1968) demonstrated that it is possible reliably to discriminate and record these categories and thus they can be treated separately. In this study 2 raters scored the verbal interactions of 22 patients and their spouses into 15 concurrent response categories. These included characteristic deficit areas in aphasic patients, such as word-production, sentence production, relevance, unclear and perseverative utterances. An overall product moment correlation (r = 0.98) was obtained between ratings of judges, which indicates that these categories can be reliably recorded by different judges.

In Goodkin's (1969) study the selection of response category to be treated was determined by the experimenter selecting the area of most apparent deficit. Goodkin points out that systematic programming research would be of value in determining the order in which dimensions of responding should receive attention and in evaluating what the goals should be at each level of a patient's programme.

The overall conclusions from these studies by Goodkin is that this operant training technique im proves the language behaviour of certain aphasic patients. It is however, not clear which aspects of the procedure are producing the effect. The use of single cases also means that no information is available on the extent to which this type of approach is applicable to aphasics in general. Goodkin has, however, done a further study which gives greater indication of the general applicability of the technique.

Goodkin, Diller and Shah (1973) trained spouses to improve the functional speech of aphasic patients. Twenty three aphasic patients and their spouses were selected on the ability to attend as out-patients over a period of 15 weeks. All had ceased to improve with speech therapy as measured by the FCP and most were at least 2 years post onset of their C.V.A. Seventeen aphasic-spouse pairs comprised the experimental group, for whom reinforcement and other procedures were contingent on target behaviours. Six aphasic-spouse pairs comprised the control group, who received a comparable amount of reinforcement but this was randomly given and not contingent of any particular class of behaviours. This control group made it possible to eliminate the effects of the experimenters' interest and spouses involvement in the treatment. The general treatment plan consisted of obtaining a full day's sample of talking behaviour between spouses at home, both before and after training, obtaining speech samples in a controlled setting, developing a system for analysing the talking behaviour of patient and spouse, teaching the spouse principles and techniques of behaviour modification and evaluating changes in the patient-spouse interaction resulting from training. The training consisted of obtaining base rates of speech samples in the laboratory using the same procedure as Goodkin (1966). Each spouse was then given an individual course in principles and techniques of behaviour modification. The spouse responses were then shaped, using feedback from the experimenter on how he was responding in relation to the goals set for him and the patient. The spouse was instructed to use verbal reinforcement, tokens, modelling and self-punishment. Each treatment was continued until the responses of each patient and spouse category stabilized. After a minimum of 15 sessions, new base rates were obtained in the laboratory and home setting, and these data were compared with pre-training base rate data.

The results indicated significant gains in functional speech after aphasics had been considered to have reached a 'plateau' in speech therapy. Significant changes in the desired direction were also produced in the spouses. The average gain in patient target behaviours was 14.9% and in spouse target behaviours was 11.9%. Control patients changed -4.4% and control spouses 3.01%. In the home setting changes were 12.5% for experimental group patients and 3.0% for experimental group spouses compared with 5.4% for control patients and -2.4% for control spouses. Patient changes therefore generalized significantly more to the home than spouse changes. The measure of functional speech, the median FCP, increased in the experimental group from 52.4% to 63.8%, whereas controls changed from 35.1% to 41%. This indicates that improvement occurred, but comparison of the two groups is limited by the fact that the experimental group started at a higher level than the control group. To assess whether gain was a function of the patients' verbal level prior to treatment, the six lowest level experimental subjects were compared with the control subjects. These increased in median FCP from 44.2% to 53.6% and every subject improved by at least 4.8% points whereas only one control subject increased by more than 1.3% points on the FCP. The changes in target behaviours were found to be significant for the experimental group, but not for the control group. However, there is still a difference between the two groups at initial testing.

The results further indicated that while target behaviours show most change in the desired direction, several other categories are simultaneously modified in the desired direction, so there is some generalization of effect of treatment.

This study indicates that this technique of training talking behaviour of aphasic patients can be used by spouses to train patients. This is an important finding since the spouse has more time with the patient than the speech therapist, and so can be used as a valuable supplemental therapist. Since the shortage of speech therapists means that many aphasics receive insufficient treatment, the situation could be partly alleviated by training the spouse to carry out certain training procedures, with the speech therapist in a supervisory role.

Goodkin et al suggest that the lack of success of other attempts at programmed instruction with aphasics was due to the lack of empirically determined workable reinforcers. Moderately or severely impaired aphasics have little awareness of their speech or little ability to comprehend the correct response when presented and so can make little use of feedback. Reinforcement must be presented in such a way that the patient can process. Using continuous recording techniques it is possible to determine for each patient which form of reinforcement can be used.

They also discuss whether the measured change obtained is truly significant. While significant changes in the prescribed direction occurred and subjective impression was that some patients made very noticeable gains, the degree to which a patients' speech deviated from normal speech was not objectively assessed. This, they state, was because no standards were then available against which speech of aphasics could be compared. This problem, they consider, arises in all attempts to evaluate treatment procedures for aphasic patients. Gains in ability may occur, but if they are of no practical value to the patient, then they are of academic interest only and do not warrant the vast amount of effort needed to produce them.

This work of Goodkin et al is of important practical significance.

It has shown that spouses can train aphasic patients. The procedures used have been demonstrated, by comparison with a control group, to produce changes in functional communication ability. It now seems important that the treatment be broken down to its component elements to determine which are important and which act as fillers to the total treatment package. Goodkin, in his various studies (1966, 1968, 1973), has used combinations of reinforcement procedures, for example verbal reinforcement, tokens, modelling and self-reinforcement, and has suggested that some may be more effective than others. However, no evaluation has been carried out to determine whether the effectiveness of different procedures is specific to the patient concerned. If certain procedures are generally more effective with certain groups of patients then it might be possible to improve on the treatment, by making it shorter, more effective and simpler to carry out, by omitting the other possible procedures.

Another aspect of the treatment package which needs to be considered is for whom it is appropriate. So far studies have used patients who have ceased to benefit from speech therapy. The improvement could then have occurred due to the change in approach used rather than due to the treatment itself. This seems unlikely since Goodkin et al obtained differences between experimental and control groups, both of which were receiving a treatment different from speech therapy. Most patients have been more than 2 years post-onset because of the requirement that they should have stabilized in their language abilities prior to commencing treatment. No investigation has so far been reported which has determined whether the procedure is appropriate for recent dysphasics. Spontaneous recovery is important at this stage (see section 3.1) and so any evaluation of the procedure would need to be by group comparisons rather than by measurement of pre- and post-training abilities.

The verbal conditioning studies mentioned above have been concerned with the treatment of general aspects of aphasics' language behaviours. For example, Goodkin (1966, 1968, 1973) has been concerned with the production of words, phrases and sentences, and whether they are clear, relevant and non-perseverative. More recently work has been done on specific aspects of the content of aphasics' speech.

4.2.2.2.2 Specific Speech Characteristics

Devine-Smith (1974) has applied operant conditioning techniques to modify the use of various syntactical constructions. The study aimed to determine whether patients could learn to use a particular part of speech which they did not use spontaneously. Two male aphasic patients, age 32 and 65 years, who were 6 years and 1 year post stroke were used as subjects. They were assessed on their ability to read, to recognise objects, and to arrange a set of 3 cards, consisting of 2 nouns naming the objects and a preposition naming spatial relationships between objects, for example, cup on book. The subjects were able to match objects and object names correctly but made errors on the card ordering task. They were then trained, using a 'loose operant conditioning paradigm' in the use of the four prepositions, and were able to perform the training task with a high degree of success. However, when given the object display and the 3 word sequencing task their performance had not substantially improved. A training procedure was then introduced which concentrated on the sequencing aspect of the task. This produced a statistically significant increase in the patients' ability to do the sequencing task. The results of this work suggested that operant conditioning techniques may be used to train patients with language problems. The extent to which this is a language problem, or a non-verbal mechanism, sequencing, is questionable. However, operant conditioning was used to teach a patient a particular language behaviour. No recording of generalization was provided so it is unclear whether the learning was specific to the task or generalized to other related tasks. It also is not clear whether the improved performance obtained resulted in a functional gain in the patients' communication ability.

The application of operant conditioning to deal with specific problems may be very useful with certain patients. Those patients who have particular areas of deficit, such as relations, plurals and verb tenses, may benefit from this type of training for their specific problem, but this type of circumscribed deficit is not common. A problem which arises is the difficulty of evaluating the approach, when few patients with similar specific circumscribed deficits in their language are available. A large number of patients would need to be given programmes of this kind before any general conclusions could be drawn.

4.2.2.2.3 Specific Treatment Procedures

An alternative to considering specific language deficits is to consider specific procedures in treatment programmes and to determine whether they have an effect on verbal behaviour. McDearmon and Potter (1975) considered the use of representational prompts, cues. These are generally used in speech therapy but in this study were conceptualized in terms of operant behaviour principles. They consider two types of prompts, symbolic, such as written, printed or spoken words and realistic, such as pictures and objects. In teaching an aphasic patient to name a given representation of an object the clinician attempts to find a second representation which, when paired with the first, will evoke the desired naming response. In successive naming tasks both representations are presented simultaneously, but the second which acts as a prompt is gradually faded and eliminated. McDearmon and Potter report that they have used such prompts with fading, reinforcement and precision sequencing of learning steps in the treatment of aphasia. They found that greater flexibility was required than is found in typical programmed instruction, and so used individualized material. This they found satisfactory and report on improvements with several patients. No formal evaluation of this procedure was carried out, but it seems likely that it would warrant further investigation.

Another therapeutic variable which has been considered is stimulus repetition. Helmick and Wipplinger (1975) examined the effect of stimulus repetition on a programme aimed at enhancing naming skills in an adult aphasic patient. Three treatment programmes were used: therapy MAX, 24 stimulus repetitions; therapy MIN, 6 stimulus repetitions and a no-treatment programme. Therapy consisted of tasks such as naming pictures, using the word in a sentence and tracing-copying. Therapy was given for four weeks, during which alternate presentations of the two therapy programmes occurred. The patient was eight weeks post CVA so that as far as possible the effects of spontaneous recovery would be elmininated. Each treatment procedure involved a separate set of 15 vocabulary words. The results indicated that the systematic management programme enhanced the naming skills of the subject. Greater gains in naming ability occurred under treatment conditions than under no treatment conditions. However, the no-treatment condition did produce a substantial gain in naming ability. Large amounts of stimulus repetition were no more effective than small amounts, MAX therapy did not lead to better results than MIN. Helmick and Wipplinger suggest that generalization of effects from MAX to MIN could have obscured differences between the two conditions. However, these differences were at an equivalent level throughout treatment and so generalization is not likely to have produced this effect.

The results of this study show the need for evaluation of individual therapeutic variables in order to design the most effective therapeutic techniques for aphasic patients. Stimulus repetition is generally considered important and yet it may have a relatively minor role compared to other therapeutic variables, though it is not possible to draw conclusions from a single case study.

4.2.2.4 Evaluation of Verbal Conditioning

The development of these verbal operant conditioning techniques has given rise to a need for an evaluation of their effectiveness in relation to alternative treatment methods.

Most of the studies mentioned above have considered whether the treatment procedure produced an improvement in aphasics' communication skills (Bloom 1962, Goodkin 1966, 1968, Devine Smith 1974, McDearman and Potter 1975). Comparison has been made between a pre-training or baseline measure and post-training measure. Goodkin (1966, 1969) used baseline conditions which were obtained once a patient had ceased to improve with speech therapy, and so one may assume that if speech therapy had continued the observed improvement would not have occurred.

Other studies have included comparisons with control groups, Goodkin et al (1973) used a non-contingent reinforcement control group and found a difference between this group and a contingent reinforcement group. These patients were all ones who had ceased to benefit from speech therapy and so one might assume that if speech therapy had continued the improvement observed may not have occurred. Both groups improved from baseline conditions on the FCP, though specific target behaviours did not show this general change. This could be a result of a different treatment being given, regardless of its content. There might also have been an initial improvement in the control group on specific target behaviours, but this could then have declined as the lack of contingency between the behaviour and reinforcement became apparent. FCP scores were used to compare gains with speech therapy and gains with the experimental treatment procedure and these were not significantly different. Subjects who made a high or low gain in speech therapy made a comparable gain during the experimental treatment procedure. However, during speech therapy spontaneous recovery may have been involved to a greater extent, and hence reduced the difference between speech therapy and the experimental treatment.

An important feature of this experiment was the difference obtained between contingent and non-contingent reinforcement. Previous work has shown that encouragement has a positive effect on therapy. Darley (1968) asked 3 groups of aphasic patients to do one of two tasks, name pictures or read words. One group was encouraged, the second discouraged and the third was a neutral condition. After three days patients in the encouraged condition performed significantly better than the discouraged. The neutral condition patients came in between, but closer to encouraged patients. Darley considers this finding of relevance to the prognosis of the patient, since the attitude of those around them is likely to influence the improvement obtained. However, it is not really possible to predict this from the experiment since the length of time the effect persisted in the three groups is not known, nor is the effect of prolonged rather than short term encouragement or discouragement. However, the study does indicate the role that encouragement, such as verbal reinforcement, is likely to have in the therapy situation. Ignoring behaviours may be equivalent to the neutral condition and so unlikely to decrease behaviour on which it is contingent. The work of Goodkin et al (1973) indicates that encouragement is likely to further enhance the effectiveness of treatment if it is contingent on specified desirable behaviours.

Helmick and Wipplinger (1975) used a no-treatment control group to determine the effect of their treatment procedures. Other studies have looked at alternative treatment procedures as a means of determining the effect of a treatment procedure. Any treatment may be more effective than no treatment, but unless it is more effective than the alternative treatments available, it is unlikely to be adopted. West (1973) conducted a study to directly compare an experimental treatment programme based on a conditioning procedure with an alternative treatment, speech therapy.

West compared an experimental treatment programme based on items similar to the token test with speech therapy, as a means of improving auditory comprehension. Five adult aphasics received the experimental treatment programme and five matched controls received speech therapy. All had mild to moderate impairment of auditory comprehension, and matching was carried out on aphasia type, severity rating and initial token test score. The experimental treatment programme consisted of household objects of different colours. Commands were given at three levels of difficulty using sets of these objects. Correct responses were verbally reinforced with remarks such as 'good' and 'that's correct'. A subject remained at a given level until he was able to perform correctly on 90% of the commands in 30 consecutive commands. The Token Test and the MTDDA were administered before and after treatment and 8 to 9 months after the completion of treatment. On the token test the experimental group showed a mean increase of 17.2%, whereas the speech therapy group showed a mean decrease of 3.8%. The MTDDA scores showed less impressive changes but these were in the predicted direction. The experimental group showed most improvement on following directions, whereas controls showed most improvement on understanding sentences and repeating digits.

This study has the advantage of dealing with a selected problem, auditory comprehension and evaluating how it may best be treated. However, there are still various inadequacies. The two groups are very small, which limits statistical consideration of the results. There is no statistical data presented, just comparison in terms of more or less improvement in either group. Although the difference is large, if there is considerable variation of amount of improvement within the group then the difference between these groups may not be significant.

The general conclusions which may be drawn about the use of operant techniques in language rehabilitation are few because of the paucity of studies. Most studies only provide indications of what techniques can be used and for whom they might be appropriate.

4.2.3. Conclusions

The operant techniques used fall into two major categories, programmed instruction and verbal conditioning, which overlap to a certain extent. Programmed instruction involves presentation of pre-sequenced material in a carefully structured manner, such that aphasics may learn certain language skills. Error rate is kept low, by very gradual sequencing of material, and feedback is by progression through the programme. This highly structured learning situation seems to be appropriate for severe aphasics, where the skills to be learned are often pre-verbal, such as matching, copying and discrimination learning. However, the one main attempt to evaluate programmed instruction in comparison with speech therapy or no treatment found that none of the conditions had an effect on patients language performance (Sarno et al 1970). However, the patient group selected comprised those with the poorest prognosis, and so the findings may not apply to all severe aphasics.

Verbal conditioning techniques have generally been used with patients at a slightly higher level of language functioning. These have generally been found to produce changes in behaviour in the desired direction. Verbal conditioning techniques have been used as a follow up to speech therapy at a stage when patients performance has become stable and for this purpose have generally been found to be effective. Another aspect for which they seem useful is to train specific and very limited language skills rather than attempt a general language rehabilitation. In this context they also seem to have been effective, but they have rarely been compared to alternative treatments.

Future developments in the use of operant techniques may follow any of several directions. The techniques which have so far been developed have not been fully evaluated. It is still necessary to determine for whom each technique is appropriate, such as, recent or long-term aphasics, severe or mild aphasics, or young or old aphasics. Many could be further improved and extended. Much of this is likely to be possible by determining which factors in the total treatment package contribute most or are essential to produce the desired changes. Factors such as reinforcement, stimulus repetition, punishment, prompting and self-monitoring all need to be considered. For this reason, it is difficult to determine at this stage how useful this diverse group of training techniques will be. They may only be applicable to specific problems or they may provide the foundation for a total scheme of language rehabilitation. At the present, they seem to have considerable potential and so warrant further evaluation before they can be generally adopted or dismissed.

4.3. The Role of Other Treatments

4.3.1. General Rehabilitation

Besides treatment of language problems, dysphasic stroke patients usually receive general rehabilitation. This mainly consists of physiotherapy and occupational therapy but, in addition, the nursing staff may contribute to the process.

The rehabilitation received is expected to improve both the physical and the language abilities of these patients more than no rehabilitation. No rehabilitation generally involves medical and nursing care on an acute medical ward. However, there is little evidence for the efficacy of rehabilitation as a whole, or of its component treatments.

Various studies have reviewed the outcome of patients who received rehabilitation and reported in terms of the proportion attaining independence in activities of daily living, discharge home or return to work. (Carroll1962, Granger, Sherwood and Green 1977, Newman 1972). However, these are difficult to evaluate since there is no basis for comparison with other methods of patient management. Lehman et al (1975) to some extent avoided this problem by comparing those who received rehabilitation at less than and more than six months post stroke. They found that significant gains were made in the latter group at a time when spontaneous recovery was not likely to be effective. However, since the basis for selection of patients to be rehabilitated early and late is not known, interpretation of the result is limited.

A similar problem arises in a recent study which attempted to evaluate the contribution of physiotherapy, occupational therapy and speech therapy, in the rehabilitation of stroke patients (Brocklehurst, Andrews, Richards and Laycock 1977). The amount of treatment was related to the outcome and this indicated that patients receiving most treatment have the worst outcome. Since the basis for patient selection for treatment and the basis for discharge are not specified it is difficult to interpret the results. It does, however, suggest that the present system of patient rehabilitation is not very effective.

Some support for the notion that rehabilitation has little effect comes from a control trial by Feldman et al (1962). They randomly allocated 82 stroke patients to a rehabilitation and control group. The latter consisted of functionally oriented medical care. Evaluation in terms of physical and intellectual impairment indicated no superiority of rehabilitation over the control procedure. Although rehabilitation seemed to improve functional abilities more than the control procedure, there was no statistical analysis of results and the differences seem unlikely to be significant.

Further support for this finding may come from a study now in progress at Northwick Park Hospital (Smith 1976). This study is a randomised control trial of 3 different intensities of out-patient rehabilitation of stroke patients. Intensive, standard and no formal out-patient therapy are being compared to assess the effectiveness of rehabilitation. However, if results are as expected - i.e. that intensive rehabilitation is best, followed by standard and then no treatment - differences may be due to attentional factors rather than the specific rehabilitation procedures. It will also not be possible to separate out the contribution of the various therapies. For example, if language improved significantly more in the intensive treatment group, it could be due to intensive speech therapy or to increased social contacts, such as ambulance journeys, physiotherapy and talking with other patients at mealtimes. Despite these problems, this is the most potentially useful study that has attempted to evaluate rehabilitation in general, and it is evident that further studies are needed.

Since there is little indication whether rehabilitation generally is effective then the two major components of rehabilitation, physiotherapy and occupational therapy, need to be considered.

4.3.2. Physiotherapy

Although designed to increase the physical abilities of stroke patients, physiotherapy also involves a one-to-one relationship with the patient which may have an important effect on language abilities. During physiotherapy the patient may use his language functionally without the anxiety associated with trying to do language tasks. The time spent following the physiotherapists instructions and discussing physical aspects of treatment may contribute towards the language rehabilitation process. However, there seem to be no studies which have specifically evaluated the effect of the patient-therapist interaction in physiotherapy in relation to language rehabilitation.

Guidelines of how a physiotherapist should treat aphasic patients are occasionally included in text books. Johnstone (1978) advises the physiotherapist to reassure aphasic patients and points out that they should not aggravate frustration, insist on repetition of words or rush the patient. She also places particular emphasis on not letting the patient lose contact with the therapist or become isolated. However, there is no experimental evidence to indicate that following this advice will have a significant effect on the patients' language abilities.

Therefore, physiotherapy is a situation in which a dysphasic patient is regularly learning to follow instructions and attempt to communicate. This practice in communication may influence the process of recovery from aphasia, but as yet this has not been established.

4.3.3. Occupational Therapy

Occupational Therapy with dysphasic stroke patients involves three main areas of treatment. First, physical abilities are treated by the occupational therapist using activities which will increase movement. Patients have the opportunity to practice activities acquired in physiotherapy such as transferring and standing, and to do activities to improve arm function, such as manipulating plasticine and craftwork. Secondly, communication work based on the types of activities used by the speech therapist, e.g. letter, word and picture matching, with particular emphasis on writing practice is given. In addition, the occupational therapists involve the patients in group activities, through various games, in order to develop functional speech.

The third area of the occupational therapists work is in promoting social independence. This will begin with self care activities, such as washing, feeding and dressing and later involve domestic tasks, such as cooking and housework. As patients progress they are then given practice in activities outside the hospital, such as shopping and using public transport.

The theoretical rationale for activities is rarely specifically discussed. The basic assumption seems to be that practice on a particular task will improve performance. While this may be true for practical skills, such as dressing, there is less basis for assuming its importance in communication abilities. However, the activities are presented as if this were the case. Patients are given tasks graded in approximate order of difficulty, so that they are not generally given tasks which they cannot attempt. The occupational therapist will explain the task and give the patient assistance on the initial items. The therapist then leaves the patient to work independently. If the patient does little, asks for assistance, or when the therapist has time, she returns and works with the patient. This assistance consists of verbal encouragement for successful work, pointing out errors and explaining the mistakes made. The therapist then modifies the task or gives another task according to the patients' performance.

Physical treatments used in occupational therapy have greater theoretical grounding. Trombly and Scott (1977) report on the application of Bobath techniques and proprioceptive neuromuscular facilitation in the rehabilitation of stroke, but no evidence is presented as to their relative effectiveness.

Reports from rehabilitation centres that use occupational therapy as a part of their rehabilitation programme indicate favourable outcomes (Sommerville 1968, Botez 1970). However, it is impossible to conclude whether occupational therapy will influence recovery of language abilities of dysphasic stroke patients.

CHAPTER 5

EVALUATION OF LANGUAGE TREATMENT METHODS WITH 'MODERATE' APHASICS

5.1 Introduction

Experiment 1 was aimed primarily at evaluating the effectiveness of the verbal conditioning procedure developed by Goodkin (1966). It was planned to determine whether this procedure produced an improvement in the language of moderately aphasic patients greater than that produced either by speech therapy or by general verbal stimulation.

5.2. Method

5.2.1 Design

The design of this experiment met with various ethical and practical problems, which prevented the use of various experimental designs preferable to the design selected. The criteria which limited the design of the study were:

1. All patients were to receive some speech therapy. This was specified by the medical consultant who had clinical responsibility for all patients treated.
2. Treatment had to be completed within eight weeks. The admission and discharge policy was based on an eight week or four week period of rehabilitation, depending on the severity of the patient's physical and intellectual problems.
3. About thirty patients a year would be available for inclusion in the study.
4. The speech therapist's work-load could not be increased over the current level, which was approximately 2 hours per week per patient.

The two design alternatives available were as follows:

1. All patients to receive all 3 treatments in random order i.e.

A = Assessment

Interval 1	Interval 2	Interval 3
Speech Therapy	Operant Training	Non-specific Treatment

A A A A

0 ______________________________ 8 weeks

The advantages of this design are:

1. Each patient receives some speech therapy.
2. Each patient acts as his own control so that the comparability of different groups of patients is not a necessary consideration.
3. A relatively small number of patients can be used.

However it was not used because:

1. Patients were only available for eight weeks, of which the first week was rarely available for treatment. This meant that each patient would only receive just over 2 weeks in any treatment condition, which is probably insufficient for any treatment effects to be evident.
2. Each patient would need to be assessed on four separate occasions. As the speech therapist conducting the assessments only had limited time available, the assessment procedure would need to be very short if it were to be repeated four times.
3. The number of assessments involved would reduce the time available for treatment, both speech treatment and other treatments available in the unit, physiotherapy and occupational therapy.
4. Practice effects on tests might be high.
5. The same therapist could not be used for all three treatments.

2. The design selected was:

	Interval 1	Interval 2
GROUP 1	Operant Th. 2	Speech Therapy Th. 1
2	Speech Therapy Th. 1	Operant Th. 2
3	Non-Specific Th. 2	Speech Therapy Th. 1
4	Speech Therapy Th. 1	Non-Specific Th. 2
	4 weeks	4 weeks

A (start of Interval 1) A (end of Interval 1) A (end of Interval 2)

Th. = therapist

A = assessment

This design has the following advantages:

1. It is possible to compare operant training with non-specific treatment as there is no therapist difference. This is the main objective of the experiment i.e. groups 1 and 2 with 3 and 4.
2. Both therapists are giving treatments with which they have experience and expectation of producing improvement in the patients concerned.
3. Patients act as their own controls when comparing speech therapy with the two alternative treatments, although a therapist difference is involved. i.e. In groups 1 and 2 speech therapy is compared with operant training, and in groups 3 and 4 speech therapy is compared with the non-specific procedure.
4. Assessments are required on only 3 occasions.
5. Each treatment is given for nearly four weeks which should be sufficient time for any treatment effects to become apparent.

The disadvantages with this design are:

1. There is therapist difference between speech therapy and operant training procedures, but in view of the fact that neither therapist was experienced in both procedures, this was considered unavoidable.
2. Patients do not act as their own controls in comparison between operant and non-specific treatment.
3. There is a therapist difference between speech therapy and non-specific treatment which limits the evaluation of the effectiveness of speech therapy.

Despite these disadvantages, this design was considered the better of the two viable alternatives.

5.2.2. Subjects

5.2.2.1. Selection of Subjects.

All patients referred to the speech therapy department, between December 1973 and December 1977 with aphasia following a cerebral vascular accident (C.V.A.) were assessed for inclusion in the experiment.

Patients may be admitted to the unit if they are between 16 and 65 years of age and have recovered physically to the stage when they can cope with a 9.00 a.m. to 5.00 p.m. day in the occupational therapy and physiotherapy departments. They are therefore usually 3 to 6 months post onset of the C.V.A., though occasionally patients are admitted who are more recent or longer post onset.

Patients were selected for inclusion in the experiment if:

1. They had a C.V.A. and no other form of brain damage, such as a head injury.
2. They were available for a period of 8 weeks on an in-patient basis or attending as a day-patient at least 4 days per week.
3. They were referred for speech therapy by the medical staff.
4. They were aphasic and at a level for which any of the three treatments would be appropriate.

5.2.2.2. Subjects Obtained

One hundred and forty two patients were initially referred (see tables 1 and 2). Of these, 37 met the criteria for inclusion in Experiment 1 (see Section 5.2.3.). Of those excluded, 51 were too severely aphasic, 33 were too minimally aphasic and 21 were excluded as the basis of other criteria before they were classified e.g. also head injury, dysarthric and not staying for 8 weeks. Thirty seven patients were moderately aphasic and suitable for the treatment trial. Thirteen of these failed to complete the full treatment period and so a total of 24 patients was obtained for Experiment I.

Some of the 51 severely aphasic patients, excluded from this treatment trial, were included in Experiments 2 and 3 (see Chapter 6).

5.2.2.3. Patient Characteristics

The twenty four patients were aged 18 - 64 years (mean 51.41 S.D. 11.25 years). They were 1 to 36 months post onset (mean 4.8 S.D. 7.09 months). Only two patients were more than eight months post onset. There were 7 women and 17 men. This difference in sex distribution is partly a reflection of the unit having more beds for men than women. Patient characteristics are shown in table 3.

5.2.2.4. Therapists

Speech therapy was given by two qualified speech therapists who were experienced in treating aphasic patients.

In the first year of the study speech therapist 1 (ST1) treated patients while speech therapist 2 (ST2) carried out the assessments. After this speech therapist 2 left the unit and speech therapist 3 (ST3) joined in her place. Therapist 3 was not trained in the PICA and so was not able to do the independent assessment. At this stage ST3 treated the patients involved and ST1 carried out the assessment.

When ST3 had taken the course to learn the assessment procedure, she was able to assess some of the remaining patients. Half the group were treated by ST1 and half by ST3. The assessor and therapist for each patient are shown in table 24. The operant training procedure and the non-specific treatment were given by the writer, a clinical psychologist, working full-time with the unit (CP). No selection of therapists was possible as these were the only ones available.

5.2.3 Assessment

5.2.3.1. Aims of assessment

The purposes of the assessment procedure were:

1. To select patients suitable for inclusion in the treatment trial.
2. To determine the level of communication ability in order to assess change over time.
3. To measure factors that may relate to the amount of improvement that occurs and provide possible prognostic indicators.

The assessment procedure, therefore, needed to sample a wide range of communication abilities and related aspects of intellectual functioning.

5.2.3.2. Assessment procedure

Assessment was to be done 3 times at 4 week intervals. The total time devoted to each assessment could be no more than 3 sessions. In the unit, a patient's day is divided into 5 sessions of 1 or 1½ hours each. Patients were usually available to be seen by a speech therapist or psychologist during 2 of those 5 sessions. Owing to time tabling difficulties of the assessors and alternative activities for the patients, such as seeing the social worker or doctor and hydrotherapy, it was only possible for each assessment to cover 2 or 3 sessions. This generally meant a total time of 2 or 3 hours per patient. Although some sessions were 1½ hours duration, patients who are newly admitted to the unit are often unable to cope with concentrated work for more than a half hour at any one time. They tire easily, are unable to concentrate and refuse to co-operate if attempts are made to continue longer. Any further assessment sessions would have considerably reduced the time available for treatment.

The assessment procedure on each of the three occasions was shared by 2 assessors. A speech therapist (ST1 or ST3) was an independent assessor with only limited knowledge of treatment procedures used with the patient concerned. It was impossible for her not to know which therapist was seeing a patient but she did not know which treatment procedure was being used by the psychologist (CP). The independent assessor was only available for 1½ hours assessment time due to other clinical duties. On some occasions the independent assessor was not available due to illness or holidays. In these instances another speech therapist (ST4), working in a different hospital and therefore with no knowledge of the treatments being given, assessed the patient concerned. The speech therapist who should have tested the patient checked the scoring of ST4 on those items for which it was possible.

It was therefore planned that ST would do an overall assessment of language abilities, consisting of a comprehensive aphasia battery lasting 1-2 hours. It was intended that the independent assessment should cover most aspects of aphasia, since this would be the main means of evaluating treatment effects.

A second assessment session was given by CP. This was to involve selected language abilities: verbal expression, naming and receptive abilities and general intellectual functioning and was designed to last approximately 1 hour.

Since CP was a therapist, checks were included to determine whether she was showing any bias towards a particular treatment when assessing the patients. An occupational therapy student, who had no knowledge of the treatment administered the Object Naming Test which was also being administered by CP. This was only included for the first 16 of the 24 patients as at this stage there was no longer a student available to do the test.

The initial assessment was given as soon after admission as possible. On the basis of scores on the aphasia battery patients were selected for inclusion in the trial. The assessments were repeated 3½ weeks later and 7½ weeks later after each treatment interval.

5.2.3.3. <u>Assessments Used</u>

The assessments were selected on the basis of various criteria,

1. They needed to have quantitative rather than qualitative scoring systems, which were sensitive enough to show small differences in ability attributable to treatment effects yet not so sensitive that they would be influenced by extraneous factors such as patients' mood or time of day.
2. The tests needed to have high test-retest reliability, since patients were to be tested 3 times at 4 week intervals. The alternative to this requirement was the availability of 3 parallel forms of the test which could be used on successive assessments.

3. The tests needed to be short enough to be administered in the time available and yet still accomplish their individual objectives.
4. They needed to be varied and interesting in order to maintain the patients' interest and co-operation.
Various additional factors were taken into consideration when choosing tests for particular purposes.

5.2.3.3.1. Aphasia Battery

This was required to measure general language ability and was used to select patients for inclusion in the trial. In addition to the selection criteria mentioned above for all tests, the aphasia battery needed to meet various other requirements. These were:-

1. A test was needed which was comprehensive enough to cover most aspects of communication ability which might be impaired in an aphasic patient. It therefore needed to sample a wide range of language performance.
2. The test needed to cover a wide range of difficulty within each type of performance so that it is capable of assessing all important aspects of aphasia in the majority of patients.
3. The range of difficulty covered needed to be sensitive enough to reflect the degree of impairment, progress in therapy or regression.
4. The test needed to provide an index of the severity of aphasia, so that the patients could be equated to descriptions commonly used.
5. The test needed to be standardised so that results would be comparable from one assessor to another.
6. The test needed to have clearly defined norms and standard scaled scores such that comparisons across subtests could be made, in case differential treatment effects occurred according to different patterns of scores.
7. Norms also needed to be available for aphasic patients, since the majority of patients tested would be below the range of scores of a non-aphasic group.
8. Scoring needed to provide a quantitative description of aphasic responses such that the minimum of information would be lost. The scoring needed to provide qualitative information as well as quantitative, so that it would be possible to determine how and why performance was deficient.
9. The test was to be administered in one to two hours yet needed to accomplish its objectives in this time.

10. The test was to be concerned with communication ability and so the effects of age, intelligence and education needed to be minimal.

The various tests which were available for inclusion are reviewed in Section 2.5.2.

The test selected for the study was the PICA (Porch 1967). This was considered the most suitable for evaluating treatment of aphasia for the following reasons:

1. It is standardised in procedure.
2. Scoring gives a large amount of information per item and so is sensitive to small changes.
3. Normative data is available for brain-damaged patients.
4. Inter rater reliability is good so that scores obtained by the independent assessor were likely to be representative of those obtained in clinical practice and two assessors could be used.
5. The independent assessor had had the necessary training to be able to administer this test reliably.
6. Test-retest reliability is high and so differences obtained were likely to be largely due to patient changes in ability.

5.2.3.3.2. Tests of Selected Language abilities

These tests were to be given by the psychologist (CP) to supplement the assessment given by the independent assessor. These tests were to cover as wide a range of abilities as possible since they would be used with a no-treatment control group, as an independent assessor would not be available for this group. (See Experiment 4). The tests were selected on the following bases:

1. They had been found useful in clinical practice.
2. They had some bearing on the treatment procedures being used.
3. They covered a wide range of ability within the aspect being measured.
4. They would be applicable to the majority of patients.
5. They were sensitive enough to reflect changes in ability with time.

Tests were selected to assess the following abilities:

1. Handedness
2. Comprehension
3. Naming
4. Fluency
5. Picture description
6. General intellectual capacity
7. Self rating of abilities.

The tests considered are reviewed in Sections 2.5.3. and 2.5.4. Those selected were:

1. Edinburgh Handedness Inventory (Oldfield 1971).
It was considered that many of the population being assessed would be unable to read or understand the instructions and possibly unable to write or fill in the answers required. The questionnaire was therefore not administered in standard form but presented orally. Although some of the more severely aphasic patients would be likely to have difficulty with the tasks, it was considered that none of the alternative laterality measures would be appropriate for these patients.

2. Token Test (De Renzi and Vignolo 1962) Receptive ability.

This was selected as the best available measure of comprehension. (See section 2.5.3.1.). Three parallel versions were devised (see Experiment 5 Section 8.1), which were shown not to differ significantly from each other.

3. Object Naming Test (Oldfield and Wingfield 1971)

This measure of naming ability was included as suitable for a wide range of aphasic patients. Test-retest reliability was investigated in Experiment 6 (Section 8.2) and found to be high.

4. Fluency

The Fluency test was used to name as many foods as possible. and countries of the world within a two minute response period. Countries of the world may have been influenced by intelligence but since patients were mostly producing relatively few responses the effect was unlikely to be marked. This category had the advantage that it involved words unlikely to have been covered to any great extent in any of the three treatment procedures.

The Fluency test was included because it was felt that it might reflect a particular change produced by the operant techniques used, since it involves the production of words within a restricted context.

5. Picture Description.

Picture Description is a frequently used test in various aphasia batteries, such as Boston Diagnostic Aphasia Test, Schuell MTDDA. However, it is one which is difficult to quantify. It is not included in the PICA. as it is not possible to get scorable responses and it does not fit into the standard framework of the test procedure.

It was included in the assessment as a stimulus for descriptive speech. This was quantified in terms of the number of different words produced to provide an estimate of the range of vocabulary available to the patient.

6. Progressive Matrices - Intelligence (Raven 1956)

This test was selected for use because it is entirely non-verbal. A patient may indicate his answer by pointing if he is unable to talk. The first few items are very straightforward and items then get progressively more difficult. This means that patients with comprehension difficulty can usually grasp what they are required to do. In contrast to other non-verbal intelligence measures, such as the WAIS Performance Scale, manual dexterity is not involved. This aspect was important since many aphasic patients are also hemiplegic. One problem with the use of this test is that it may be affected by visual field defects, e.g. hemianopia, which may occur following a C.V.A. However, patients often learn to compensate for this difficulty.

7. Self Rating

A rating scale was designed to assess the confidence patients felt in their own use of speech and the amount of speech they used. It consisted of eight questions. Four were concerned with amounts of speech used i.e. ability to indicate needs to people, using the telephone, practising speech when given the opportunity and whether patients talked with their families or friends. Three were concerned with how patients felt about their communication attempts i.e. feeling anxiety, avoiding conversation and enjoying talking to people. There was one question on patients opinion of whether their speech was improving. Each question was answered yes or no.

5.2.3.3.3. <u>Assessment of Generalization</u>

A questionnaire was designed in order to assess the effect of treatment on speech outside the therapy setting. This is presented in Experiment 7 (Section 8.2). It was divided into a speech section and a communication section. The former was shown to have good test-retest reliability and inter rater reliability when used by trained raters. The communication section was unreliable over time when used by different raters, and therefore the only two questions from this scale to be reliable are considered as a separate shortened communication section.

The Speech Questionnaire was completed by staff who were in contact with the patient concerned. An occupational therapist, a physiotherapist and a senior nurse completed the questionnaire for each patient at the end of the first, fourth and eighth week. The staff needed time to get to know the patients and so initial ratings were done slightly later than the formal speech testing. The two later ratings were planned to coincide with the formal speech tests.

5.2.3.3.4. Follow Up Assessment

It was intended to follow up patients three months after they had completed the treatment trial. This proved impossible as many of the patients were not from the Oxford region and lived too far away to be seen. It was not considered that postal follow up would provide adequate objective data to be of value.

5.2.3.4. Assessment Time-table

Week	Day	Procedure
1	1	Admission to Unit
	2	Referral to Speech Therapy Department by Doctor
	3 4	Initial assessment by speech therapist and psychologist
	5 6 7	Questionnaire by occupational therapist, physiotherapist and nurse
2	8 - 14	Treatment Interval 1
3	15 - 21	12 x ½ hour sessions
4	22 - 25 27 28	Assessment by speech therapist and psychologist Questionnaire by occupational
5	29 30 31 - 35	therapist, physiotherapist and nurse Treatment Interval 2
6	36 - 42	12 x ½ hour sessions
7	43 - 49	
8	50 51 52 53 54	Assessment by speech therapist and psychologist. Questionnaire by occupational therapist, physiotherapist and nurse. Discharge from unit

This time-table was based on the usual pattern of an eight week admission period with patients admitted on a Monday. However, some patients were discharged earlier and attended the Unit on a day-patient basis. These were included if they attended four times a week, so that sufficient time was available for treatment to be completed.

In some instances patients discharged themselves early, but were included if most of the treatment could be completed. For this reason some patients received less than the full twelve sessions treatment. When this occurred other patients were also given fewer sessions so that there would be no difference between the groups in the amount of treatment received. It was considered more important that the sessions of treatment were balanced than the exact number of days between assessments.

Other instances where the time-table could not be adhered to were when holidays intervened. Over Christmas and Easter patients usually had a long weekend at home and so treatment was interrupted. Staff holidays also meant that intervals between assessments were in some instances longer than planned.

The interval between assessments and the number of treatment sessions given to each patient are shown in Table 4.

5.2.3.5. Administration of Tests

5.2.3.5.1. PICA

This was given in Standard form by the independent assessor, who had taken the required course in administration, scoring and interpretation of the PICA. When it was necessary to divide the test into two sections, this was generally done between Test XII and Test A, so that all the graphics tests were given together. However, if a patient became very tired or unco-operative earlier than Test XII, then testing was stopped at that point and continued in a later session.

5.2.3.5.2. Other Tests

These were administered by CP. The introduction to the testing session was "I am going to give you some different tasks to do. I want to see what things you can do, and what things you find difficult". On Sessions 1 and 2 was added "We will then be able to help you practice the things that you find difficult". On session 3 this statement was omitted and instead the patient was told "I want to see how much you have changed in your ability to do the things that you used to find difficult".

The tests were given in the same order for each patient on each occasion.

1. Edinburgh Handedness Inventory:

This test was given first as it was relatively easy for most patients and so would be likely to help them relax a little in the testing situation. It was only given on the first assessment session since handedness was a feature unlikely to change with time and premorbid handedness was the relevant factor rather than any subsequent preferences.

Oral presentation of the test was used since many aphasic patients have reading difficulties, which are often as severe or more severe than their auditory comprehension difficulties. Relatively few patients would have been able to complete the test in its original form.

The instructions used were:

"I am going to ask you which hand you used to use for various activities before you had your illness. Which hand did you use for writing?" Each subsequent question was asked in the form "Which hand (foot) did you use for .....?" The last question was given as "Which eye would you use to look through a telescope?" The questions were repeated if necessary and gestures used to aid communication.

Answers could be given verbally or by pointing to the appropriate side of the body. The test was scored using the formula

$$\frac{R}{R+L} \times 100 = \%\text{ right handedness}$$

'Don't knows' were excluded from the totals. This formula is different from the more commonly used R-L/R+L but this has the advantage that the score obtained ranges from 0 to 100% right handed rather than from 100% left handed to 100% right handed, which is easier for computational purposes.

2. Token Test:

This was given next as it was expected to be one of the easier tasks for most patients, particularly the early items. It was the first test on assessments 2 and 3.

The patient was told "Here are some coloured circles and some coloured rectangles" as the large circles and large rectangles were laid out in 2 rows in front of the patient. The colours were arranged so that no one colour rectangle and circle were opposite each other. The yellow and green rectangles were arranged next to each other in order for Part V to be completed. Apart from these restrictions the colours were arranged randomly. If the patient rearranged the tokens so that the colours of the rectangles and circles in the 2 rows matched each other, then they were left in this arrangement.

Part I was then administered using the instruction "show me the.........." for each item. This instruction was used for Parts I to IV. The items in Part I consisted of a colour and a shape specified - e.g. red circle, blue rectangle. The patient was then told "I will give you some slightly longer instructions with these pieces". Part III was administered in which the patient is required to show 2 tokens specified as in Part I. The small tokens were then laid out in front of the patient with the large tokens arranged in 2 additional rows. Colours were arranged randomly except that each column contained no one colour rectangle and circle next to each other. While this was done, the patient was told "I now have some small circles and some small rectangles. I will give you some instructions with these pieces". Part II was administered using instructions specifying size colour and shape. Part IV involved 2 items of specified size, colour and shape and was preceeded by the statement "I will now make the instruction slightly longer". The small tokens were then removed and the patient told "I am now going to give you some more instructions with the large pieces". Part V was administered.

The order of parts II and III were altered from the original version (De Renzi and Vignolo 1962) in order to decrease the number of times that the small tokens had to be laid out and removed.

Patients were required to indicate the specified token by pointing, touching or picking up, on Parts I to IV. On part V the means of indication is specified. Three shortened parallel versions of the token test (A, B and C) were used in order to reduce the total time taken for the test (see Section 8.1.1)

The patients' responses were recorded so that errors could be determined on a total correct or incorrect basis for each item. They were also scored on the number of elements of the item that were correct or incorrect. This gave the possible soores for each item in Part I as 2, Part II as 3, Part III as 4 and Part IV as 6. Items on Part V varied from containing 5 to 7 elements per item, though the total possible score for each version of the test was the same.

The order of presentation of the 3 versions (A, B and C) is shown in table 5. The test was scored for the number of items correct and a weighted score, according to the amount of information involved, was also obtained.

3. Object Naming test

This was given as the first expressive task since the instructions are fairly easy to comprehend though the task itself, is, for many aphasic patients, a difficult one.

The task was presented by "I am going to show you a series of pictures. I want you to tell me the name of each object. Some of the pictures will be difficult and some will be easier, but I want you to do as best you can".

The pictures were then given in one of 3 set orders (1, 2 or 3). The order used at each assessment is shown in table 5. The latency of naming was not recorded for the 10 practice pictures but was recorded for each of the 26 test pictures. The latency of naming was recorded by hand using a stop-watch. The name was counted as correct if it was clearly comprehensible and was given within 20 seconds. Self-corrections were scored as correct. The patient was given no feedback as to whether his answers were correct or incorrect.

The score obtained was the total number of pictures correctly named.

4. Fluency

The patient was asked "Tell me as many items of food as you can think of". An interval of 2 minutes was timed and all the food responses in this interval were recorded. If the subject had difficulty or made no attempt at the task the question was repeated. If this still produced no response the patient was asked "What did you have for breakfast (or dinner - whichever was the previous meal)".

Responses were recorded that were clear enough to be understood. Repetitions were not recorded. The patient was not told whether his answers were correct or incorrect.

The procedure used was the same for countries of the world. The cue used was "What country are we in now"? Continents were not accepted as correct answers, although America was taken as meaning U.S.A. and counted as correct.

The score was the total number of correct items given in the time allowed for both questions.

5. Picture Description.

The picture was put in front of the patient with the request "Tell me about this picture". Two minutes response time was allowed and the patients' responses were recorded verbatim. A tape recorder was used for fluent or mildly impaired patients and the responses transcribed after the assessment session. If a patient failed to respond, two prompts were given i.e. "what can you see?", and "Is there anything there that you can tell me about?"

6. Progressive Matrices

This test was given last as it can be entirely non-verbal and so most patients were likely to be at least able to make an attempt at the task. It is also a relatively long test and it was felt that if given earlier in the session, patients might refuse to do any subsequent items.

The test was introduced using gestures to supplement the verbal explanation i.e. "I have a rectangle here with a pattern on it, there is a portion missing here, what you have to do is tell me which of these 6 pieces will go in here to complete the pattern".

The first 3 items were explained to the patient if necessary. They were required to respond by pointing to the items rather than specifying the number of the item. The assessor recorded the responses. The patient was given no indication of the correctness of his responses. If he stopped he was prompted to continue. When a patient had 5 consecutive failures on a set, he was told "You can now miss out a few items,and begin again on this one". If,on any set,a score of 0 was obtained, the test was terminated. The patient was given verbal encouragement after the testing session was completed. Testing generally takes about 20-40 minutes. However, with patients who are aphasic and have comprehension difficulty, it is usually at least 30 minutes and often more. It was therefore felt desirable to shorten the test, even though this might limit the usefulness of the scale. This was done by setting the criterion of 5 consecutive failures on any set for terminating the test.

This meant that the full range of scores was available but that in many cases difficult items in a set were not attempted. Five consecutive errors were chosen because patients with cerebral vascular disorders tend to have patchy concentration. If too few errors had been allowed then these fluctuations in attention would have led to the set being terminated too early. Alternatively, if too many consecutive errors were required little shortening of the total test time would have occurred.

7. Self Rating Scale

The eight questions were read to the patient and he was asked to indicate "yes" or "no" ; e.g. "Do you enjoy talking to people"? Verbal and gestural replies were accepted as long as the meaning was clear. If the meaning was not clear the question was repeated, and patients encouraged to indicate whether the answer was "more yes" or "more no".

The score was the total number of questions answered in a positive direction.

8. The Object Naming test - independent assessor

This test was carried out by an occupational therapy student in the occupational therapy department. The patient was told that the student knew he had done the tests before that she wanted to see how he could manage on the test on that day.

The test was administered and scored in the same way as CP. The order of presentation of the 3 versions is shown in table 5.

9. Speech Questionnaires

These were initially explained to all staff in the occupational and physiotherapy departments and the senior nursing staff.

The staff member in each department who had most contact with the particular patient was asked to fill the questionnaire in about the patient's speech at that time. They were asked to try and find out about items on which they were not sure how the patient behaved.

The same staff member was asked to fill in the questionnaire for the patient concerned at all 3 assessment sessions. This was intended to reduce variability in ratings due to rater differences. In some instances, the particular staff member was on holiday or had been moved to a different department and so was not able to complete the forms at all three assessment sessions. In these instances the ratings of another staff member of the department who knew the patient concerned were used.

5.2.3.6 <u>Selection Criteria for inclusion in Experiment 1</u>

Patients were excluded who obtained any of the following PICA scores:

1. Test XII - mean score <10

Test XII is repetition of spoken object names. Patients obtaining score <10 would be either severely dysarthric or dyspraxic and would therefore be unable to participate in all three treatment procedures. Patients with mild dysarthria, in addition to dysphasia would therefore be included.

2. Test VI or X - mean score <8

Test VI involves pointing to an object designated by its use, and test X involves pointing to an object designated by its name. Patients unable to complete these tasks would be too severely impaired in receptive ability to be able to attempt the operant and non-specific treatment procedures. Seven or less was chosen as the cut-off point because below this level the answers are incorrect.

3. Test IX mean score < 7

Test IX involves completing sentences verbally. Patients scoring 6 or less would be unable to complete most of the sentences and so would be unlikely to be able to attempt either the operant or the non-specific treatment procedures. Patients excluded under 2. and 3. were classified as 'severe aphasics' and some are included in Experiments 2. and 3.

4. Test IV > 14

Test IV involves naming objects. Patients scoring more than 14 would be able to do this without any hesitation or errors and so would be likely to be too good for the operant training procedure to be appropriate.

Patients excluded on this basis were classified as 'too good'.

These exclusion criteria were chosen on the basis of clinical experience with aphasic patients. Patients scoring inside these extremes were included. Most of these patients had an overall PICA score between the 35th and 65th %ile, though some overlap between the 'moderate' and 'severe' aphasic groups occurred.

5.2.4. Treatment

5.2.4.1 Allocation to treatment

After the initial assessment by the independent assessor, those patients suitable for inclusion were allocated to a treatment group. This was done randomly within various constraints. Allocation was within groups of eight, so that patients 1 to 8 were allocated before patients 9 to 16, and when these were completed patients were allocated to numbers 17 to 24. In addition, allowance was made for staff holidays so that on a few occasions a patient could not receive a particular treatment combination as the therapist concerned was away. The allocation of treatment was not influenced by patient abilities or preferences.

5.2.4.2. Treatment procedure

Treatment sessions were specified as 30 minutes, since this is the usual time allowed to a speech therapy session. This was also found to be appropriate for the operant and non-specific treatment procedures. Patients find this time span short enough to be able to concentrate and co-operate with treatment, yet not so long that they become tired and start to have additional difficulties as a result of their tiredness.

There were twelve treatment sessions to be given in a three and a half week interval. These were spread as evenly as possible but had to fit in with the therapists other clinical commitments. In some cases less than twelve sessions were given. This was due to illness of either therapists or patients, patients leaving the unit early, or additional commitment of the therapists which meant that they could not complete the full treatment programme in the time allocated. When this occurred the treatment sessions given to other patients were adjusted so that the total number of treatment sessions in each group would not be significantly different from other groups.

5.2.4.3. Treatments given

5.2.4.3.1. Operant training

Each session was of 30 minutes duration. During this period the patient was asked a series of 10 questions. Two minutes were allowed for responding to each question.

The questions were:

1. Describe this room to me
2. Describe the clothes that you are wearing
3. Tell me what you do during the day here.
4. Tell me about your home
5. Tell me what you do in the evenings or at weekends.
6. Name as many animals as you can.
7. Name as many towns and cities as you can.
8. Tell me about your family.
9. Tell me about Rivermead.
10. Tell me about your home town.

These questions were based on those used by Goodkin (1966). They were intended to be open ended and general, so that a variety of responses were possible. They related to general topics of conversation which might be of practical use to the patient in his day to day functioning. They would therefore be likely to be used outside the therapy situation.

On the first session the number of responses which would have been reinforced was recorded. This provided a single baseline session. More sessions of baseline were not given owing to the relatively few occasions on which the patient would receive the entire treatment procedure, i.e. 12. If 4 sessions of baseline had been used, it would have been possible to determine the effects of practice on the patients' performance, but only 8 sessions of treatment would have been available. Since the operant procedure was being compared with other treatments, these comparisons would be used to evaluate the efficacy of the Procedure.

It was also unlikely that it would be possible to obtain a stable baseline with these patients. The patients were mostly relatively recent aphasics and so spontaneous recovery could account for some improvement obtained. This, together with practice, would lead to improvement in scores during baseline conditions. It would not be possible to compare the rate of improvement between baseline and treatment conditions since it is not known how the rate of spontaneous recovery changes with time.

On the second session, treatment conditions were introduced. Each response in a predetermined category was reinforced. Reinforcement consisted of verbal praise, i.e. 'yes' 'good' 'fine' and replies indicating the correctness of the response - i.e. 'that's right', 'yes, it's a chair'. In addition a token was placed in front of the therapist, opposite the patient, for each correct response. This gave a visual indication of the correctness of responding. The patient was told 'You are to try to use clear relevant phrases and sentences (or whatever the category of responses designated for that patient) in your answer to each question. When I put a token on the table you will see that you are correct. When your answers are not correct, I will not put any tokens down'. After each two minute response period this pile of tokens was counted and the patient told how many he had earned.

The response category to be reinforced was decided from baseline performance. If the responses consisted only of words and phrases these were reinforced initially. If it included sentences then phrases and sentences were reinforced. In all cases these had to be clear and non-perseverative, but relevance was included only for those patients who were able to produce accurate responses on baseline performance.

The 2 minute reponse time allowed for each question was terminated after a reinforced response, unless 30 seconds had elapsed since the end of the 2 minute interval, in which case, the interval was terminated regardless of the type of responses being given. This was intended to maintain a reinforcing situation following each question before the patient progressed to the next question, and it should encourage the patient to attempt subsequent questions.

This procedure was repeated for each session. With some of the more severe aphasics, all 10 questions could not be given in the 30 minute session. As many questions as could be given in 30 minutes were therefore administered. Each session was begun by a short general conversation and encouragement in order to help the patient relax in the treatment situation.

Any patients who progressed so that they had a stable number of tokens (within 10) over 3 sessions and had shown an average increase of over 50% from baseline, were then to be given the next category requirements and told that reinforcements would be contingent on these responses. However, in practice this did not occur.

Each patient's score was calculated following each session. The score given was the average number of responses in the category designated over the total number of questions given i.e. average number tokens earned per question. Since no patient's response category to be reinforced changed during treatment, the average number earned could be compared at each session. If patients' response categories had needed to be altered then it would have been necessary to start a new "score" since scores obtained from the two categories involved would not have been comparable.

Responses which failed to meet the requirements for reinforcement were attended to but no verbal reinforcement was given. No tokens were added to the pile following these responses. No corrections or assistance were given at any stage.

The characteristics of the treatment procedure are as follows:

Specific features.

1. Verbal reinforcement, i.e. words which subjectively or objectively convey that patients responses are correct, was contingent on responses corresponding to a category designated to be increased in frequency.

2. The therapist placed tokens in full view of the patient following a correct response, giving a visual feedback of correctness of the response.

3. The average score for a session was given to the patient at the end of the session and he was told how that related to previous sessions, so the patient knew whether his performance was improving, deteriorating or remaining constant.

4. Responses which were not correct, as defined by the response category required, were attended to but no verbal reinforcement or token was given.

5. No errors were corrected and no missing words were supplied or assistance given in the form of cues.

General features

6. The same task was given at every session

7. Progress to the next stage, i.e. category to be reinforced, occurred when a patient achieved a certain criterion at the previous level.

8. The task was the same for all patients but the response level required was determined according to their initial level of

functioning.

9. The task was entirely verbal, with no external materials used, apart from the surroundings.

10. As with all the treatments given, the therapist aimed at being interested in the patients and pleased to see them. The therapist also conversed on general topics before and after the treatment session.

11. The emphasis was on verbal communication rather than on the task given.

The differences between this procedure and the other treatment procedures is outlined in Section 5.2.4.3.4.

5.2.4.3.2. Non-specific treatment

This was designed as a control treatment procedure, It was intended that it should as far as possible replicate the type of interaction the patient might have with any untrained personnel or acquaintances.

It was designed to contain none of the characteristics essential to either the operant training procedure or to speech therapy. It does however, have some general features in common with either or both of the other two treatment procedures.

Each session was of 30 minutes duration. In common with both other treatments some general conversation was given at the beginning of each session, to put the patient at ease, and at the end of session.

The procedure consisted of the therapist conversing with the patient about certain topics in order to obtain 10 items of information. This was done in a conversational manner, although direct questioning was used where necessary. Verbal encouragement was not given in relation to particular responses. The answers were obtained, regardless of the clarity, perseverative nature or relevance of the responses. Appropriate words were supplied when necessary in order to assist the flow of conversation. The therapist also guessed at the required word when the patient was unable to produce it.

One topic was discussed per session. At the beginning of each session the patient was told the day's topic of conversation. The task was presented to them as practice in talking to people, to help them in their conversation ability. The topics used were selected from the following alternatives:

1. Patient's home.
2. Weather
3. Patient's family
4. Daily activities at Rivermead.
5. Evenings at Rivermead.
6. Weekends.
7. Patient's interests and hobbies.
8. Patient's childhood and schooldays
9. Patient's work
10. Patient's home town
11. London
12. Radio and Television
13. Holidays
14. Food
15. Current events in news
16. Countryside.

There were 10 prespecified items of information to be collected in relation to each topic. Once the required information had been collected the conversation could go on to any other aspects of the same general topic of conversation. The initiation of this conversation was left as far as possible to the patient, though the therapist would take the initiative when any silences or difficulties initiating conversation occurred.

The non-specific treatment procedure had the following characteristics.

1. Verbal encouragement was not given for successful verbal communication but only in relation to the task - e.g. "my house is - (points to appropriate colour)", would be encouraged in the non-specific procedure but would not be reinforced in the operant procedure if the response requirement were sentences.

2. No feedback of progress was given.

3. The task was entirely verbal, with no external materials used.

4. The same task was given for all patients and this was not broken down into stages.

5. Missing words were supplied when necessary, direct questioning was used to circumvent problems and responses were not corrected unless this was necessary to clarify the information conveyed.

6. Emphasis was on the task of conveying ihformation rather than on the amount of communication achieved by the patient.

7. The therapist aimed at showing interest in the patient and appearing pleased to see him. General conversation was used at

the beginning of a session to put a patient at his ease, and at the end of a session.

The differences between this procedure and the other treatments given is outlined in Section 5.2.4.3.4.)

5.2.4.3.3. Speech Therapy

Each session was 30 minutes long. During each session the patient was given several tasks aimed at improving various aspects of his communication ability. Tasks were selected by the speech therapist according to what she felt was appropriate for that particular patient at that particular time. There was no specification of the types of tasks to be given or the order in which they were to be given. The types of task were those commonly used by speech therapists in treating aphasic patients.

The tasks given involved both receptive and expressive abilities. Early stages included automatic and serial speech, which are generally well retained; matching tasks, including matching pictures to spoken and written words, phrases and sentences, and written words, phrases and sentences with spoken word phrases and sentences; auditory memory and discrimination tasks. Expressive verbal abilities were built up in stages using imitation, sentence completion, word games, sequencing tasks, grammar, syntax and spontaneous conversation. Once some expressive abilities had been established, then patients were helped in communication situations outside the therapy situation - e.g. shopping, telephoning, using public transport, according to their needs. Writing was built up in parallel with verbal expression, involving stages of copying, sentence completion, writing to dictation and spontaneous writing. Grammar and syntax were also dealt with in relation to written work. Reading was treated by a progression from mechanical reading of words, phrases and sentences to reading comprehension of these, and also of passages of written prose. Reading work involved both reading aloud and silent reading.

Speech therapy, in common with other treatment procedures, involved general conversation at the beginning and end of each session to put the patient at ease and to establish rapport. General conversation was also used in the middle of a session if a patient became tired. At these times the speech therapist had an opportunity to explain the patients difficulties to them, and in this way indicate to the patients that she understood their problems and was aware of how they felt. It also provided an opportunity for patients to bring up complaints and problems that they wished to discuss.

More specific to speech therapy was the aspects of the patient-therapist interaction during tasks being completed. The therapists gave frequent verbal encouragement to the patient. This included times when patients were not progressing, in order to encourage them to persevere with their attempts. When difficulties were encountered, the therapist gave the patient assistance in overcoming the difficulty. This assistance sometimes took the form of cues or the patients were encouraged to use gestures or writing to circumvent the problem. Mistakes were corrected at the time they were made, or if this would interfere with the flow of speech, then at a suitable pause in the conversation, or treatment was altered according to the nature of the mistakes.

The tasks were given in stages so that the patient progressed from easy to more difficult tasks as their abilities changed. The ordering of these tasks was chosen on the basis of clinical experience of the therapists. Progress to the next stage occurred when the therapist felt that the patient would be able to experience some success on the new tasks involved. The tasks were arranged so that as many modalities as possible could be incorporated together. This meant that a particular task might be presented verbally and in written form, and the patient might be required to respond verbally, gesturally and graphically. Other tasks only involved a few of these input-output channels. At all times emphasis was placed on success at communication, rather than on the content of the task given. Most of the tasks given involved a response from the patient, in this way the therapist could determine whether the patient had understood the task, and also some form of expression, even if only pointing, would be involved.

The speech therapist discussed patients'progress in the occupational therapy department with the occupational therapists. Whenever possible the speech therapists aimed to get the patients' family involved in his treatment, so that this could provide a back-up to speech therapy done in the treatment setting.

5.2.4.3.4. Essential differences between treatments

The essential differences between speech therapy, operant training and the non-specific treatment procedures are as follows:

1. Speech therapists gave verbal encouragement to the patient non-contingently. If the patient was not progressing or failing on a task, he was given verbal encouragement to persevere or to make an attempt at that task. This type of approach was also used in the non-specific treatment procedure. Patients were given non-contingent verbal encouragement in order to maintain their attempts at the task. However, if they failed in the task direct assistance was given rather than encouragement to attempt to communicate. In comparison, verbal encouragement was contingent on successful performance in the operant training. No encouragement was given, if a patient was failing or not attempting a task. The reason for this difference, is that in the operant procedure verbal encouragement is assumed to act as a positive reinforcer. If this is so, then verbal encouragement following unsuccessful attempts at a task or lack of attempt at a task would increase the frequency of this type of response. Patients would thereby be trained to fail or to refuse to attempt tasks.

2. In speech therapy mistakes were corrected. This was done using cues, or procedures to circumvent the problem or by direct assistance. Correction of mistakes was given immediately following the mistake or at a pause in the conversation, if this would have interrupted the flow of speech. In contrast, the non-specific procedure does not involve the use of cues. The reason is that relatives and acquaintances are unlikely to be familiar with this type of approach and so not use it unless specifically trained to do so. Correction of mistakes was given directly, if necessary, to convey a particular point. Alternatively the therapist used direct questioning if it was unclear what the patient had meant. This again occurs in the natural environment, particularly when emphasis is placed on the content of a conversation. In the operant procedure mistakes are ignored, and no assistance is given either by cues or direct means. The reason is based on the assumption that the therapists interest and assistance is reinforcing. If a patient is reinforced by this attention, then attention given when mistakes are made, may seem to increase the frequency of mistakes. If a patient receives more attention, through assistance, when he has difficulty, than when he is communicating successfully, then failing behaviour is likely to be maintained. Although positive reinforcement is likely to be given in the speech therapy situation for successful communication, the amount of attention involved then may not be as great as following a mistake, particularly if explanation of the error is involved.

3. The emphasis in both speech therapy and operant training was on communication rather than on the content of the task. These treatments were concerned that the patient should learn to attempt to communicate to the maximum of his ability and reinforcement is given for this. However, in the non-specific procedure, the aim was to convey information regardless of how it was done. In the natural environment there are many situations in which the aphasic is required to convey information - e.g. giving history to doctors, asking for items of shopping, and it is not important how this is done. Patients may use any means of communicating available, - e.g. pointing, whistling, and the person requiring information may assist by direct questioning rather than being concerned with letting the patient communicate to the best of his ability. Reinforcement in the non-specific treatment was therefore given when information had been conveyed rather than when the patient had communicated well, and so did not increase the likelihood of his using all the communication skills available.

4. There are also differences in the nature of the tasks given. Both speech therapy and operant training use a sequence of tasks or requirements, progressing from easy to more difficult, starting at a point where the patient can have success with the task. The reason for this grading of tasks is to ensure a low error rate. Most efficient learning occurs with low error rate, therefore, by starting with easy tasks it is possible to ensure few errors, and from there it is possible to increase the difficulty of tasks until errors begin to occur at greater frequency. In the natural environment, the demands put on the aphasic patient are not necessarily graded, but involve a mixture of relatively difficult and easier tasks. The non-specific treatment procedure therefore is not graded, but easy and difficult questions occur together.

5. Speech therapy and the operant training procedure used differ in their use of different stimulus modalities. Speech therapy aims at stimulating all modalities, on the theoretical basis that different modalities reinforce each other. The operant training procedure is essentially verbal in input and output. Since one ultimate target behaviour is fluent verbal communication, this means of expression is used throughout the training. Comprehension is a prerequisite of relevant verbal communication, and so if this latter aspect is being shaped during the treatment procedure, then comprehension is also being shaped.

6. Speech therapy and the operant training procedure used also differ in the use of external stimulus materials - e.g. pictures, written words, matching tasks. This is not an essential difference for any operant procedure, but only a feature of the particular operant training programme being used. Since the target for this is fluent verbal communication, shaping of this does not require the inclusion of any visual materials, but only of auditory stimulation and a verbal response.

7. Another feature specific to this particular operant procedure is that the progress by increasing task requirements is on the basis of recordable improvement in verbal communication. On the other hand speech therapy offers greater flexibility in progress from one task to another, and this can be done on a subjective impression of improvement based on clinical experience. However, this latter aspect may mean that greater variability of progress occurs due to therapist differences.

8. The operant procedure involves a repetition of the same task, with the performance requirements being changed according to progress. This is a shaping procedure and assumes that generalisation occurs from the task selected to other communication abilities and situations. Speech therapy utilizes a variety of different tasks, and the nature of the tasks including the response requirements, may change as progress occurs. This makes monitoring of progress more difficult, but does reduce the chance of a patient becoming bored with a particular task. However, speech therapy, in common with the operant training procedure, relies heavily on generalisation from the tasks used to other situations, although to a lesser extent to other communication abilities. Generalisation probably has a less important role to play in the non-specific treatment, which is concerned with topics which may be discussed in everyday life.

Therefore these three treatment procedures have several features in common, but a few differences which are expected to be important in determining their relative effectiveness. Ideally evaluation of each component difference needs to be carried out, but the present study is dealing with 'treatment packages' and so can only hope to highlight differences between treatments which may be of importance. The similarities and differences between the three treatments are summarised overleaf.

Summary of Similarities and Differences between treatment procedures in Experiment 1

	Treatment	
Speech Therapy	Operant Training	Non-specific treatment
1. Encouragement is given regardless of progress so patients think they are progressing	Encouragement is contingent on the correct response	Encouragement is non-contingent and did not necessarily given for uttering the required word.
2. Patients are told they are progressing	Feedback of progress is by counting tokens	No feedback of progress
3. Mainly spoken practice, but in addition use non -verbal materials such as pictures, and practice reading and writing	Entirely spoken practice. No external material is used apart from surroundings	Entirely spoken practice with no external materials used.
4. Cues are provided for missing words or the patient is encouraged to circumvent the problem using gestures and writing	Missing words are ignored	Missing words are supplied.
5. Patients progress from easy to difficult tasks as their abilities change. A variety of tasks are given	The same task is used but the response requirements are altered according to the patients abilities.	No breakdown of the task into stages according to a patients abilities. The task is always general conversation
6. General conversation at beginning and end of session and when patients are tired	The conversation is general at beginning and end of session	General conversation throughout.
7. Emphasis is on communication	Emphasis is on spoken communication	Emphasis is on the task.

5.3. Results

The test scores obtained by each subject are shown in table 6.

5.3.1. Comparison of language treatment methods

The results were analysed using the analysis of variance shown in table 7. This analysis of variance is a mixed hierarchical and cross classification analysis with repeated measures on one factor.

The design is based on two cross-classifications of group and interval factors. One is a cross-over of speech therapy and non-specific treatment. The other is a cross-over of speech therapy and operant training. Comparison of these two blocks of treatment combinations provides a means of comparing non-specific treatment with operant training. The speech therapy given in each block is the same and so any differences between blocks should be due to differences between the non-specific and operant training procedures. The comparison of groups within blocks i.e. group 1 v. group 2 and group 3 v. group 4 provides an analysis of interactions between the treatments and the intervals.

The within subject variance occurs across two time intervals. The first time interval represents the difference in performance between the second and the initial assessment. The second time interval represents the difference in performance between the final and the second assessments. The interaction between intervals and blocks is assessed by comparing cells a, c, f and h with b, d, e and g as given in table 7.

Within each block are two treatments for comparison i.e. speech therapy and non-specific treatment in the first block, and speech therapy and operant training in the second block.

There was missing data on some variables. This was partly due to some patients refusing to complete test items, for example, patient 27 refused to complete the Progressive Matrices at the third assessment. The independent assessments on the Object Naming test by the occupational therapy students were not complete as students were not always available to give the test. This occurred mostly in the final year of the experiment when no complete data was available for any patient on this measure. Missing data occurred on the Speech Questionnaires filled in by the nursing and physiotherapy staff. Patients, who were attending as day patients, no longer came into contact with the nursing staff and so the nurses were unable to complete these questionnaires. One patient recovered physically and ceased to attend the physiotherapy department so no questionnaire could be completed about his speech at the third assessment.

The missing values were estimated from the treatment group mean and the corresponding residual degrees of freedom was reduced by one for each missing value inserted. The missing values inserted in the analysis are shown in table 8.

The analysis was carried out by computer.

The mean scores for the various cells of the analysis of variance table are shown in tables 9 and 10. The F values obtained from the analysis of variance are shown in table 11.

All the F values obtained were non-significant apart from eight which were significant at $p < .05$ and three which were significant at $p < .01$. Since 234 F values were calculated these could have occurred due to chance alone and therefore cannot be interpreted as indicating significant differences between the various factors.

The F values significant at $p < 0.01$ were relatively large and may indicate real differences. These significant values indicate that speech therapy produced a greater improvement in Progressive Matrices score than the non-specific treatment. The mean change was 5.92 for speech therapy and 0 for non-specific treatment for patients in the first block ($n = 12$).

The non-specific treatment prodcued a greater change in communication ability, as rated by the nursing staff using the Speech Questionnaire, than speech therapy. The mean change with the non-specific treatment was +2.10 whereas the change with speech therapy was -0.71 for patients in the first block ($n = 12$).

Communication ability, as assessed by physiotherapists on two questions of the communication scale of the Speech Questionnaire, improved significantly more during the first interval than the second. The mean improvement in the first interval was +0.61 whereas in the second interval there was a mean change of -0.69 ($n = 24$).

The F values significant at $p < 0.05$ are likely to be chance findings. However, they suggest various differences between conditions which need to be considered. Interval effects occurred on two variables, P.I.C.A. I and P.I.C.A. IX. Patients improved more during the first interval than the second on both tasks.

Interactions between interval and blocks significant at the 5% level occurred for three variables. Object Naming, Picture Description and P.I.C.A. D, are presented graphically in figures 1, 2 and 3. They indicate that on the two verbal tasks, Object Naming and Picture Description, patients in the first block improved more in the first interval whereas those in the second block improved more during the second interval. Since there was no difference between treatments, and speech therapy occurs in both the first and second blocks, interpretation of these results are not clear. The interaction effect for P.I.C.A. D indicated that patients in the second block became worse during the second interval.

Treatment effects significant at the 5% level occurred on three measures. The non-specific treatment improved speech, as rated by the ward staff, significantly more than speech therapy. The mean change with speech therapy for these patients (n = 12) was -2.23 whereas with the non-specific treatment they improved +5.79.

On the graphics scale of the P.I.C.A. two significant differences between treatments in block 2 occurred. On test A, writing sentences to describe the function of objects, operant training produced more improvement than speech therapy. The mean change for operant training was +0.56 as compared with -0.33 for speech therapy. On test D, copying object names, speech therapy produced significantly more improvement than operant training. The average change for speech therapy was + 1.80 as compared with -0.59 for operant training.

Generally the results indicate that there are no significant differences between the three treatment conditions or the two intervals. Therefore neither speech therapy or operant training produced an improvement in language abilities greater than that which may be obtained by spontaneous recovery and an attention placebo.

5.3.2. Evaluation of Change Over Time

Improvement in scores occurs between initial and final assessments. Since this cannot be attributed to the effects of specific treatment it is assumed to be due to either spontaneous recovery, or an attention placebo effect of receiving individual treatment sessions or both.

The change in scores over both intervals was examined to determine whether significant improvement occurred. The mean values at each assessment are shown in table 12.

The t values calculated from the analysis of variance using the formula ($t = \text{mean change in score}/\sqrt{\text{within group mean square}/\text{number of subjects}}$) Armitage 1971) are given in table 13. These indicate that on most tasks significant improvement in abilities occurred. Only eight of the 39 t values calculated indicate no significant improvement in ability.

These results therefore indicate that significant improvement in language ability occurs between initial and final assessment, which may be attributed to spontaneous recovery or an attention placebo effect or both. The lack of differences between treatments or intervals is therefore unlikely to be due to insensitivity of the measured used to change.

In addition, data is available from the operant training sessions, which indicate progress over time with this treatment. The number of tokens earned in each session is shown in table 14 and presented graphically in figure 4. These indicate very little change over time, and the most noticeable feature is the very large variability within subjects across treatment sessions. The number of tokens earned at initial and final sessions was compared using a t test for paired data. The t value obtained was 3.76 which with 11 degrees of freedom is significant at $p < 0.005$. This indicates there is a significant difference between initial and final performance on the operant training task. Correlations between the change in number of tokens earned and the change in language abilities was calculated. The correlation co-efficients obtained (Pearson product moment) are shown in table 15. These are all non-significant. Change in the number of tokens earned is therefore unrelated to change in language abilities on either objective language tests or functional ratings of speech.

5.3.3. The effect of biographical variables on change in abilities

The correlations between change from initial to final assessment and the biographical variables, age , months post onset and handedness were investigated. Pearson product moment correlations obtained are shown in table 16. A two-tailed test of significance was used to determine whether the correlation co-efficients obtained were significant or whether they were likely to be due to chance.

5.3.3.1 Age

The correlations obtained between age and change were all non-significant. This indicates that age did not significantly relate to the amount of change in abilities between initial and final assessments.

The relation between age and overall change in language ability as measured with the overall PICA score, is shown in figure 5. The correlation is 0.19 which is not significant.

5.3.3.2 Months Post Onset

The correlations between months post onset and change scores are all non-significant except for one. There was a significant correlation, at the 5% level, between months post onset and Object Naming, indicating that patients who are more recent post stroke change more in their naming ability. This relation is shown in figure 7.

The correlation obtained between months post onset and overall change on the PICA is -0.27 and is shown in figure 6. Inspection of graphs showing score changes in relation to months post onset for Object Naming and overall PICA (figures 7 and 8), suggested that improvement was most marked in the first month and thereafter few changes occurred. This was tested for all variables using Jonckheere's distribution free k sample test against ordered alternatives (Jonckheere 1954). The results are shown in table 17. The values obtained for different months post onset were in the expected order of decreasing value for 11 of the 38 variables. This is more than would be expected on the basis of chance alone. The results therefore indicate that for some language abilities there is a trend of decreasing change in ability with increase in months post onset. These abilities are mostly expressive verbal abilities.

5.3.3.3. Handedness

Handedness showed a significant correlation with change on two of the variables, Picture Description and PICA XII, imitation of object names. These indicated that the more right handed improved more on these two tasks. All other correlations between handedness and change were not significant.

The correlation between handedness and overall PICA change was $r = 0.27$ which is not significant and is shown in figure 9.

Generally, therefore, there was no significant correlation between the biographical variables, age, months post onset and handedness, and change in abilities. There was however, a trend for increasing months post onset to be associated with decreasing change in expressive verbal abilities. The three biographical variables also show low partial correlations with each other. These are shown in figures 10,11 and 12.

5.3.4. The relation between results obtained by CP and an independent assessor

The agreement between the two assessors was checked by calculating Pearson product moment correlation co-efficients between the two Object Naming scores at each of the three assessments. The correlation co-efficients obtained were r = 0.84, 0.79 and 0.83 at initial, middle and final assessments respectively. These are all significant ($p < 0.01$) which indicates agreement between the two assessors.

5.3.5. The agreement between different departments in ratings of functional speech.

Speech Questionnaires were completed by one member of the nursing, physiotherapy and occupational therapy staff at each assessment. These were used to measure functional speech and communication ability.

The agreement between raters at each assessment was investigated using Kendall's co-efficient of concordance.

These results are shown in table 18. They indicate that there is significant agreement between three raters for the speech section of the questionnaire. This indicates that patients'functional speech abilities are equivalent in the different settings.

The results from the communication section as a whole and when only questions four and five are considered generally show less agreement. The agreement at the initial assessment of communication is not significant, but is significant on the second and third assessment. When questions four and five of the communication section are considered alone, no significant agreement occurs at initial and second assessments but the agreement does reach significance at the 5% level at the third assessment.

5.3.6. <u>The relation between measures of functional speech and objective test results.</u>

Pearson product moment correlation co-efficients were calculated between ratings of functional speech, the Speech Questionnaire and objective test scores. These results are shown in table 19 and indicate the extent to which the two types of measure are inter-related. Since 270 correlation co-efficients were calculated only those significant at $p < 0.05$ are shown in table 19. On the basis of chance alone 14 would be expected to be significant at the 5% level, 3 at the 1% level. Therefore as only 3 were significant at the 1% level, these may have occurred due to chance. Eighteen more were significant at the 5% level, which is more that would be expected on a chance basis. However, it is relatively few and so results generally indicate no significant correlation between improvement on language tests and improvement in ratings of functional speech.

5.3.7. <u>Response of Individual Patients to Particular Treatments</u>

The results of individual patients were examined to determine whether specific procedures were effective with individual patients even though they were ineffective for the patients as a group.

Patients'progress in relation to treatments given is shown in figure 8 for the overall P.I.C.A. score. Visual inspection of the graph suggests that speech therapy was effective for Patient 133 and to a lesser extent Patients 13, 20 and 93. These patients show little change or deteriorate with the non-specific treatment but improve with speech therapy. Operant training was most effective with Patient 84 who improved a little with speech therapy but greater gains were made with operant training. The non-specific precdure seemed to benefit those patients who were earliest post stroke. Marked improvement occurred in patients 98, 117 and 131 who were one, one and two months post stroke respectively. Little change occurred in Patients 50, 60 and 140 who were more than 6 months post stroke.

Patients' progress on tests of specific abilities in relation to particular treatments indicates similar findings, in that particular treatments benefit certain patients. These are shown in figures 7 and 13 to 16. These results are inconsistent with results from the P.I.C.A. in that it is different patients who benefit from some of the treatments.

Comprehension was improved in Patient 84 with operant training. All other changes in comprehension seem to relate to months post onset rather than treatment (figure 13). On the Object Naming (figure 7) speech therapy improved Patient 53 and operant training improved Patient 84. The graph of the Progressive Matrices (figure 16) suggests that speech therapy produced improvement in Patients 50, 93 and 133 and operant training improved Patients 85 and 104. Fluency (figure 14) was improved by operant training for Patient 84 and by non-specific treatment for Patients 13 and 20. Picture description (figure 15) suggests speech therapy improved Patient 27, operant training improved Patient 116 and non-specific treatment improved Patient 13.

Therefore all treatment procedures improve particular abilities in some patients. The patients who benefit from speech therapy and non-specific training differ according to the ability considered. The operant procedure improved Patient 84 on all tasks except the Progressive Matrices and Picture Description.

Although individual patients benefit from certain procedures in relation to particular abilities, the general trend observable in these graphs is for months-post-onset to be the predominant factor influencing recovery.

5.4. Discussion of Results

5.4.1. Comparison of language treatment methods

The results indicate that there were no significant differences in the effectiveness of the three treatment conditions for this group of patients. This is consistent with previous studies on speech therapy that have used a comparable treatment interval and type of patient (Sarno, Silverman and Sands 1970, Enderby and David 1979) but is not consistent with the evaluation of operant training by Goodkin et al (1973).

Speech therapy was no more effective than the non-specific treatment in improving language abilities. However, it did produce significantly more improvement in performance on a non-verbal intelligence test, the Progressive Matrices. This finding was not supported by Enderby and David (1979 Personal Communication) who also included the Progressive Matrices as an assessment procedure.

Speech therapy was the only treatment procedure to include visual material. Pictures were used as stimulus material on a variety of tasks and this may have provided practice in dealing with visual material. However, it is unclear why practice with visual material would improve non-verbal abilities, whereas practice on verbal tasks did not improve verbal abilities. If the improvement in non-verbal abilities observed was mediated by an improvement in right hemisphere function then it may be that improvement in a relatively intact hemisphere can occur but not in a severely damaged hemisphere. It may be that right hemisphere functioning showed some impairment due to interference effects (see section 3.2.1) but was sufficiently intact for stimulation to produce improved functioning.

Speech therapy was also found to be significantly worse than the non-specific treatment in improving communication ability on the ward. Although this might be expected on the basis of the similarity between the non-specific procedure and the type of interactions a patient would have with the nursing staff, it is difficult to interpret because of the low reliability of the measure (see section 8). When the two questions in the section with adequate reliability are considered alone the difference between treatment conditions is no longer significant. It therefore seems likely that the significant difference in communication between speech therapy and non-specific treatment is due to poor reliability of the measure and chance, rather than representing any real difference between treatment conditions. However, the speech section of the questionnaire also indicated that the non-specific treatment produced significantly more improvement in speech on the ward than speech therapy ($p < 0.05$). This section has adequate reliability and so this difference is unlikely to have resulted from poor reliability of the measure used. There is an additional problem, which is that a parametric analysis of variance was used. The Speech Questionnaire scores although likely to be normally distributed are probably not an equal interval scale. The results from the questionnaire need to be interpreted with this in mind. An equivalent non-parametric analysis was not available and so the parametric analysis was used. Despite these problems the results do suggest that the non-specific training improved functional speech more than speech therapy. However, this effect seems specific to the ward situation. Corresponding differences did not occur in the physiotherapy and occupational therapy departments. The F values obtained from analysis of ratings from the Speech Questionnaire in these two departments are relatively small and therefore do not approach significant levels.

The significant interactions between intervals and blocks are difficult to interpret since they represent combinations of treatments. Speech therapy occurs in each combination of interval and treatment block and so it is difficult to account for differences observed when the same treatment is given. It may be that these findings are due to chance alone and do not represent real differences between the various conditions. Even if they do represent real differences, they are so difficult to interpret that until further studies are available the findings are of little practical value.

The differences between operant training and speech therapy on the graphics scale may also be chance findings. Since one aspect of writing ability is improved by each treatment, this seems likely. The results on the other FICA graphics tests do not approach significance which might be expected if there were real differences according to the treatment procedure. Test F, which also involves copying, might be expected to improve more with speech therapy, but this does not occur. Similarly test B, writing object names spontaneously, is the most similar to test A,. yet does not indicate any tendency for operant training to produce more improvement than speech therapy.

5.4.2. Change in abilities over time

5.4.2.1 General improvement

Improvement in abilities occurred which cannot attributed to the effects of specific treatment. It is therefore assumed to be either due to spontaneous recovery or to an attention placebo effect of receiving individual treatment sessions, or a combination of both.

It is likely that spontaneous recovery was occurring in these patients because they were all relatively young and recent post stroke. Patients were all under 65 years, which is relatively young for stroke patients. If, as some literature suggests, young patients recover better (see section 3.2.3) then the patients included in this experiement would be likely to recover spontaneously. The patients were also relatively recent post stroke. Fourteen patients were three months or less post onset and at this stage spontaneous recovery is probably more marked (Culton 1969, Basso, Faglioni and Vignolo 1975). Six patients were between three and six months post stroke, when spontaneous recovery is thought by some authors (Vignolo 1964, Kertesz and McCabe 1977) to have an observable effect. It is likely that spontaneous recovery would account for a large proportion of the improvement in test scores.

Improvement in most abilities was marked and probably due to spontaneous recovery and this may account for the lack of treatment effects found. Spontaneous recovery may have contributed so much to improvement that it masked any differential effects of the treatments given. Any of the treatments would have added so little to the recovery process that they appeared ineffective.

5.4.2.2. Interval effects in the Analysis of Variance

The analysis of variance (section 5.3.1) included an investigation of interval effects. This evaluated whether there were any differences in improvement between their improvement within first and second intervals. In view of the expected pattern of spontaneous recovery, marked initially and decreasing over time, it was surprising that so few significant differences between intervals were recorded. One was significant at the 1% level and two at the 5% level which might have occurred on the basis of chance alone.

P.I.C.A. I and P.I.C.A. IX both indicate that expressive verbal abilities are improving more in the first interval than the second. It is also on these tasks that most spontaneous recovery occurs (section 5.3.2.) and so there is possibly more scope for differential effects between intervals to be observed.

Physiotherapists ratings of communication abilities on questions four and five of the scale indicate greater improvement in the first than the second interval. These questions are concerned with anxiety about communicating and appreciating opportunities to communicate and, on a theoretical basis, would not be expected to differ across time intervals. An initial decrease in anxiety might have occurred as the patient got to know his physiotherapist and thereafter no further change would occur. As anxiety decreases, the patient may then appreciate opportunities to communicate rather than feeling too anxious to communicate. These results seem to have a plausible explanation but similar findings would be expected on the ward and in occupational therapy, which did not occur.

5.4.2.3. Operant training

The operant training procedure did not generally show significant differences from either speech therapy or the non-specific treatment procedure. This is not consistent with data from Goodkin et al (1973) who found more improvement in their operant training group than their control group which received non-contingent reinforcement (see section 4.2.) However, they did not analyse the data statistically so the significance of the differences obtained is not known and they used different outcome measures i.e. FCP and change in target behaviours.

The graph of tokens earned in the operant training session (figure 4) indicates very minimal improvement. The most noticeable feature is the very large variability within subjects between sessions. This lack of improvement could have been due to the lack of reinforcement. The'reinforcers' used, praise and feedback of progress, were not shown to be effective for each individual patient, therefore they may not have had any reinforcing properties and so no improvement in performance would be expected.

Praise and feedback of progress were assumed to be reinforcing since most patients were concerned about making progress towards recovery. They would also be 'prepared' stimuli (Seligman 1972) and therefore acquisition would be more likely than if'unprepared' stimuli had been used. However, since a large amount of recovery is occurring spontaneously further indications of recovery might have been inadequate as a reinforcer. The patient might be aware of his own improvement and the feedback given would merely serve to increase the frequency of reinforcement within a variable ratio schedule. The likelihood that this will significantly affect performance rates, when very few reinforcement events occur within a short space of time, is low.

There are also no significant correlations between change in the number of tokens earned and change in language abilities, as measured with objective language tests or functional ratings of speech. This suggests that the operant procedure had no effect on abilities and the improvement noted for these patients was entirely due to spontaneous recovery or an attention placebo effect or both. It might be expected that if spontaneous recovery is producing improvement in abilities than corresponding changes in abilities would occur, as reflected by the number of tokens earned. As this does not seem to be the case,it may be that the operant training procedure actually hinders the patients' performance and hence no improvement in the tokens earned occurs.

5.4.3. Effect of Biographical variables on change in abilities

5.4.3.1. Age

The lack of correlation between age and change in ability may have resulted from the method of selecting patients for inclusion in the experiment. The upper age limit was 65 years because this was the oldest that patients were admitted to the rehabilitation unit. Patients who were dysphasic after a stroke and over 65 years attended geriatric rehabilitation departments. Few strokes occur in people under 40 years and so most patients attending for rehabilitation were in the 40 - 60 age group. Within this narrow range age may have little significant effect. It may be only when patients up to 70 or 80 years are included in studies that age relates to changing abilities. However, the present finding is consistent with most of the recent literature which indicates that age is of relatively minor importance (see section 3.2.3.).

5.4.3.2. Months Post Onset

The correlations between months post onset and change scores are all non-significant except for one. This one suggests that patients who are more recent post stroke change more in their naming ability. However, in view of 39 correlation co-efficients having been calculated, two would be expected to be significant on the basis of chance alone. This may therefore be a chance finding. In addition, the correlation obtained between months post onset and object naming, given by an independent assessor, was -0.01 which is not significant. This latter result was based on fewer patients than the Object Naming given by CP, but as it is so low it makes it likely that the significant correlation obtained for Object Naming was due to chance.

The lack of correlation between months post onset and change in ability suggests that the two are unrelated. However, inspection of graphs of change in relation to months post onset suggested that significant improvement might occur in the first month post stroke and thereafter few significant changes occur. If this were the case then it would not necessarily be apparent from a correlation co-efficient, therefore a test of trend was also used. Jonckheere's test indicated that change scores were in the expected order of decreasing value with increasing months post onset on 11 of the 39 variables. All except two of these variables with significant results, were for tests of expressive verbal abilities. These tests included naming, describing a picture, verbal fluency, sentence completion and therapists' ratings of speech. The one test which did not show a significant trend, which might be expected on the basis of the above results, was the Object Naming test given by an independent assessor. However, the sample size for this variable was very small, due to missing data, and this may have affected results. The two tests which showed a significant trend, yet did not involve expressive verbal abilities, were P.I.C.A. test VII and P.I.C.A. overall score. P.I.C.A. test VII, reading cards and placing them in a position specified in relation to a given object, showed the trend of more recent aphasics improving more. However, test V reading cards and placing them in a position specified in relation to an object designated by function did not show a trend significant at the 5% level, but it was significant at the 6% level and therefore shows some consistency. This suggests that the significant result for P.I.C.A. VII may have not been entirely due to chance. The overall score of the P.I.C.A. showed the trend of more recent aphasics improving more and as this is a composite score, derived from different abilities, it may only reflect the fact that some of its components show a significant trend.

There is therefore a trend for expressive verbal abilities, and to a lesser extent reading, to improve more early after a stroke and the amount of change occurring to decrease with time. This trend is not evident on related language tasks involving comprehension, gestural expression and writing, or on a measure of general intellectual ability.

The finding of significant trends but non-significant correlations of months post onset with change may have resulted from the narrow range of months post onset of patients in the experiment. Twenty of the twenty four patients were six months or less post stroke. However, as it is within this six months that most differential effects of months post onset should occur, after six months patients' abilities are not expected to change, so this seems as unlikely explanation. It therefore seems more likely that the period of marked spontaneous recovery may be very short, such as one month, and thereafter few significant changes occur. There is however, considerable variability between patients in their relative recovery rates.

The results of this experiment indicate that recovery is occurring and treatment is ineffective. It may be that treatment should commence at a stage when spontaneous recovery has ceased.

However, the graphs of overall P.I.C.A. scores (figure 8) for patients who received treatment more than six months post stroke does not support this hypothesis. All four of these patients received four weeks speech therapy and four weeks non-specific treatment. Three of these four, i.e. patients 50, 60 and 140, show little improvement and no differences between treatment conditions. Patient 133 does show a beneficial effect from speech therapy. After four weeks of non-specific treatment her overall P.I.C.A. score had decreased slightly but with four weeks speech therapy this improved markedly. The change cannot be attributed to spontaneous recovery as she was eight months post stroke and had not improved during the non-specific treatment period. It is however, interesting to note that this particular patient was young, i.e. 28 years, and very highly motivated towards speech therapy.

None of the patients in this experiment who received operant training were more than six months post stroke. The previous studies on the operant training procedure (Goodkin 1966, Goodkin et al 1973) were conducted on patients who had ceased to improve with speech therapy. The procedure may be appropriate at that stage, as it aims to make best use of language abilities that remain, whereas it may be inappropriate in the early months post stroke while the patients' available language is changing.

5.4.3.3. Handedness

Since 39 correlation co-efficients were calculated the two significant at the 5% level may have occurred due to chance alone. It should be noted that these two significant correlations are in the unexpected direction. The more right handed improved more whereas the previous literature suggests (see section 3.2.6) that left handers or those with mixed handedness improve more.

5.4.4. The relation between results obtained by CP and an independent assessor

The object naming test was administered by an independent assessor as well as by CP in order to check for any bias, since CP was a therapist as well as an assessor. The agreement in results between these two assessors was therefore investigated.

Results from the analysis of variance comparing treatment methods were similar. No significant differences occurred between non-specific treatment and operant training, speech therapy and either non-specific treatment or operant training or between intervals according to either assessor. However, a significant interaction, interval x block, was obtained in the analysis of CP's results which did not occur with results from the independent assessor. However, this seems unlikely to reflect bias on the part of CP since it is a relatively unimportant finding as regards its implications, and would be difficult to produce even with deliberate bias. One additional problem which arises when comparing the two sets of results is that there were fewer patients assessed by the independent assessor than by the CP.

Improvement in Object Naming, significant at the 0.5% level, occurred for both assessors. Correlations between Object Naming and biographical variables, age and handedness, were not significant for either assessor. Months post onset showed significant correlation with Object Naming administered by CP, but not when administered by the independent assessor. This again could be due to differences in the patient sample.

The agreement between the two assessors was calculated for these patients for whom there was complete data. The correlation co-efficients obtained indicated significant agreement between the two assessors.

In view of the high agreement between assessors and the consistency between them in the conclusions reached, it seems unlikely that CP was biased in her assessments, as a result of being a therapist. The results from CP can reasonably be assumed to be unbiased measures of patient performance.

5.4.5. The agreement between different departments in ratings of functional speech

The agreement between the nurses, physiotherapists and occupational therapists in rating speech abilities was high. This suggests that functional speech in the three departments is equivalent and not specific to the setting. However, on the speech section the nurses results indicate a significant ($p < 0.05$) treatment effect which did not occur for the ratings by physiotherapists and occupational therapists (see section 5.3.1).

The agreement between raters was much lower on the communication scale. This could be due to the low reliability of this section of the Speech Questionnaire (see section 8.1). However, even when only questions 4 and 5 are considered, which were found to have adequate reliability, the agreement between raters is even lower. This suggests that the poor agreement between departments may not entirely result from low reliability of the questionnaire. Therefore, there may be real differences in patients' communication abilities in the different settings. On the ward communication would involve general conversation and very practical day to day tasks, such as dressing and bathing. Communication in physiotherapy and occupational therapy is likely to be far more task oriented. On this basis one might expect greatest difficulty in occupational therapy and least on the ward. The average score obtained in each department at each assessment (see table 11) indicate that communication abilities are consistently rated higher by the nurses than the occupational therapists. Ratings on the communication section, are higher in the physiotherapy department than in occupational therapy ratings but vary in relation to ward ratings. When questions four and five are considered the trend is for occupational therapy ratings to be higher than those on the ward. It therefore seems that communication ability as a whole is better on the ward than in occupational therapy, but when patients' anxiety about communicating and their appreciation of opportunites to communicate is considered, they have fewer problems in occupational therapy than on the ward. Ratings in physiotherapy show no consistent trend in this respect.

5.4.6. The relation between measures of functional speech and objective test results.

The results indicate little agreement between improvement on objective tests and improvement in functional speech. There are no significant correlations between improvement in test score and improvement in speech as rated in the different departments. This suggests that improvement in language abilities is not necessarily associated with an improvement in the speech that a patient uses and therefore makes generalization of change from therapy to other settings unlikely even if therapy can produce a change in abilities. Both types of measure show improvement over time, which is presumably largely due to spontaneous recovery, but the two are not directly related.

Some correlations between improvement in communication ability and test score change were significant. However, the communication measure has been shown to not be reliable (see section 8) which limits interpretation of these results. When questions 4 and 5 are considered separately some correlations are significant but these do not show a consistent pattern. Ward C(4+5)seems to be positively related to improvement in writing (P.I.C.A. D, E, Graphic) but this seems to be likely to be a chance finding. Improvement in writing ability seems unlikely to decrease patients' anxiety about communicating and increase their appreciation of opportunities to communicate, and even more unlikely that this effect would be specific to the ward and not also occur in physiotherapy and occupational therapy.

The lack of significant relation between test improvement and change in functional speech also raises the question of the validity of the Speech Questionnaire as a measure of language ability. However, in a 'severe' aphasic group correlations between the two types of measure are high (see section 6.), and so it seems likely that it does measure language ability.

The lack of agreement between the two types of measure also indicates that future studies should include both types of measure in the evaluation of treatment. If treatment is effective in improving test performance but does not produce an improvement in functional speech it is unlikely to be of any practical value to the patient. It would, however, have theoretical implications for the design of treatment procedures and the mechanism of recovery. The measurement of functional speech has not been adequately developed and this will be necessary before further studies can provide the required information.

5.4.7. Response of individual patients to particular treatments

The overall P.I.C.A. score provides a general measure of language ability and so is the most important when considering overall effects of treatment. On this measure patient 133 showed a beneficial effect from speech therapy. She was young, 28 years, as was patient 93, 18 years, who also benefitted from speech therapy. However, patients 13 and 20, who show a similar response to patient 93, were older, 52 and 39 years respectively. The other noticeable characteristic of patient 133 was her very high motivation, which was not as marked in most other patients. Patients 93 and 133 also improved on Progressive Matrices with speech therapy, which suggests that the beneficial effect is not specific to language tasks.

The patient who made most noticeable gains with the operant procedure was patient 84. He was a 55 year old man 3 months post stroke. His most noticeable characteristic was that he was a fluent aphasic. He produced a lot of speech with many paraphasias and occasional jargon. He may have benefitted from operant training because his high verbal output provided many opportunities for contingent reinforcement. Patients producing few words in a session will have less reinforcement opportunities than patients with a high verbal output. Patient 84 seemed to use the feedback in the form of tokens and verbal praise, for example, 'good' and 'that's right', to monitor his own conversation. There were no other fluent aphasics in the experiment with whom to compare patient 84 to help evaluate whether fluency might be an important factor determining response to operant training. However, it does seem that this might be worth investigating in future studies. It is also interesting to note that improvement occurred on all language tasks but not on the Progressive Matrices, which suggests the operant training, unlike speech therapy, is relatively specific in the abilities improved.

Improvement in overall P.I.C.A. with non-specific treatment seems more closely related to months post onset than to responses of individual patients. However, it did appear to have a beneficial effect on Fluency for two patients, 13 and 20. There is no obvious feature of these patients or of the treatment procedure to explain this finding. Generally therefore the non-specific procedure is having very little treatment effect even when individual patients are considered and so the recovery observed is probably really a non-specific effect of any treatment or spontaneous recovery or both.

These results suggest that if factors which predict response to a particular treatment can be identified then more effective treatment regimes might be developed. However, a variety of further studies are needed before this is likely to become possible. This study has only provided very tentative suggestions on possible factors. More detailed individual case studies with reversal from treatment to no treatment and attention placebo conditions at various stages would provide further indication of suitable factors to investigate. This method would also have the advantage of not requiring large groups of patients.

5.4.8. Implications of Results for future studies

5.4.8.1. Generality of Results

5.4.8.1.1. Patient Selection

The results obtained in this experiment are from a highly selected group of aphasic patients. They are not necessarily typical of aphasic stroke patients and so any generalization of findings from this population to other groups will be limited.

They are all relatively young and recent post stroke. As these patients should be the most likely to respond to treatment it seems unlikely that more favourable results would be obtained with older or longer term stroke patients. Speech therapy is normally begun early so that it can utilize the spontaneous recovery process occurring simultaneously with a treatment effect. However, there is no clear evidence that this significantly affects outcome. From the present results it seems that in the early stages it might be better to leave patients without treatment to see how far they will improve spontaneously. Then, when their abilities cease to show improvement without treatment, to introduce a treatment procedure to determine whether any additional gains can be made. Treatment could be continued while abilities were improving and then discontinued or changed when abilities ceased to change.

5.4.8.1.2. Severity of Aphasia.

The degree of aphasia in patients in this experiment also covered a narrow range. In practical terms, the patients included were those who could say a few words but not speak in complete sentences. On the P.I.C.A., this represented an overall score between the 35th and 65th %ile. This selection was done to ensure all treatments were appropriate for all patients. Studies on prognosis in aphasia suggest that (section 3.2.2.) the more severe aphasics improve less, which would indicate that as treatment was ineffective in this group it would also be ineffective with more severely aphasic patients. Further investigation of the effect of treating severe aphasic patients is given in Chapter 6. No conclusions can be drawn from these results on the effect of treatment in mildly aphasic patients i.e. those excluded as 'too good' in the present study.

The method of referral to the rehabilitation unit may also have influenced the characteristics of the patients included in the study. Some patients were several months post stroke, and these may have been sent to the unit, rather than attending for speech therapy in their local hospital, because of lack of progress. Patients making good progress would be unlikely to be referred, unless there were social or domestic reasons or progress in physical abilities was slower than expected. This means that more severe aphasics and those making little progress are more likely to be included in the study as compared with a study conducted in a district general hospital.

The distribution of P.I.C.A. overall scores in the group of patients referred to the speech therapy department suggests that the unit may receive more severe aphasics. The 'moderate' group in Experiment 1 represent thirty percent of the P.I.C.A. standardization sample and are thirty percent of the group referred for speech therapy. Thirty seven of 121 patients initially classified as 'too good' 'moderate' or 'severe' were in the 'moderate' category i.e.30%. However, there were more 'severely' aphasic patients in the present referral group than in the P.I.C.A. standardization sample. In the present series 42% were 'severe' i.e. below the 35%ile, whereas only 27% were 'mild' i.e. above the 65%ile. The results reported are therefore applicable to approximately a third of aphasic patients in the under 65 year age group. Considering that results indicate that treatment has no significant effect, it is a substantial proportion. If this group were no longer treated and efforts concentrated on the remaining 66% they would receive a considerable increase in treatment time. However, the question of whether they would benefit remains to be answered.

5.4.8.1.3. <u>Intensity of treatment</u>

The intensity of treatment given was selected on the basis of current practice within the speech therapy department. Twelve half hour treatment sessions within 3½ weeks was considered average. The question arises as to whether this amount of treatment is so little that it is unlikely to have any effect, and whether if more intensive treatment were given, it might produce a beneficial effect. This question is unanswerable without further studies. However, since the present allocation of treatment time seems to have no signficant effect, it might be more productive to treat a few patients intensively and some not at all. In this way the effect of intensive treatment could be evaluated and, if found to be effective, there would be reason to improve treatment facilities.

The amount of treatment given is comparable to other studies in progress. A stroke rehabilitation study at Northwick Park Hospital (Smith 1978) is comparing intensive treatment which includes 4 hours speech therapy per week for dysphasic patients, with standard treatment, including 2 hours per week speech therapy with no treatment. Two comparisons of treatment by volunteers with treatment by speech therapists are in progress, one of which involves 30 hours in 15 to 20 weeks (Enderby and David 1978) and the other involves 3 to 5 half hour treatment sessions per week (Wechsler 1978). Therefore, although a limited amount of treatment time is involved, this is representative of general clinical practice.

5.4.8.1.4. Therapists

The generality of the results is also affected by the representativeness of the therapists. The therapists in the Study were the only ones available, so the extent to which results obtained by them relate to results obtained by other therapists is open to question. The operant training and non-specific treatment were given by one therapist, CP, speech therapy was given by two other therapists, ST1 and ST3. If the therapists were all poor therapists then the results obtained could then have been due to inadequate therapy. The inclusion of two speech therapists means that results are more likely to be representative of speech therapists in general than if only one therapist were involved. They were also both qualified and experienced in working with dysphasic patients. They probably had more experience working with adult aphasic patients than most speech therapists working in general hospitals. The operant training was carried out by a qualified clinical psychologist experienced in working with stroke patients. There was no reason to expect these therapists to be relatively poor compared with other therapists. Although no conclusions can be drawn about the specificity of results in the present study without replication studies, it does seem unlikely that the results obtained could be entirely specific to the therapists involved.

5.4.8.1.5. Content of therapy

The content of the operant procedure is fairly precisely specified. Variation may occur in judgements of whether responses fit a particular category or consequently whether they should be reinforced or ignored. The reinforcing value of the therapists attention and praise may depend on the patieht-therapist relationship established through general conversation at the beginning and end of each session. Apart from these aspects, there is probably little variation in content of operant training for different patients, or across different sessions.

Speech therapy involves different procedures both within a session, between sessions and between patients. The content of treatment is therefore more varied as well as being less precisely specified. Records are not kept of performance throughout each session and often the therapist will use the same materials to work on different aspects of language and different materials for different patients. The patient-therapist interactions are not defined at any stage in treatment and similarly not recorded. It is therefore impossible to determine how the content of the speech therapy given is typical of that given generally by speech therapists. There are two ways in which this could be remedied. One is by more precise recording of performance and patient-therapist interactions during treatment so that the content of the therapy is open to examination. The other is by replication of the study using different therapists, who would be likely to conduct their speech therapy in a slightly different manner. The former would probably be a more constructive approach since it would allow evaluation of the effects of particular features of treatment on particular aspects of performance.

The generality of the results is therefore limited to some extent by the type of patients seen and the therapy given. Further studies are needed to see if present findings are replicated, and to consider different groups of patients or therapists. However, it does seem that speech therapy and operant training are probably ineffective given under present conditions. More intensive treatment given at a stage when a patient is not improving spontaneously would seem to be the most important follow up to the present study. If this is ineffective then it seems unlikely that therapy in its present form is of practical use. The second major aspect is for development of precise recording of the content of therapy so that effective elements from within the total treatment packages may be obtained, and the ineffective 'fillers' excluded.

5.4.8.2. Practical and Design Considerations

Much of the design of the experiment had to be based on practical limitations rather than purely experimental design consideration.

The number of patients available at any one time, or over a period of time, was limited. There was no direct way of increasing the number of aphasic stroke patients admitted to the unit. The admissions when they occurred were not evenly spaced. This meant that at times there were 4 patients in the experiment at any one time and at others there was none. Allowances of therapist time had to be therefore based on a possible maximum, otherwise they would not have been able to cope with the increased case load. The range of patients suitable for inclusion was also small and numbers were likely to be low. This meant that the experimental design had to be suitable for small numbers of patients. It was anticipated that far more patients would be suitable for inclusion than in fact occurred. The aim was to include a total of 48 patients over a period of 3 years. As it took 3½ years for 16 patients to be completed, it was apparent that 48 patients was an unrealistic goal and the target number was reduced to 24,a number which took 4 years.

Any treatment trial involving patients is likely to be limited by their medical condition. These patients all had a cerebral vascular accident which is a serious illness and one which is likely to recur. Those patients most recent post stroke were likely to be medically unstable. This meant that interruptions in treatment programme due to illness, raised blood pressure and epileptic fits, were unavoidable. In order to avoid most of these problems it would have been necessary to only include patients who were more than 6 months post stroke and had no medical complications and these patients are rarely admitted to the unit. Even then, there would remain the possibility of epilepsy occurring as a late sequel of brain damage.

Admission and discharge dates tended to be determined according to therapists and doctors plans. However, patients would often become homesick, particularly if they were a long distance from their homes and their relatives could not visit. Some also left early because they did not like the unit or the treatment they were receiving or became depressed and refused to participate in the treatment programme. Some with relatively mild speech problems did not consider they needed further treatment and left early. Many patients went home for weekends and it was often following a weekend at home that they refused to return. In these cases it was therefore not possible even to assess them before discharge and evaluate their progress according to the treatment they had received. Thirteen moderate aphasics out of 37 failed to complete treatment sufficient for inclusion in the trial.

All these variables influenced time intervals between assessments and the distribution and number of treatment sessions.

Therefore if a rigid programme had been required no data would have been available. It was therefore necessary to compromise between the design targets and the practical feasibility of meeting these with each individual patient.

Another practical limitation on the design was the involvement of various members of staff throughout the unit. The most involvement apart from the author lay with the speech therapists. They had no personal commitment to the research project, but participated out of interest. Their co-operation was vital and no difficulties were encountered. However, because their prime responsibility was to their clinical work, they could not give priority to the patients included in the research trial. Although they did this whenever possible, there were times when they could not see patients as often as required or on the exact day when the assessment was due.

A similar situation arose with the occupational therapy student giving the Object Naming test as an independent check on CP. The Speech Questionnaires filled in by the occupational therapists, physiotherapists and nurses could not always be done on the required day. The staff might be off-duty that day, too busy or forget and consequently these were filled in on a later date. It seems that this is likely to arise whenever the prime responsibility of those involved is not to the research project.

Although these practical difficulties were encountered, and meant that the original design was not precisely adhered to, no systematic deviations were noted that would be likely to affect the results obtained. The variations in timing of patient assessment and treatment, and the large proportion of drop-outs do not seem to involve systematically any particular treatment or therapist.

5.4.8.3. Ethical Considerations

Speech therapy has been given to dysphasic stroke patients for many years. Despite the fact that no-one has shown conclusively that it influences the course of recovery it is considered by a large proportion of the medical and paramedical professions as an essential component of treatment for dysphasic stroke patients. Some consider that its effects are purely psychological rather than actively changing the patients' language abilities, but nonetheless they consider that even if this is its role, it is an essential one. For these reasons the consultant who had clinical responsibility for the patients specified at the outset all patients should have some speech therapy. This specification was also based on previous experience of patients who were not receiving speech therapy complaining.

However, for part of the time patients were receiving a non-specific treatment which might not be expected to help patients' language abilities. It would however, provide the psychological support, which is sometimes specified as the sole function of speech therapy (Hopkins 1975). It was therefore felt that this, and the lack of evidence either for or against speech therapy, meant that it would be an appropriate procedure to include in the treatment trial.

Most of stroke rehabilitation procedures such as physiotherapy, occupational therapy and speech therapy have not been evaluated and so there is no evidence that by not receiving any of the treatments involved a patient would be deprived of a chance of recovery. Many patients, in other hospitals, are discharged home following a stroke with no further rehabilitation once medical care is no longer necessary. This occurs either because resources are not available or because remedial therapy is not considered necessary. Patients at Rivermead are therefore getting considerably more treatment than average and this means that even without speech therapy, they receive relatively intensive treatment. The withdrawing of speech therapy services for some patients in this situation therefore meant that they received additional occupational therapy rather than no treatment.

In addition the treatment trial represented a very short time span in relation to the whole process of recovery from a stroke. Any lack of treatment for one month, would be unlikely to affect the course of recovery when considered at a year after the stroke.

Therefore ethical considerations have not presented a problem in the present study, and would be unlikely to limit future studies of this nature.

5.4.9. Theoretical Implications

5.4.9.1. Speech Therapy

The theoretical framework of speech therapy becomes open to question as the treatment derived from it does not appear to be effective. Since speech therapy is a treatment 'package', the contribution of the separate components may need to be investigated in order to determine why it was not shown significantly to affect the course of recovery. Some aspects have been evaluated, for example, the use of cues, but the basic concepts of stimulation, multimodal responding and non-contingent encouragement need further investigation.

Recent developments in speech therapy technique have included systematic recording of progress, recording of treatment procedures used and the application of behavioural principles in the management of patients. These may facilitate a more precise evaluation of the essential and redundant components in the treatment package such that its effectiveness may be improved. A study in progress which is attempting to do this is reported by Enderby and David (1978). They are recording the aims of specific activities within a treatment session and relating the amount of time spent on a particular language ability to improvement in that ability.

This is based on the assumption that practice on a particular task will improve the abilities involved in doing that task. This may be an inappropriate basis for treatment. An alternative would be to provide the patient with means of circumventing problems likely to be encountered rather than practicing them. For instance, it may be more appropriate to teach a patient to draw pictures of objects to indicate his meaning rather than trying to write the names of objects.

5.4.9.2. Operant Training

The operant training procedure produced little change in ability on the training task. This may have been a result of ineffective reinforcement. Feedback of progress and praise may provide insufficient incentive for improvement to occur. This seems surprising in view of most patients concern about progress and apparent pleasure when rewarded with such comments as 'good' and 'that's right'. An alternative explanation is that the patients do not have the ability to produce the necessary language and no amount of reinforcement will increase it. Those patients who might benefit from the operant training procedure are the ones who have more language available than they generally use. It is often observed that patients can do activities but they don't. For example, they may be able to speak in sentences but generally use single words to convey their meaning. In these instances the operant training would serve to encourage use of available language rather than develop available language.

The one patient to benefit from operant training was a fluent aphasic. In this instance the reinforcement may have provided the necessary feedback for the patient to be able to monitor his own speech. It is however, not clear how any carry over occurred when direct feedback was no longer being applied. It would, however, seem worth attempting the operant training procedure with more fluent aphasics to determine whether this was likely to have been a chance result.

For some patients, the low level of responding may have made it unlikely for sufficient appropriate responses to be made within a treatment session for reinforcement to have an effect. In these cases a more reliable means of eliciting the required response is needed. Techniques, such as verbal prompting, might have facilitated responses which could then have been reinforced. Modelling of responses was used by Goodkin (1969) and this may also help to guarantee a response being elicited from the patient.

Another possible reason for relatively little change in treatment sessions is that non-reinforcement of responses was occurring at other times. This would mean that the desired responses would be on a partial reinforcement schedule with a very low reinforcement rate. Consequently any behaviour change would be expected to be very slow. However, it would also mean that extinction would be relatively unlikely and consequently expressive abilities would be maintained although at a low level.

5.4.9.3. Spontaneous Recovery

The lack of effective treatment and the marked improvement over time, with a trend of decreasing change with increasing months post onset on some tasks, suggest that spontaneous recovery had a very important effect in these patients. This effect seems to be most marked for expressive language abilities. It is generally assumed that an improvement in comprehension has to precede improvement in expressive language. It is possible that the improvement in comprehension occurred so early that by the time the patients were assessed initially the marked change in comprehension had already occurred. Figure 13 shows the change in token test scores and does indicate quite marked changes in the first month, with little improvement thereafter. Change in expressive language may take longer and consequently show a significant trend with increasing months post onset.

Since treatment when spontaneous recovery is occurring appears to be ineffective, it might be that it is effective when spontaneous recovery ceases. This would be at different stages according to the ability considered. Early on comprehension may need treatment while expressive language is still recovering spontaneously. At a later stage work on expressive language tasks may be appropriate.

Generally these results seem to indicate that spontaneous recovery is marked and decreases over time. It does, however, seem to be unrelated to age or premorbid handedness in the group studied.

5.5. Conclusions

This experiment has shown that there was no significant difference between operant training, speech therapy and a non-specific treatment in improving the language of 24 'moderate' aphasics. Patients improved but this was unrelated to the treatment given. It was therefore likely to be due to spontaneous recovery and an attention placebo effect. The recovery observed did not relate to age or handedness, but was related to months post onset for some language tasks. These mainly involved expressive verbal abilities. There was also no consistent relation between improvement on tests of language abilities and ratings of functional speech, indicating that even if change is partly due to an attention placebo effect of individual treatment generalization from therapy tasks to practical use of speech probably does not occur.

Therefore, the treatment procedures currently used with moderately aphasic patients at Rivermead Rehabilitation Centre contribute little to the rehabilitation of their language problems.

CHAPTER 6

EVALUATION OF LANGUAGE TREATMENT METHODS WITH SEVERE APHASICS

6.1 Experiment 2 - Preliminary investigation of Variables and Assessment Procedures appropriate for Evaluating Treatment with Severe Aphasics

6.1.1 Introduction

Experiment 2 was a pilot study for Experiment 3, to check that assessment procedures used in Experiment 1 were appropriate for severe aphasics and to determine which variables needed to be controlled when evaluating treatment effects.

The aims were to investigate whether language abilities showed a significant improvement over a 4 week interval. The relation between this change and age, months post onset and number of sessions speech therapy was to be investigated. It was expected that younger patients, those with recent onset of aphasia and those receiving more speech therapy would improve most. Comparison of patients receiving more speech therapy with those receiving less would be expected to indicate differences at the second assessment. An additional aim was to investigate whether different assessment procedures intercorrelate highly. If this were to be the case then some could be excluded from subsequent experiments on the basis of being redundant.

6.1.2 Method

Eighteen aphasic patients who were rejected consecutively from Experiment 1 on the basis of being 'too severe' were used as subjects. These patients were all severe aphasics, according to the criteria used in Experiment 1 (see section 5.2.3.6), following a stroke 1 to 9 months previously (mean 4.00 S.D. 2.49 months). The group consisted of 12 men and 6 women age 39 to 64 years (mean 49.6 S.D. 7.9 years). All were in-patients at Rivermead Rehabilitation Centre and admitted between 06.12.73 and 20.03.75.

Patient characteristics are shown in table 20.

6.1.2.2 Assessment

Each patient was assessed during his first week of admission using the assessment procedure for Experiment 1 (see section 5.2.3.3). Patients were reassessed 4 weeks later on the same battery of tests. Parallel forms of the Token Test and Object Naming Test were used on the second occasion.

The Edinburgh Handedness Inventory was given but proved difficult to score. Patients either failed to understand the questions and consequently could not answer or gave unintelligible answers, such as saying 'right' and pointing to the left hand. Although test scores were obtained these are of doubtful validity.

Assessment was carried out by CP and the PICA was given by a speech therapist (ST1 or ST2). Reassessment was carried out by CP for tests initially given by CP and by ST1 or ST2. Independent assessors were not used for the PICA. The PICA was given by the therapist treating the patient, or if she was unable to do the assessment, the PICA was given by CP.

6.1.2.3 Treatment

The treatment interval chosen was 4 weeks in order to be comparable to the treatment period used with moderate aphasics in Experiment 1 and controls in experiment 4. Changes in ability would be expected during this period and patients were often admitted to the unit for 4 weeks with the aim of improving their language abilities.

During the four weeks interval, all patients received speech therapy. No restrictions were placed on the number or duration of sessions. A record was kept of the number of sessions. Most of these lasted a half hour. Slight variations more or less were not recorded but it was assumed that these would balance out during the 4 week interval.

The general features of speech therapy were as outlined for Experiment 1 (section 5.2.4.3.3.) The tasks given were slightly different.

Most work was done on auditory comprehension. This involved pointing to pictures designated by name and by function. If a patient found pictures too difficult to cope with then concrete objects were used. Double commands were also introduced, for example, "point to the car and the pencil".

Visual matching of pictures with pictures was used as an early stage before introducing words to be matched with pictures. Reading short phrases was the upper limit achieved by most of this group.

Written work was introduced in similar stages. Mostly patients were copying letters and words, but some also required practice on shapes. Those at a higher level were writing words and phrases to dictation or to label pictures.

Time was spent on expressive speech mainly involving naming and describing the function of objects. In addition, simple everyday phrases and automatic serial speech, such as "good morning" and "how are you"? were practiced as a means of crude communication.

Some patients had dyspraxia as well as dysphasia. In the speech therapy sessions proprioceptive neuromuscular facilitation techniques were used to stimulate lips and tongue, in order to teach sounds and sequences of sounds.

6.1.3 Results

The test scores obtained by each patient are shown in table 21. The mean and standard deviation of test scores for the group at each assessment are shown in table 22.

6.1.3.1 Evaluation of Change in Abilities over time

The improvement in test scores was investigated to determine whether a significant change in ability had occurred. Tests given by CP and the verbal scale of the PICA are discussed in Experiment 4. The evaluation of change over time on these tests is given in section 7.3.2.3.

The PICA gestural and graphic scales and measures of functional speech were not available for 'no treatment' controls and are therefore not included in Experiment 4.

A t test for related data was calculated to compare the first and second assessments on these tests. The results are shown in table 23.

These results indicate significant change on two subtests of the PICA, test X and test E, and on the two subscales, gestural and graphic and in the overall score. Significant change also occurred on physiotherapists' and occupational therapists' ratings of speech and occupational therapists' rating of communication.

6.1.3.2. The relation between biographical variables and change in abilities

The Pearson product moment correlations between change in abilities and age and months post onset are shown in table 24.

The correlation between age and change in ability is generally non-significant (two-tailed test). Five of the 38 correlations were significant at the 5% level which is more than would be expected on the basis of chance alone. These indicate that younger patients changed more on Progressive Matrices and PICA subtest E, older patients changed more on PICA subtests IX, A and B.

The correlation between months post onset and change are also generally non-significant (two-tailed test). Four were significant at the 5% level indicating more recent aphasics change more in Object Naming, Self Rating and PICA tests VIII and F. Since 38 correlations were calculated these four are slightly more than would be expected on the basis of chance alone and are all in the same direction which would also not be predicted on a chance basis.

The correlation between change in ability and handedness was not considered due to the doubtful validity of the Edinburgh Handedness Inventory with these patients.

6.1.3.3. The relation between Number of Sessions Speech Therapy and Change in Abilities

Pearson product moment correlations between change in ability and the number of sessions speech therapy are shown in table 24.

These correlations are generally non-significant (two-tailed test). Three of the 38 variables show significant correlations at the 5% level. PICA test V indicates greater change in ability with fewer sessions speech therapy, PICA tests VIII and XI indicate greater change in ability with more sessions speech therapy.

In order to investigate further the lack of relation between amount of speech therapy and change, the group was divided according to the amount of speech therapy received. The nine patients receiving more than twelve sessions therapy were compared with the nine patients receiving twelve sessions or less. The division at 12 sessions was only to obtain two equal size groups of patients.

The two groups were compared at initial assessment and at final assessment using t tests for independent data. The t values obtained are shown in table 25.

The t values indicate no significant differences between the two groups at initial assessment or at final assessment.

6.1.3.4 The Relations between Different Measures of Ability

The intercorrelations between different assessment procedures were examined. Pearson product moment correlations were calculated between each assessment and every other assessment given on the same occasion. Intercorrelations at initial and final assessment were considered separately. Correlations within the PICA were not considered as these tests are known to intercorrelate highly (Porch 1967). The aim was to determine which tests were highly correlated with the PICA so that redundant test items could be excluded for subsequent experiments. The intercorrelations between PICA scores and other tests of ability are shown in table 26.

In view of the large number of correlations calculated the probability of finding significant correlations due to chance was high. Therefore only those significant at the 1% level or above were considered. There were nine of these.

The Token Test, Progressive Matrices and Self Rating do not correlate significantly with any of the PICA subjects. Object Naming, Fluency and Picture Description all correlate significantly with verbal tests of the PICA and in a positive direction, so that high scores are related to high scores on the PICA. In addition there is a significant negative correlation between PICA A and both Fluency and Picture Description. Apart from test A, all other gestural and graphic tests of the PICA are not significantly correlated with Object Naming, Fluency and Picture Description.

6.1.4 Discussion of Results

6.1.4.1 Evaluation of Change in abilities over time

Generally there are few tests which show significant change in ability, though all the scales of the PICA indicate significant change. This suggests that changes were occurring on most tests but these only reached significance for a few of the individual tests. Examination of the mean scores shows that only on tests IV and F are the final assessment mean scores lower than the initial assessment mean scores.

Those tests of the PICA which show significant change are two of the easiest tests, test X, pointing to named objects and test E, copying object names. On these tests patients achieved at least partial success on initial testing. Test XI matching object with object is easier than test X, and test F, copying geometric shapes is easier than test E, but these show no significant change. This may have been a ceiling effect with most patients scoring at or near the top of the scale on initial testing, and so leaving little scope for improvement. Many of the other subtests of the PICA are relatively difficult for severe aphasics and significant change does not occur.

Ratings of functional speech indicate that patients speech abilities changed significantly in physiotherapy and occupational therapy departments but not on the ward. This lack of improvement on the ward may have been due to an overestimation of patients language abilities initially. Many severely aphasic patients appear to understand general conversation and cope well with familiar day-to-day tasks, such as dressing, washing and feeding themselves. Consequently their comprehension and speech problems only become apparent when day-to-day ward routine alters.

The observed change in speech in the physiotherapy and occupational therapy without significant change on many test items suggests that several of the tests were insensitive to change. Since scores on the tests given show significant improvement when given to moderate aphasics it may be that they are too difficult for severe aphasics. Even though severe aphasics improve in some respects, this may be insufficient to score more than the minimum on some of the tests given. Basal scores were frequently obtained on the Object Naming and Fluency tests and so these tasks may be too difficult to reflect change in language ability generally. Future studies on severe aphasics will need more easier items if changes in language ability are to be detected.

More change may have been recorded if a longer interval between testing was used. However, since patients were often admitted to the unit for 4 weeks rehabilitation arrived at improving their language ability, the expectation was that significant improvement could occur in this time interval. These patients would be likely to improve on the basis of spontaneous recovery alone and so 4 weeks should have been an adequate interval between assessments.

6.1.4.2 The relation between biographical variables and change in ability

Age and months post onset appeared to be relatively unimportant determinants of change in ability. However, the lack of correlation could also be partly due to insensitivity of the tests used to change. If few changes are occuring it is not possible to get a valid correlation of change with the biographical variables concerned.

Another factor contributing to the small number of significant correlations is the narrow range of age and months post onset of the group. The patients were all relatively young and relatively recent post stroke and the ranges in comparison with the total stroke population were small. The group may therefore have been sufficiently homogeneous for age and months post onset not to have a significant effect on change.

6.1.4.3 <u>The relation between number of sessions speech therapy and change in ability</u>

The lack of correlation between the number of sessions speech therapy and change may have occurred if therapists gave most treatment to patients least likely to change. The number of speech therapy sessions was, as far as it is possible to tell, determined by chance, and the therapists had no policy about which patients were to receive more treatment. As far as the speech therapists were aware, the amount of treatment was determined by the availability of patients at different times of day.

Comparison of patients receiving more than twelve sessions treatment with those receiving twelve sessions or less supports the results of the correlations. The two groups were not significantly different at initial assessment. This suggests that the level of abilities at initial assessment was not the basis for giving more treatment. Those patients with severest problems did not get more treatment than those with less severe problems. Comparison of the two groups 4 weeks later indicates no signficant differences between the two groups, which suggests that speech therapy had no significant effect.

It appears from the present data that speech therapy does not significantly affect recovery in severe aphasics. However, there was no random allocation of treatment time or random allocation into more intensive and less intensive treatment conditions, which would be necessary for any conclusions to be drawn. To verify these observations it will be necessary to compare speech therapy with an attention placebo control group, with random allocation of patients to groups.

6.1.4.4 The relations between different measures of ability

Different tests are assumed to be measuring the same language ability and if this is the case then some tests may be excluded from subsequent studies on the basis of being redundant.

Comprehension is measured by the Token Test, and by PICA tests VI and X which involve pointing to specified objects. There was a significant ($p<0.05$) correlation between the Token Test weighted score and PICA VI on the second occasion. However, this alone is insufficient to indicate that these measures are assessing the same ability. The Token Test weighted score also correlated significantly ($p<0.05$) with some of the graphics scale tests, B, C and D on the second occasion. These findings could have occurred by chance alone and so it seems that the Token Test is not measuring the same ability as any of the PICA tests. A memory component may be involved in the Token Test as the instructions were longer and not repeated as they are on the PICA.

Naming is assessed by the Object Naming Test and PICA IV, which are significantly correlated on each occasion but only at the 5% level. The only real difference between the tests is that one involves naming pictures and the other objects. However, the scoring system is different and may account for discrepancies. On the Object Naming Test a high proportion of subjects score 0 as they are not able to name objects, whereas even attempts on PICA IV will be scored. The large number of basal scores on the former test make significant correlations unlikely. Generally most of the significant correlations occur on tests of expressive verbal abilities. Object Naming, Fluency and Picture Description all correlate with verbal tests of the PICA. Some of these measures could probably be excluded from subsequent studies without important information being lost. Progressive Matrices and Self Rating were not expected to relate to PICA test scores and the correlations obtained support this expectation. On initial assessment there were significant correlations between Self Rating and PICA I, describing function of objects and PICA IV, naming objects, but this does not occur on the second assessment. It may be that initially patients who are able to name and describe objects rate more highly than ability to use the speech they have. The ability to produce single words may be a significant stage as regards confidence in their speech abilities, as it is when single words are available that patients can begin to express themselves verbally. Until that stage patients have to rely on answering questions and communicating with gesture. By the second assessement patients confidence may have improved sufficiently for the ability to produce words to become less important as a determining factor.

The significant negative correlations between PICA A and Fluency and Picture Description are difficult to interpret. It seems likely that they are chance findings since the other graphic subtests do not show similar correlations with these two verbal tests. The scores of all patients on the test are very low and only indicate whether they attempt the task and produce an unintelligible response (score 3 or 4), or whether they refuse the task in an intelligible manner (score 5). Patients who attempt the task but fail get a lower score than those who refuse. It may be these patients that attempt the Fluency and Picture Description tasks and consequently get some score, whereas those who refuse test A also may refuse the fluency and picture description tasks and consequently fail to score at all on these latter tasks. However, if this were the case it might have been expected that similar results would have occurred on other graphics tests and on other tasks in which refusing to attempt the task produces the lowest score, such as Object Naming or the Token Test. The results on the two occasions would also be expected to be consistent with each other.

6.1.5 Conclusions

Significant changes in score were obtained on relatively few tests. Patients only changed in a few abilities. The abilities that did not change were mostly the more difficult tests on which few patients were able to succeed. Given that patients would be expected to improve as a result of spontaneous recovery alone, the lack of improvement indicated may have been a result of the difficulty of the tests used. If the abilities assessed were those which severe aphasics were unlikely to improve even with 4 weeks treatment, then the results would indicate no significant change. It is however, possible that no significant change occurred. Subsequent studies on severe aphasics therefore need to include simpler items which would make them sensitive to changes, if any changes are occurring. If no significant improvement then occurs it can be concluded that significant changes in ability do not occur in these patients over this time interval.

Within the narrow range of age and months post-onset considered, these factors appear to be of no significance in terms of changes in language ability. In a more varied population these factors may be of relevance. The number of sessions speech therapy also had no effect on change in ability. This was unlikely to be entirely due to the shortness of the time interval since significant changes in ability did occur on some tests.

Examination of the inter-relationships between test scores indicated that some tests of verbal ability could be excluded as they were providing redundant information. Other tests were modified in accordance with findings from Experiment 2 in order to be suitable for Experiment 3.

On the basis of results obtained in Experiment 2 the assessment battery was modified for the subsequent experiment with severe aphasics. The Edinburgh Handedness Inventory was not to be given as the answers obtained with severe aphasics were of dubious validity. The Token Test was retained as it appeared to measure a different aspect of comprehension from PICA tests VI and X. The Object Naming Test was simplified by including the ten practice items, which were relatively easy, and excluding some of the more difficult items. The Fluency and Picture Description tests were excluded as they correlated highly with the PICA verbal tests and were therefore redundant. The Progressive Matrices and Self Rating were retained as they did not correlate highly with any of the PICA tests. In addition, some simpler tasks were added to the assessment procedure used for Experiment 3 (see section 6.2.2.4).

On the basis of findings in Experiment 2, a further investigation of treatment effects with severe aphasics (Experiment 3) was carried out.

6.2 Experiment 3 Evaluation of operant training procedures with severe aphasics

6.2.1 Introduction

The aim of Experiment 3 was to determine whether operant techniques can be used in the language rehabilitation of severe aphasics, and whether any changes obtained can also be obtained by speech therapy or a non-specific placebo treatment.

6.2.2. Method

6.2.2.1 Design

3 alternative designs were considered:

Alternative 1

	A 4 weeks A	4 weeks A
Group 1	Speech therapy	Operant
2	Operant	Speech therapy
3	Non-specific	Speech therapy
4	Speech therapy	Non-specific

A = Assessment

This design has the following advantages:

a. Each patient acts as his own control for 2 of the 3 treatment procedures.

b. An independent assessor gives an assessment following each treatment procedure.

The disadvantages are:

a. There would be a therapist difference between speech therapy and both the non-specific and operant procedures.

b. Each patient would be needed for 8 weeks and so many might not complete the full time.

c. At the time of planning, many severe aphasics were admitted for 4 weeks only and so would not be available for inclusion in the trial.

d. Two speech therapists would be involved, one for treatment and one as an independent assessor and so the experiment would be more susceptible to disruption by illness, holidays etc. than if only one speech therapist were involved.

e. The time that speech therapists have available is very limited and so this experiment could not run concunrently with Experiment 1.

Alternative 2

	A 4 weeks A
Group 1	Operant
2	Non-specific
3	Speech therapy

A = Assessment

The advantages of this design are:

a. Eighteen patients have already been assessed over 4 weeks of speech therapy (see Experiment 2) and so this data could be used as group 3.

b. Using only a 4 week interval will enable groups to be larger than in alternative 1 because more patients are likely to complete treatment.

c. The possibility of including more patients will lead to less wasted experimental time and probably a shorter overall time for the expefiment to be completed.

d. Only one speech therapist would be invòlved, as an independent assessor.

e. The lesser involvement of speech therapists would mean the experiment could run concurrently with Experiment 1.

The disadvantages are:

a. There would be a therapist difference between speech therapy and the two other procedures.

b. The assessment procedure will need to be the same as in experiment 2, where some tests were found to give basal scores only.

c. The change with speech therapy was not assessed by an independent assessor. The assessor knew the patient had received speech therapy and in some cases the assessor was also the therapist.

Alternative 3

	A 4 weeks A	4 weeks A
Group 1	Operant and speech therapy	Non-specific & Speech Therapy
2	Non-specific & speech therapy	Operant & Speech therapy

A = Assessment

The advantages of this design are:

a. It will be primarily concerned with comparing operant and non-specific treatments, since all patients will be receiving speech therapy throughout.

b. There will not be a therapist difference between the two treatments under investigation.

c. Full use will be made of patients staying eight weeks.

d. Each patient acts as his own control and so smaller numbers of patients are needed than if two separate groups are being compared.

e. Only one speech therapist will be involved as an independent assessor and so the experiment can run concurrently with Experiment 1.

The disadvantages are:

a. No direct comparison can be made with speech therapy because of therapist differences, lack of independent assessment of speech therapy (see Experiment 2) and differences in the number of treatment sessions received.

b. If patients reach their ceiling with speech therapy the comparison would be meaningless. However, in view of the severity of the aphasia, there is large scope for improvement.

c. The inter-action between speech therapy and other treatments cannot be evaluated.

Alternative 3 was chosen because of three main factors. It was felt that the experiment needed to run concurrently with Experiment 1 as severe aphasics were available at this stage and it was likely that Experiment 1 would take many months to complete. The speech therapists involvement needed to be minimized, as they could not spend as much time as was desirable on research work. The main concern of this thesis is to examine the use of operant speech training procedures and so, as design 3 most effectively evaluates these, it was considered to be the most appropriate. Experience with the small number of patients available in Experiment 1 tended to favour a design in which as few patients as possible could be used, since it was extremely unlikely that large numbers of severe aphasics would be available for inclusion in the study.

6.2.2.2 Subjects

Twelve severely aphasic patients (according to criteria used in Experiment 1) were included in this experiment. These patients had been successive admissions during the period January 1976 - July 1977 and had been excluded from Experiment 1 as 'too severe'. They had all been referred for speech therapy for aphasia following a stroke 1 to 12 months previously (mean 4.17 S.D. 3.90 months). The patients were aged 26 to 64 years (mean 52.4 S.D. 12.7 years) and there were 9 men and 3 women.

Patient characteristics are shown in table 27.

6.2.2.3 Procedure

Each patient was assessed during his first week of admission. This was repeated 4 weeks and 8 weeks later. During the two 4 week intervals patients all received speech therapy. The number of sessions was balanced between the two intervals. It was intended that each patient would receive an equal number of speech therapy sessions during the two intervals, but in some cases this did not occur due to patients missing sessions on account of illness or other hospital appointments. The number of sessions therefore had to be balanced out for the whole group. The numbers of speech therapy sessions received are shown in table 27.

Patients were randomly allocated to two groups, which received either operant or non-specific treatment procedures for eight half hour sessions. Following the assessment at 4 weeks, the patients then received the alternative of the two treatments.

6.2.2.4 Assessment

The assessments were carried out before and after each treatment. The main assessment procedure used was the PICA (Porch 1967). This was carried out by a speech therapist. The speech therapist was in most cases also treating the patient concerned, but in some instances, for reasons of illness, holidays or lack of time, another speech therapist would do the PICA. The speech therapist was however, blind to the other treatment that the patient had been receiving. The PICA was therefore given by an assessor blind to the treatment procedure under consideration.

In addition to the PICA, other assessment procedures were given by the therapist who was doing the operant and non-specific treatments (CP). These assessments were:

i. Token Test (De Renzi and Vignolo 1962) shortened version. Three parallel forms A, B and C were used as in Experiment 1.

ii. Object Naming test, (Oldfield and Wingfield 1971). The 10 practice items and 10 easiest (i.e. most frequently used words) items of the 26 objects were used. This was aimed at making the test simpler for the severely aphasic patients since in Experiment 2 many had received basal scores on the standard version of this test.

iii Progressive Matrices (Raven 1958). This was included as a measure of intelligence which could be given non-verbally. It was shortened for use with these patients. Sets A to D of the standard progressive matrices were given. Any set was discontinued after 3 consecutive failures on that set. If a score of 0 was obtained on any set then the test was discontinued at that point.

iv Self Rating. The scale devised for Experiment 1 was used

v Eisenson Examination of Aphasia, (Eisenson 1954). The visual agnosia sections for colours, shapes and reduced size pictures were given. The performance on these three sections was scored according to the PICA 16 point scoring system. This item was included to assess comprehension of colour and shape names which are necessary for success on the easiest items of the Token Test. Comprehension of picture names was included as an item on which these severely aphasic patients might have at least partial success.

vi Peabody Picture Vocabulary Test, (Dunn 1965). The first 50 items were given and scored on a right or wrong basis. This test was included as a relatively simple measure of comprehension, on which patients were unlikely to have severe difficulties. It was intended to counteract the depressing effect of repeated failures on other test items and to offer encouragement to the patients by giving a task that they were likely to able to attempt without undue difficulty. Basal and ceiling scores were not obtained in the standard manner because many patients would fluctuate in ability and so a large number of items would need to be given. The order of difficulty is also not appropriate for a British adult population and so many items would need to be given which would make the test very long.

vii The Speech Questionnaire. This questionnaire designed for Experiment 1 was completed by the nursing staff, physiotherapists and occupational therapists.

6.2.2.5 <u>Treatment Procedures</u>

6.2.2.5.1 <u>Operant Training</u>

The operant training procedure was based on the use of a specific electric board designed by Keith and Darley (1967) as a teaching machine for training severely aphasic patients in matching tasks. The main features of this equipment are that the patient receives immediate feedback of correctness of each response. A light comes on when the patient makes a correct match. This is supplemented by verbal reinforcement from the experimenter, in the form of 'yes', 'that's right' or 'good'. When responses are incorrect the light does not come on, and the experimenter shakes her head to indicate 'no' but makes no verbal response.

Each session lasts for 30 minutes, and is carried out on an individual basis. On the first session the patient is shown how to use the apparatus using matching of shapes e.g. a circle, star and square, as examples. Once the patient has achieved an errorless trial i.e. 6 items on the training task, the treatment procedure begins.

The patient was presented with letters to be matched with letters as an initial task. The therapist, CP, showed the patient the first pair matching and demonstrated placing the styli into the correct positions, and the light coming on to indicate a correct response. The patient was encouraged to continue and helped to progress from one item to the next by CP placing one stylus into position and indicating to the patient to find the corresponding matching letter. The tasks used all involved the same matching procedure as initially trained using non-verbal matching. CP prompted patients using gestures if they did not progress from one item to the next; however, once the task had been correctly performed once, further instructions were rarely necessary. The tasks used in the treatment procedure were matching:

Single letters	with single letters
Pairs of letters	with pairs of letters
Object pictures	with object pictures
Object pictures	with object pictures and names
Object names	with object names
Object pictures	with names
Names	with object pictures
Object pictures	with descriptive phrases

Pictures of relations between objects with words describing relations between objects.

The words could also be given verbally by the therapist so the task involved reading and verbal comprehension or given silently so only reading was involved.

For tasks involving pictures or words a series of cards was used which involved object names. These were of increasing difficulty according to the frequency of usage of the name. These frequencies were determined from the Davis Howes count of spoken English (Howes 1966). Thirteen sets of six object names in graded order of difficulty were obtained. Line pictures were drawn of each object.

The object names used were:

Card	1	2	3	4	5	6	7
	House	Bridge	Train	Ship	Step	Gun	Mask
	Table	Money	Radio	Ball	Bus	Mountain	Bird
	Car	Foot	Bone	Horse	Meat	Sun	Muscle
	Man	Arm	Window	Wall	Plane	Cup	Wheel
	Door	Case	Eye	Fish	Bag	Plate	Box
	Road	Fire	Fly	Neck	Music	Bath	Belt

Card	8	9	10	11	12	13
	Desk	Finger	Shell	Flag	Pump	Tail
	Wave	Iron	Pocket	Plug	Saddle	Snake
	Stool	Pillow	Signal	Banana	Igloo	Parachute
	Ring	Brush	Roof	Goal	Barrel	Wheelchair
	Moon	Fountain	Flowers	Tower	Camera	Buttons
	Bicycle	Chair	Nose	Star	Egg	Basin

Tasks were given in approximate order of difficulty. On the initial session letter matching, word matching, picture word matching and word picture matching were given to determine the level at which a patient was capable of success. If a patient scored 6 correct out of 6 on a task it was assumed he was able to do that task. If he scored 4 or 5 this was considered an appropriate task to give practice on. If he scored 3 or less this task was deferred until a later stage in treatment.

Once the task had been selected the 13 sets of 6 object names were used for that task. Each task-list combination was given 4 times or until two consecutive errorless trials had been achieved. On subsequent sessions an initial errorless performance on a task-list combination was sufficient for termination of that task-list combination. Once an error was made on the initial trial of the session, two consecutive errorless trials were required.

The rate at which a patient progressed through the trials depended on his performance. The amount attempted and error rates are shown in table 28.

Following attempting picture-phrase matching tasks, a series of cards involving relations between objects was constructed i.e. on, under, inside, next to, to the right of, to the left of, etc.

Diagrams of shapes on, under, beside etc. each other were to be matched with the word describing the relation between the objects. For example a picture of a circle on a square, was to be matched with the word 'on' and a circle beside a square was to be matched with the word 'beside'.

The arrangement of correct combinations could be altered by adjusting wires on the back of the board. Five different position combinations were used throughout treatment. Although this is relatively few and patients might have been able to remember some combinations of position, any more possible combinations would have led to a large proportion of the treatment session being spent rearranging wires.

The tasks were selected on the basis of those being assessed by the PICA. The PICA is designed to test a wide range of language skills and Porch suggests treatment is based on these types of tasks. They are also the types of tasks used by speech therapists and occupational therapists in training language in dysphasic patients.

Specific effects of the procedure used should be reflected on changes in PICA subtests V, VI, VII, VIII, X, the Eisenson and Peabody. Any generalization that occurs from the specific tasks will be evident in the other assessments given and in the modality and overall scales of the PICA.

Verbal skills were not trained as part of the operant procedure for most patients as so few were able even to attempt imitation of spoken words. However, repetition of single words was introduced for 6 patients and one patient (no. 95) who was matching phrases, also attempted sentence completion and naming tasks.

6.2.2.5.2 Non-Specific Treatment

This was designed as an attention placebo treatment. General conversation, as had been used in Experiment 1, could not be used with the severe aphasic group as most could not understand general conversation and none could provide enough answers to questions for a half hour conversation to be attempted. A procedure was therefore designed which was expected to have no effect on language skills. A series of non-verbal tasks were devised to occupy the patient but not intended to improve his language ability in any way.

The tasks used were:-

i) Non-verbal matching.

Cards with colours, shapes, letters, combinations of shapes were given to the patient who was required to match the cards.

ii) Visuospatial tasks.

The WAIS Block Design (Wechsler 1955) was used and practice was given on copying patterns with the blocks. Designs of varying difficulty were given involving both 4 and 9 blocks.

The WAIS performance scale items i.e. Object Assembly, Digit Symbol, Picture Completion, Picture Arrangements were given and practiced. In addition the cube counting (Ratcliff 1970) and Gollen incomplete pictures (Gollen 1960) were given to some patients.

iii) Copying and visual recall of the Benton Visual Retention Test designs (Benton 1963) and complex diagrams similar to and including the Rey-Osterreith figure (Rey 1959) were given.

iv) Non-verbal digit span using Corsi blocks (Milner 1971) was used to practice non-verbal recall, as was the Williams delayed recall task (Williams 1968) using drawings instead of verbal expression.

v) Manual dexterity tasks such as the Crawford small parts dexterity test (Crawford & Crawford 1956) were included as non-verbal tasks, and presented as practice in using the non-dominant hand as most patients were hemiplegic on their dominant side.

vi) Sorting Wisconsin cards (Grant and Berg 1948) according to colour, shape and number.

Tasks were given in any order, and repeated if necessary. The patients were given practice on different tasks but feedback of correctness of responses was not systemmatically given. Errors were sometimes ignored and sometimes the patient was given help when he had difficulty. Tasks were not graded in any order. The only task to be given frequently was Block Design, which could be repeated on most sessions because few patients were able to do all of the designs.

Table 29 shows the tasks given to each patient on each session.

6.2.2.5.3 Speech Therapy

All patients received speech therapy throughout. The treatment was the same as is described in Experiment 2. (See section 6.1.2.3). The therapist and the number of sessions is shown in table 27.

6.2.3 Results

The test scores obtained by each patient are shown in table 30. The mean and standard deviations of test scores are shown in table 31.

6.2.3.1 Comparison of operant training and an attention placebo treatment

The main question to be answered by this experiment is whether operant speech training procedures improve language ability more than an attention placebo, at the same time as patients in either treatment condition are receiving speech therapy.

Results were analysed using a simple cross over analysis (Armitage 1971) to give t values. The t values obtained are shown in table 32.

Treatment effects show no significant differences except on two variables. The non-specific treatment produced significantly more improvement on PICA test V, reading cards describing the function of objects ($p<0.01$) and on PICA test F, copying geometric shapes ($p<0.05$) than the operant training procedure.

Interval effects were also non-significant except for PICA test F, on which significantly more change occurred in the first interval than the second interval ($p<0.05$). The interactions, treatment x interval, (Group comparison) were also non-significant apart from two. PICA test VI, pointing to objects designated by function showed significantly more improvement for the treatment combination NS-OP ($p<0.05$). The opposite treatment combination, Op-NS, produced significantly more improvement ($p<0.01$) in communication as rated by the occupational therapists.

6.2.3.2 Evaluation of change in abilities over time

The analysis of variance comparing the two treatment groups was further evaluated for the change between initial and final assessments. The t values (see section 5.3) are shown in table 33.

Significant change in ability occurred on 21 of the 40 measures which is more than would be expected on the basis of chance alone. Significant change occurred on 10 of the PICA tests, on the 3 PICA scales and in the overall score. All verbal tests showed significant change.

The Progressive Matrices, Peabody PVT and Eisenson showed significant change. The ratings of functional speech showed no change on the ward, change in speech but not communication in physiotherapy and change on all ratings in occupational therapy.

6.2.3.3 The relation between biographical variables and change in abilities.

Pearson product moment correlation co-efficients were calculated between change in abilities over the 8 week interval and the biographical variables, age and the months post onset and the significance determined using a two-tailed test. The values obtained are shown in table 34.

Age was significantly correlated with change in ratings of speech in the physiotherapy department. All other correlations with age were non-significant.

Months post onset were significantly correlated with change on the Token Test, Eisenson shapes, PICA E and occupational therapists rating of communication on questions 4 and 5. All other correlations with months post onset were non-significant.

6.2.4 Discussion of Results

6.2.4.1 Comparison of operant training and an attention placebo

Generally there are no significant differences between the two procedures in their effect on communication ability. This could result from no change in ability having occurred or from both treatments having an equivalent effect. The lack of difference between the two treatment conditions is consistent with previous studies on severe aphasics, notably that of Sarno, Silverman and Sands (1970), who found that treatment had no effect for a severely aphasic group.

Although for most tasks there was no difference between treatment conditions, an interesting finding was that on two tasks, significantly greater improvement occurred under the control condition than with the operant training procedure. These tasks were PICA test V, reading cards which describe the function of an object and placing the cards in the correct relation to the object, e.g. Put this card to the right of the one used for cleaning teeth, and PICA test F copying geometric shapes.

The reasons for this unexpected finding are purely speculative. However, various alternatives might be considered. First it might be that practice on non-verbal tasks stimulates the right hemisphere which increases the ability of the right hemisphere to take over the functions of the damaged left hemisphere.

Various studies have demonstrated that the right hemisphere has some linguistic capabilities, and these studies are reviewed by Searleman (1977). The suggestion is made that the right hemispheres linguistic capabilities are in the comprehension of written words to which the patient has to respond non-verbally. This is essentially the task on PICA test V. However, this same task is involved on test VII, when the patient has to place cards in a position in relation to a named object e.g. put this card under the pen. On test VII the superiority of the attention placebo group was not significant but was in a direction consistent with findings on test V.

The evidence that the right hemisphere has the ability to comprehend written words comes from work with commisurectomy patients. In these patients the corpus callosum and other forebrain commisures are sectioned as a treatment for intractable epileptic seizures. Gazzaniga and Sperry (1967) instructed subjects to point to a picture of a stimulus presented to his left visual field or unseen in his left hand. For example, if the word spoon was flashed on the left visual field the subject was able to point to a picture of a spoon or retrieve it with his left hand, without being able to name it. Therefore, when the subject is responding non-verbally it becomes apparent that the right hemisphere can comprehend at least some verbal material. However, the problem in these studies is of cross cueing, which involves the left hemisphere knowing the answer and by some means giving it to the right hemisphere. In the case of hemisphere damaged patients this cross cueing probably could not occur. On the basis of these findings it would also be predicted that performance on other tests of the PICA should be improved by right hemisphere stimulation. Tests III and X involve subjects pointing to objects designated by function or by name. Results on these subtests indicate no significant treatment effects.

The alternative explanation is that practice on non-verbal tasks produces an improvement in general intellectual functioning which facilitates performance on all tasks. Oxbury (1975) found that Block Design is a predictor of ability in activities of daily living regardless of the hemisphere that is damaged. The suggestion is that Block Design is related to general level of functioning and those aphasics with poor Block Design ability are those with general intellectual impairment as well as language deficits. Practice on Block Design and similar tasks may therefore improve general intellectual functioning and result in improved language performance. However, this offers no explanation as to why the effect should be specific to a reading and a writing task.

A third aspect to be considered is that both reading and writing involve a perceptual component. If practice on perceptual tasks improves perception of letters then improvement should occur. On test V the type of improvement observed is from related responses, i.e. putting the cards by a related object, e.g. knife rather than fork, to correct objects after cueing. This change would seem to involve improved interpretation of what is read rather than improved reading of specific words. The improvement therefore seems to occur in the interpretation of visually presented material rather than in the perception.

None of the three alternatives suggested entirely account for the findings obtained. It certainly seems that there is evidence for involvement of the right hemisphere in language recovery of aphasic patients, (Tikovsky, Kooi and Thomas 1960, Zangwill 1960, Neilson 1946, Kinsbourne 1971) but it is not clear whether practice on non-verbal tasks should increase the right hemisphere involvement.

The work of Buffery (1977) on brain function therapy would seem to indicate the opposite. It would be necessary to stimulate the right hemisphere with verbal material to produce compensatory activity which would contribute to restoration of higher cortical function. In the present study the stimulation was using non-verbal material.

6.2.4.2 Evaluation of Change in Abilities over time

These results indicate that significant change in abilities occurred over the 8 week interval. The lack of differences between treatments therefore cannot be attributed to lack of change in patients abilities or insensitivity of the measures used to change. The observed change is therefore likely to be due to spontaneous recovery or speech therapy or both. However, since Experiment 2 suggests that speech therapy does not affect recovery it seems more likely that the change in ability is due to spontaneous recovery. The possibility of speech therapy having an effect on abilities cannot be ruled out since Experiment 2 was not designed to properly evaluate the effectiveness of speech therapy.

Another consideration is that Experiment 2 showed little change in ability over a 4 week interval. It may be that 8 weeks of speech therapy is sufficient to bring about significant change in abilities, whereas 4 weeks is not. This would account for the discrepancies in results between Experiments 2 and 3. It also suggests that 8 weeks of treatment with speech therapy may produce a significant change in abilities. It is however, not possible to determine from Experiment 3 whether change over the 8 weeks interval was due to speech therapy or spontaneous recovery and is more likely due to both.

Significant changes were most consistent on expressive verbal tasks. All the PICA verbal tests showed significant change. However, change on the Object Naming test, a similar task to PICA test IV, was not significant. Even though the Object Naming test had been simplified from Experiment 2 (see section 6.1.2) by including the 10 practice items in the test score. The patients were still mostly scoring at basal values on all occasions and so the lack of change on this task may have been because it was still too difficult for severe aphasics.

The Token Test also shows no change over time. Although for the number correct score this could be due to items being too difficult, change would be expected on the weighted score. The inclusion of the identification of shape and colour from the Eisenson indicates improvement in shape identification but not colour. Average scores are near the middle of the scale and so this lack of change cannot be attributed to ceiling or basal effects. Comprehension tests of the PICA, VI and X suggest some improvement is occurring. Test VI pointing to objects designated by function does show significant change, as does the Peabody PVT which involves comprehension of object names.

Reading and writing tasks show a variable response over time with improvement on some tasks, PICA VII, C and E but not others, PICA V, A, B, D and F.

The Progressive Matrices shows the most marked improvement. This suggests that improvement in non-verbal abilities accompanies changes in language abilities.

The measures of functional speech support findings from the objective tests in that they mostly indicate significant change in speech and communication. Ward Staff do not rate patients speech as changing yet it is so rated by occupational therapists and physiotherapists. It may have been that the Nursing Staff initially overestimated the patients abilities in the same way as is suggested for Experiment 2. (see section 6.1.4.1). The mean score for speech on the ward at initial assessment is 14.08 as compared with 6.75 in physiotherapy and 6.54 in occupational therapy. By the final assessment ratings in the three departments are at more comparable levels, 16.16, 15.50 and 12.81, though the ward rating remains the highest.

It therefore seems that the improvement observed on objective tests has functional significance for patients day-to-day communication activities.

6.2.4.3. The relation between biographical variables and change in abilities

Patients showed significant change in abilities which was assumed to be mainly due to spontaneous recovery. This was unrelated to age of the patients. The lack of relation between age and spontaneous recovery was probably largely a result of the narrow age range of the patients in the study. All were relatively young for stroke patients, though the range in terms of years was quite high, 26 to 66 years. However, it may be that only when very elderly patients are considered does age have an important effect on recovery. In the relatively young group, age appears to have no significant effect on recovery.

The lack of significant correlations between months post onset and change in ability is surprising in view of the recency of the patients post stroke. Five correlations were significant at the 5% level which is slightly more than would be expected on the basis of chance alone but nonetheless relatively few. The patients ranged from 1 to 12 months post stroke, which should be enough to reflect differences. However, there were relatively few patients in the group and six of the twelve patients were at 1 or 2 months post onset so more data is needed to assess adequately any trends.

6.2.5 Conclusions

Experiment 3 showed that an operant training procedure did not improve language abilities of severe aphasic patients significantly more than an attention placebo control. All patients received some speech therapy but the addition of operant training had no additional effect as compared with the addition of non-verbal tasks. The only finding of significance in the comparison of treatments was that practice on non-verbal tasks may improve selected aspects of reading and copying shapes more than practice on verbal tasks. No mechanism was considered to account satisfactorily for this result.

Patients showed a change in ability over time which could be attributed to the effects of speech therapy or to spontaneous recovery. In view of the lack of beneficial effect of speech therapy found in Experiment 2 it seems more likely that this was due to spontaneous recovery. The amount of change was found to be independent of age or months post onset.

It seems that treatment of severe aphasics as currently occurs at Rivermead Rehabilitation Centre, is ineffective. The effectiveness of speech therapy with severe aphasics has not been evaluated in these experiments and this would appear now to be necessary. The present results suggest it might be worth increasing the non-verbal content of treatment in order to improve language abilities. In addition, the frequency and intensity of treatment could be increased to determine whether that would affect outcome.

Any of these studies would help to determine the most effective use of professional time in the rehabilitation of severe aphasics.

CHAPTER 7

EXPERIMENT 4. COMPARISON OF APHASICS RECEIVING SPEECH THERAPY WITH AN 'UNTREATED' CONTROL GROUP

7.1 Introduction

There were no aphasic stroke patients at Rivermead Rehabilitation Centre who received no speech therapy. A group of patients who were receiving no speech therapy was obtained from other hospitals in the Oxford Region for comparison purposes. The aim was to compare the effects of spontaneous recovery alone with individual treatment. For severe aphasics this was speech therapy, for moderate aphasics this was either speech therapy, operant training or non-specific treatment. The hospitals concerned all had no speech therapy service available at the beginning of the experiment, and although other variables were involved, provided a no treatment control group for comparison with Rivermead treated patients.

7.2 Method

7.2.1 Subjects

Twenty aphasic stroke patients who were receiving no or very little, a maximum of one hour per week, speech therapy comprised the untreated control group. Initially there was no speech therapy available at the hospitals concerned, later some was available but services were so limited that they were not considered likely to have a significant effect. The collection of 'untreated' patients for the control group had to be discontinued when the speech therapy service increased and patients were able to receive more than one hour's treatment per week.

The control group patients were 18 - 69 years (mean 51.0 S.D. 12.8 years) and were aphasic following a stroke 1 - 6 months previously (mean 3.3, S.D. 1.6 months). They were all in-patients at initial testing but on reassessment some were attending the hospitals as day-patients. The biographical characteristics of these patients are shown in table 35.

The patients were divided into 'severe' and 'moderate' aphasics according to the criteria used in Experiment 1 (see section 5.2.3.6.). There were 9 moderate and 11 severe aphasics.

7.2.2. Procedure

Each patient was assessed initially in the referring hospital, by the clinical psychologist (CP). They were reassessed 4 weeks later by CP on the same battery of tests, using parallel forms of tests where possible. The four week interval was chosen in order to be comparable to the treatment interval of the treated patients. At final assessment some patients had been discharged from hospital and were attending as day patients. These patients were seen in their own homes if necessary.

7.2.3 Assessment

The assessments used were a selection of tests used in experiments 1 and 2. The assessment had to be completed within one hour. The reason was that many patients would be unable to tolerate a longer testing session and, in view of the distance of the hospitals concerned from Rivermead, testing had to be completed on one occasion. It would have been impractical for CP to return the following day to complete the tests.

The tests used were those given by CP in experiments 1 and 2. These were the Token Test, Object Naming, Progressive Matrices, Fluency, Picture Description, Self Rating and Edinburgh Handedness Inventory (for details see section 5.2.3.3.) In addition the verbal scale of the PICA was given, that is tests I. IV. IX. and XII. These were included in order to provide some comparisons of the control with treated patients on abilities assessed by a speech therapist in Experiments 1 and 2. There was insufficient time for the full PICA to be given.

On retesting the same tests were given, except for the Edinburgh Handedness Inventory, which was not repeated. Parallel forms of the Token Test and Object Naming were given on the second occasion. The administration of tests was the same as in experiment 1 (see section 5.2.3.5).

7.2.4. 'No treatment' interval

During the four week interval the patients received no or very little speech therapy. The actual amount of treatment received is shown in table 35. In addition patients received some occupational therapy, the amount is shown in table 35. The occupational therapists gave some practice on language tasks, but the emphasis was on activities of daily living, such as washing, dressing and cooking. The occupational therapists did not aim to compensate for the lack of speech therapy and in no case were patients receiving more occupational therapy than the Rivermead experimental patients. The times specified are those spent in the occupational therapy department. In some cases the amount of time spent in active treatment was considerably less. The remaining time was occupied with waiting for treatment, drinking tea, resting and waiting to be collected by ambulances.

7.3 Results

The test scores obtained by each patient in the control group are shown in table 36.

The analysis of results was carried out separately for moderate and severe aphasics.

7.3.1 Moderate Aphasics

The mean and standard deviation of test scores at each assessment are shown in table 37. The mean and standard deviation of age and months post onset for the moderate aphasics are also shown in table 37.

7.3.1.1 Comparison of untreated and treated moderate aphasics on biographical variables.

The 'untreated' moderate controls were compared with treated moderate aphasics for the variables age, months post onset and handedness using a one way analysis of variance. This was to check that there were no significant differences between the groups that might affect response to treatment or no treatment conditions.

The F values obtained are shown in table 38. They indicate no significant differences between the groups.

7.3.1.2 Comparison of 'treated' and 'untreated' groups

The results obtained by the 'untreated' moderate aphasics were compared with those obtained by treated patients in Experiment 1. An analysis of variance of the difference between initial assessment and assessment four weeks later was carried out. The four treated groups in Experiment 1 (see section 5.2.1.2) were compared with the untreated control group in a planned comparison (Winer 1971)

The results of this comparison are shown in table 39.

No significant differences occurred between the treated patients and the untreated control group.

7.3.1.3 Evaluation of change in abilities over time

The results were examined to see if significant change in ability occurred between first and second assessments for all moderate aphasics, treated and untreated, using the same formula as in Experiment 1 (section 5.3.2 Armitage (1971)).

The t values obtained are shown in table 40.

These indicate that significant change in ability occurred between initial and second assessment on all tests except PICA XII.

The language abilities of untreated and treated aphasics therefore improve over a four week interval.

7.3.2. Severe aphasics

The mean and standard deviation of scores at each assessment are shown in table 41. The mean and standard deviation of age and months post onset for the severe aphasics are also shown in table 41.

7.3.2.1 Comparison of treated and untreated on biographical variables

Treated and untreated severe aphasics were compared on biggraphical variables to check that these were not significantly different. This was done using a one-way analysis of variance, for age, months post onset and handedness. The handedness results are of doubtful validity with severe aphasics as many patients did not appear to understand the instructions and gave answers which were difficult to understand and in some cases unintelligible. The F values obtained are shown in table 42. No significant differences occurred between the two groups on the biographical variables considered.

7.3.2.2 Comparison of 'treated' and 'untreated' groups

Untreated severe aphasics were compared with severe aphasics in Experiment 2. This was done using an analysis of variance with unequal numbers in each group.

The F values obtained in the analysis of variance are shown in table 43.

The F values obtained are all non-significant indicating no differences, significant at the 5% level, between severe aphasics treated with speech therapy and untreated controls.

7.3.2.3 Evaluation of change over time

The extent to which the abilities assessed changed between assessments was evaluated using the same formula as for moderate aphasics (see section 7.3.1.3).

The t values obtained are shown in table 44.

This indicates that, of the twelve variables, five show significant improvement. This is more than would be expected on the basis of chance alone. Significant improvement occurred on the Progressive Matrices, Fluency, PICA test IX, PICA test XII and the verbal scale of the PICA.

7.3.3 Results from individual patients

Two patients from the control group were subsequently admitted to Rivermead and included in the study. These were patient no. 32 and patient no. 93, who were both in the control group and subsequently in the moderate group for experiment 1. Patient 32 was in the severe control group and subsequently included in the moderate treated group, as, during the interval between being assessed as a control patient and being admitted to the rehabilitation unit, his language abilities improved to a moderate level. Patient 94 was both in the moderate control group and the moderate treated group. This will have affected the independence of the groups in the analysis of variance. However, the effect is likely to be slight and as the results so convincingly indicated no difference between the groups it is likely that if this patient had been excluded the conclusions reached would be the same. The results of testing these two patients are shown in figures 17 to 20. These graphs indicate no marked improvement in PICA verbal tests, picture description, token test scores and self ratings following admission to Rivermead. Three measures, Object Naming, Fluency and Progressive Matrices, do show increased rate of improvement during the treatment period. These findings are consistent across both patients.

7.3.4 Relation between biographical variables and change in ability for 'untreated' patients.

The relations between both age and months post onset and change in ability was investigated for the untreated control patients. The relation between change in ability and handedness was not investigated because of the doubtful validity of the EHI scores when used with severe aphasics. Severe and moderate aphasics were considered together. Pearson product moment correlation co-efficients were calculated and these are shown in table 45.

Results indicate that age and months post onset were not significantly related to change in ability.

The effect of months post onset on scores is shown graphically for four of the measures used in figures 21 to 25. The PICA verbal was plotted graphically as a summary of tests I, IV, IX and XII. In addition object naming; one of the measures of comprehension, the Token Test number correct; the Progressive Matrices and picture description are shown. Fluency was not plotted as so many patients obtained basal scores. Self Rating was not plotted as results would be difficult to interpret as there was no basis for expecting a trend of scores to increase or decrease over time.

7.3.5 The relation between intelligence and change in language ability

Intelligence levels have been suggested as a determinant of recovery (Eisenson 1954) yet this has rarely been investigated experimentally. One study by Messerli, Tissot and Rodriguez (1976) suggests that intelligence is an important determinant of extent of recovery.

Pearson product moment correlation co-efficients were calculated between initial score on the Progressive matrices and change in ability on other tests. These results are shown in table 46.

Results indicate no significant correlations between initial score on Progressive Matrices and change in abilities. Therefore, intelligence was not a prognostic indicator for recovery in these patients.

7.3.6 The relation between self-rating and change in ability

Self-rating of language ability was considered as possibly relevant to the amount of recovery (see section 2.5.4). Pearson product moment correlations were calculated between Self-Rating at initial assessment and change in abilities. These are shown in table 47.

Results indicate that change on two tasks, Progressive Matrices and Fluency, was significantly related to initial Self-Rating. These correlations were negative indicating that patients with lower initial estimates of their language abilities changed more. This was not as predicted since it was expected that those patients with greater confidence to use their speech, would talk more and hence be more likely to improve.

7.4 Discussion of Results

7.4.1 Comparisons between 'treated' and 'untreated' groups

The patients in experiments 1 and 2 were not significantly different from the untreated control groups on biographical variables or in their recovery over a four week interval. This suggests that individual treatment, speech therapy, operant training or non-specific treatment has no significant effect. However, there were other differences between the groups apart from the presence or absence of individual treatment. These would mostly be expected to increase the chances of finding significant differences between treated and untreated groups.

The patients in the control groups were all in general hospitals, whereas the treated patients were in a rehabilitation unit specializing in the treatment of brain damage. The staff in the rehabilitation unit were therefore more experienced in dealing with brain damaged patients. All treatments in the rehabilitation unit tended to be more intensive, i.e. 9 a.m. to 4.30 p.m. daily, whereas in the general hospitals treatment was for 2 to 4 hours per day. There was, in particular, a difference in the amount and content of occupational therapy. The Rivermead patients all received at least three hours occupational therapy a day and much of this involved language work. Not only did the general hospital occupational therapy departments give on average less treatment time, this was also more oriented towards activities of daily living than language tasks. On this basis alone it might be expected that Rivermead patients would do better.

However, there are certain features of general hospitals which would favour recovery. Rivermead patients come from all over the United Kingdom, though priority is given to those in the Oxford Region. Many are therefore homesick or get few visitors. The control patients were all in their local hospital and therefore more likely to get visitors and consequently less likely to become depressed. No recording of mood was included in the assessment but certainly homesickness does affect some Rivermead patients such that they are considered unable to benefit from treatment.

An additional problem to be considered when comparing the 'treated' and 'untreated' groups is the basis for selection of Rivermead patients. It is not clear on what basis patients are selected for referral to a rehabilitation unit. The occupational therapists in the hospitals concerned felt that it was more likely to be difficult social problems and uncertain employment possibilities than speech problems alone. However, it does seem likely that those patients who are improving well spontaneously will not be referred to a special unit. If there are pressures on the general hospital beds, then patients who are slow to recover or difficult to rehabilitate might be referred elsewhere for continuing treatment. If this type of selection were operating it would decrease the likelihood of getting a difference between the two groups in favour of the treated patients. If this was a major factor in referral policy then the controls might actually be expected to do better than the Rivermead patients.

A group of patients receiving speech therapy in a general hospital setting could be compared with the no treatment controls to help clarify this point. The study of Enderby and David (1976) currently underway, which will compare speech therapy with non-specific treatment by volunteers, should provide some data of relevance to this point. If Enderby and David find a significant difference between speech therapy and volunteer treatment groups, one possible inference would be that no differences were found between the rehabilitation unit patients and the general hospital patients in this study because only patients making limited progress are seen in the rehabilitation unit. This selection factor would then counterbalance any benefits which may be produced by individual language treatments.

7.4.2 Change in abilities over time

The moderate aphasics show significant improvement in abilities over time on all tasks except one. The severe aphasics only show significant improvement on some tasks. Spontaneous recovery would be expected to have occurred because the patients were all relatively young and recent post stroke. The lack of significant change in the severe aphasics occurred mostly on the more difficult tasks, Object Naming, Picture Description, PICA I and PICA IV. This may have been because the patients were scoring so low that they did not improve enough to get more than a minimum score. Tables 37 and 41 show the mean scores on these for the control patients, which are relatively low. The lack of improvement in comprehension, as measured with the Token Test, is surprising since spontaneous recovery alone would be expected to produce change on this relatively easy task. The high standard deviations indicate considerable variability within the group and it may be for this reason that no significant change occurred for group as a whole.

Generally results indicate an improvement in ability which is probably due to spontaneous recovery. The reason that this appears more marked for moderate aphasics than for severe aphasics may be a reflection of the difficulty of the tasks used rather than representing a real difference in improvement rate between the two groups.

7.4.3 Results from individual patients

The improvement in scores of the two patients who were treated following inclusion in the no treatment control group indicate no marked improvement following the beginning of treatment at Rivermead. Most improvement in patient 32 occurs between the final assessment under no treatment conditions and his admission to Rivermead. During that interval he received occupational therapy but not speech therapy. Patient 93 shows a similar, but not so marked, tendency.

The consistency of results between the two patients in the measures which show an improvement with treatment suggests that this may be more than a chance effect. Both patients show an increased rate of improvement on the Progressive Matrices following admission to Rivermead, when they were included in Experiment 1. Experiment 1 indicated that speech therapy improves ability on the Progressive Matrices more than an attention placebo control. Both patients received speech therapy while at Rivermead. Results for patient 32 show no difference in improvement rate on the Progressive Matrices between speech therapy and operant conditioning. Patient 93 improved more while receiving speech therapy than the attention placebo treatment. It therefore may partly be the introduction of individual language treatment at Rivermead which produced the improvement on the Progressive Matrices. However, although Object Naming and Fluency also improved following admission, comparable findings did not occur in Experiment 1 for these two tests. It is also surprising that these two tasks show improvement after admission to the rehabilitation unit yet the Picture Description and PICA verbal tests do not, since all these tasks are relatively similar in content.

Another feature of the results is that these three tasks, Progressive Matrices, Object Naming and Fluency show marked improvement over time. These may therefore be relatively sensitive measures of change in ability and will reflect minor advantages of receiving treatment without reaching statistical significance.

Another feature of the graphs of improvement in scores for patients 32 and 93 is that they do not consistently show a marked improvement early post stroke gradually decreasing over time. This would be expected on the basis that spontaneous recovery was likely to be occurring. However, some abilities show a steady improvement, such as PICA scores for patient 32 and Token Test scores for patient 93. Others show an improvement late in recovery, for example, Progressive Matrices scores and Object Naming Scores of both patients.

The expected pattern of recovery did occur on PICA scores for patient 93 and Token Test Scores of patient 32, but this is considerably fewer tests than might have been expected to show greatest recovery early post stroke.

Generally results from these two individual patients suggest that treatment may affect certain abilities, such as naming, fluency and non-verbal intelligence. These will therefore improve when treatment is introduced. Other tasks, such as comprehension and certain expressive verbal abilities, will be more influenced by spontaneous recovery.

7.4.4 Relation between biographical variables and change in ability

The lack of correlation between age and change in ability seems unlikely to be entirely due to a narrow range of age being represented since patients in this group were between 18 and 69 years. However, the majority, sixteen patients, are in the 47 to 69 year age group which is a relatively narrow range. It therefore seems likely that under 70 years, age has little sighificant effect on change in ability.

Similarly, months post onset seems to have little signifcant effect. Patients were in a narrow range of months post onset, one to six months, but even within this range differences might be expected. Eight of the twelve correlations calculated are in the expected direction but none reach significance at the 5% level. It may be that only the first few months post onset are important and thereafter change is minimal. Experiment 1 showed a trend with most change in the second month post onset and little change later post onset. However, graphs of change in ability in relation to months post onset (figures 21 to 25) offer no support for this suggestion. Change in ability on these seems unrelated to months post onset which supports the results of the correlations calculated Unlike Experiment 1 there is no evidence to suggest there may be a trend of decreasing improvement with increasing months post onset.

One feature of figure 21 is that change appears more marked in patients starting at a higher level of abilities than those starting at a lower level. However, it may represent an artefact of the sixteen point PICA scale. If the intervals are not all equal and those lower in the scale are larger than those higher then this result would be accounted for. The experimenters (ST2, ST3 and CP) all considered that the gaps between scores at the lower end of the scale represent greater differences in ability than those at the higher end of the scale. This has been investigated experimentally by Lincoln, Pickersgill and Valentine (1979) who offer some support for the suggestion.

7.4.5. The relation between intelligence and self rating and change in ability

The lack of correlation between change in ability and intelligence indicates this is not likely to predict spontaneous recovery. It also suggests that those patients with more generalised intellectual impairment, resulting in poor non-verbal abilities, are not necessarily those who make a poor recovery in language ability. Although correlations were mostly positive, and therefore in this predicted direction, they were so small that they did not even approach significance.

The correlations between self rating and change were generally in the unexpected direction, low self ratings being associated with greater change. This could be because patients who were critical of their own performance, tended to notice errors and therefore were able to make attempts to correct them. The specific tests which reached significance could be due to chance, or at least one of them may be. However, it is difficult to interpret why change in these two abilities might be related to patients' self ratings, while other abilities are not.

7.5 Conclusions

Comparison of the aphasic patients in Experiments 1 and 2 with a 'no treatment' control group indicated no significant difference between the groups over a 4 week interval. The effect of attending rehabilitation unit and receiving individual treatment, speech therapy, operant conditioning or non-specific treatment, appears no greater than that achieved by occupational therapy with very little or no speech therapy in a general hospital. Although the comparability of the two groups is questionable it seems unlikely that the improvements in ability observed can be attributed to anything other than spontaneous recovery.

Therefore it would seem that a study in which patients were randomly allocated to a speech therapy or attention placebo and a no treatment control group would now be both ethically justifiable and also necessary for the further evaluation of the effectiveness of language treatment methods.

CHAPTER 8

EVALUATION OF ASSESSMENT PROCEDURES

8.1 Experiment 5. Experiment to investigate whether the three forms of the Token Test used in Experiments 1 to 4 can be considered as parallel forms

8.1.1 Introduction

The Token Test (De Renzi and Vignolo 1962) was divided into three parts and each part used to assess ability at a different stage in Experiments 1 to 4. These were used as measures of change in ability and therefore, needed to be equivalent. The present experiment was designed to determine whether the three forms of the test were equivalent and consequently changes in ability did not occur due to differences between the three versions.

8.1.2 Method

Eighteen patients who were dysphasic following a stroke or head injury were given the three forms of the Token Test on three separate occasions. Testing was carried out on 3 days with a gap of 1 or 2 days between each version of the test. The order of presentation of the 3 versions was random, so that an order effect would not produce differences between the 3 forms. The total assessment was completed within a week so that changes in language ability due to recovery of function were not likely. Patient characteristics are shown in table 48.

8.1.3 Results

The number of items correct and the weighted score for each patient on each version are shown in table 49. A two way analysis of variance, subjects X forms, was calculated and the results are shown in table 50.

The results indicate that, for either the number correct or the weighted score, there is no significant difference between the three forms but there is a highly significant difference between subjects.

The strength of association (Hays 1965) represented by this significant subject effect and non-significant difference between forms was calculated and the results are shown in table 50.

These estimates show that a very strong association exists between the subjects and the scores obtained. Similarly, there is a very weak association between the form of the test given and the scores obtained.

8.1.4 Discussion of Results

The 3 forms of the Token Test devised by splitting the full version into 3 parts provide equivalent scores. These 3 shortened versions together include more items on Parts I to IV (see section 2), than the original version and three items fewer on Part V. Since the three are so similar to each other, their combined total is probably very similar to results obtained with the full version of the test. The three forms are therefore considered as shortened versions of the Token Test, though there has been no verification of the scores on each correlating highly with the full version of the test.

In experiments 1 to 4 the three forms are used to measure change in ability. The order of presentation of the 3 forms is randomized within each group and so, even if scores are not equivalent, the results can be anaylsed. However, it is possible to draw more conclusions from changes in score with the available data to suggest the 3 forms are in fact equivalent.

8.1.5 Conclusions

The three shortened forms of the Token Test were found to be equivalent to each other when either number correct or weighted score is considered. This means that they may be used as parallel shortened forms of the Token Test. However, there has been no confirmation of a relation between each form and the full version of the test.

8.2 Experiment 6. Experiment to investigate the Test-Retest reliability of the Oldfield-Wingfield Object Naming Test.

8.2.1 Introduction

The Object Naming Test (Oldfield and Wingfield 1965) was used as a measure of change in naming ability. It was therefore necessary that the test gave stable scores over time when no change in ability had occurred, if results evaluating change over time were to be interpreted. In experiments 1 to 4 the change in ability on this test was evaluated but no reliability data was available in the literature.

8.2.2 Method

Eighteen patients who were dysphasic following a stroke or head injury were given the Object Naming Test on two separate occasions. The patients were assessed initially on a Thursday or Friday using one of the three predetermined orders of test presentation. On the following Monday they were retested using the same order of administration of the test cards. The interval used was short so that change in ability would not have occurred due to recovery of function. Patient characteristics are shown in table 48.

8.2.3 Results

The number of items correctly named on each occasion by each subject is given in table 51.

The correlation between results on the two occasions was $r = 0.98$ which is significant at the 0.1% level of significance. The means and standard deviation on the two occasions (table 51) were very similar which suggests that practice effects were not occurring.

8.2.4 Discussion of Results

Although a test with high test-retest reliability is not necessary when comparing treatment groups, it is necessary for evaluating change over time. As this data was not available and changes in ability over time were investigated in experiments 1 to 4 it was considered worthy of investigation. For clinical purposes it is also useful to have reliability data on commonly used tests. Reliability over time is usually determined by correlating results on two occasions (Anastasi 1976) though these may be spuriously high if doing a test on one occasion influences ability on subsequent occasions. However, since the mean scores obtained on the two occasions are so similar, it seems unlikely that significant practice effects have occurred which would limit the interpretation of results.

8.2.5 Conclusions

The results of giving the Object Naming Test on two separate occasions show a high correlation and similar means and standard deviations. This indicates that the test has adequate test-retest reliability to be used as a measure of change in ability.

8.3 Experiment 7. Experiment to investigate the reliability of the Speech Questionnaire, devised to assess functional speech.

8.3.1 Introduction

The Speech Questionnaire was devised in order to evaluate whether changes in communication ability produced in a treatment setting generalized outside the therapy setting. The questionnaire was designed to assess functional speech in everyday settings in order to determine any practical benefits of treatment. The Speech Questionnaire is presented in Appendix 1.

8.3.2. Design of the Speech Questionnaire

It was considered that the FCP (Sarno 1969), a functional speech rating scale was unsuitable.for the present studies because it needed to be completed by a speech therapist and many items would be inappropriate in the different settings to be considered. A series of questions about speech and language was collected through consultation with two speech therapists and three occupational therapists. The questions were selected,on the basis of clinical experience,as representative of abilities of dysphasic patients in various stages of recovery.

Twenty questions were chosen, thirteen on speech and seven on general aspects of communication. Each question had four possible answers graded in order of difficulty. For example 'Does the patient respond to your questions?' No, with single words, with phrases or with sentences'; or in four categories, for example 'Does he/she converse with other patients? Often, sometimes, rarely or no'. The exception to this was question 1 with six alternatives plus the possible answer 'no' to all questions. This could be scored on a 0 to 3 basis by giving a score of 0.5 to each section answered in the affirmative. It was decided to use four categories of response for each question so that there was no mid-point which would have been likely to have been overused. The four categories were always given in order of severity of impairment, which has the disadvantage that the rater may maintain a position set when completing the questionnaire. However, randomization of these categories might have been confusing for raters who, initially, were unfamiliar with using rating scales.

Scoring of each question was on a 0 to 3 basis, with a high score indicating better language ability. The scores for each question were added to give totals for the speech section and the communication section. This procedure assumes, in the absence of any evidence to the contrary, that each question is of equal importance. At that time no better system was available and so, despite its inadequacies, this method of obtaining total scores was used.

The questionnaire was used to rate a series of pilot patients. Since no particular problems arose at that stage it was used in Experiment 1 as a measure of functional speech. In the meantime it was considered that it was necessary to check both the test-retest and interrater reliabilities.

8.3.3. Inter-rater reliability of the Speech Questionnaire

Different patients were rated by different therapists within a department; it was therefore necessary that those raters should agree in their use of the Speech Questionnaire if results from one patient were to be compared with those of another.

8.3.3.1 Experiment 7.1. Inexperienced raters

8.3.3.1.1 Method

1. Subjects

Six patients who were dysphasic following brain damage attending occupational therapy work assessment section and were not included in experiment 1 were selected. Patient characteristics are shown in table 48.

2. Raters

Three occupational therapists (Raters 1, 2 and 3) who were working in the occupational therapy department work assessment section were selected. None of the raters was assessing patients in Experiment 1 as this was done by occupational therapists in the main occupational therapy section. The raters had no previous experience with the Speech Questionnaire and had not been involved in its design.

3. Procedure

Each rater was asked to assess each of the six patients on a specific day. This was done independently with no discussion among raters. Raters were given the Speech Questionnaire five days before they were due to complete it so that they could observe relevant aspects of the patients' behaviour.

8.3.3.1.2 Results

Each question was scored on a 0 to 3 basis. The scores obtained by each patient are shown in table 52. The S score is the total of the thirteen speech questions, the C score is the total for the seven questions on general communication ability.

Kendal coefficient of concordance, W, was calculated for the S section and the C section to determine the agreement between raters.

The values obtained were W = 0.50 for the speech section and W = 0.51 for the communication section. These are both non-significant and indicate no significant agreement between the raters in their assessment of the six patients.

8.3.3.1.3 Discussion of Results

It was considered that the lack of agreement between raters could have been due to the lack of experience of the raters in using the Speech Questionnaire. It was therefore decided to test this in two ways. The first was to determine the interrater reliability of raters already familiar with using the Speech Questionnaire. The second was to train the three raters in experiment 7.1.in the use of the Speech Questionnaire, to determine whether this improved the agreement between them.

8.3.3.2 Experiment 7.2. Experienced Raters

8.3.3.2.1 Method

1. Subjects

Six dysphasic patients who were attending the main occupational therapy section and who were not included in Experiment 1 were selected. These patients were all considered by the speech therapists to be relatively stable in their language abilities. Two of these had been rated in experiment 7.1 but this was by different raters. Patient characteristics are shown in table 48.

2. Raters

Three occupational therapists who were already familiar with the Speech Questionnaire were selected (Raters 4, 5 and 6). They had all discussed the questionnaire during the design stages and had been using it to rate patients in Experiment 1.

3. Procedure

The raters were given the Speech Questionnaire five days before it was due to completed so that they could observe the relevant aspects of patients' behaviour. The three raters then completed the questionnaire for all six patients on a specified day, without discussing it amongst themselves.

8.3.3.2.2 Results

The scores of patients are shown in table 52. Kendall co-efficient of concordance was calculated for the speech and the communication sections. The values obtained were W = 0.95 and W = 0.64 respectively. The former is significant at the 1% level of significance, but the latter is not significant.

8.3.3.2.3 Discussion of Results

These results indicate significant agreement in ratings of speech but not in ratings of general communication ability. This may be because the speech questions refer to directly observable behaviour, whereas some of the communication section requires inferences from behaviour rather than direct observation. For example, questions such as 'Is he anxious about communicating?', 'Does he understand general conversation?' require more judgement than questions such as, 'Does he initiate conversation?, Is his speech clear?' The extent to which this may have caused the low reliability is considered in section 8.3.4.

8.3.3.3 Experiment 7.3 Inexperienced raters from experiment 7.1 after training.

8.3.3.3.1 Method

1. Subjects

Seven dysphasic patients who were attending the occupational therapy work assessment section were selected. These were all considered by the speech therapists to be relatively stable in their language abilities. One of these patients was rated by the same raters in experiment 7.1. Patient characteristics are shown in table 48.

2. Raters

The three raters from experiment 7.1 (raters 1, 2 and 3) were trained in the use of the Speech Questionnaire. This consisted of a half hour session in which the writer discussed the questionnaire with the raters. Each question was explained and its use with different example patients was presented. The writer made a note of questions and problems raised by the raters and made an annotated version of the questionnaire as a reference for the raters.

3. Procedure

The raters were given the questionnaire five days before it had to be completed. Each rater assessed all seven patients.

8.3.3.3.2 Results

The scores obtained are shown in table 52. Kendall co-efficient of concordance, W, was calculated for the speech section and communication section. These were W = 0.83 and W = 0.42 respectively. The former is significant at the 1% level of significance, the latter is not significant.

8.3.3.3.3. Discussion of Results

The results obtained after training the three raters from experiment 7.1 are consistent with experiment 7.2. They indicate that the speech section has high inter-rater reliability but the communication section does not. The effect of training was to increase agreement on the speech section but to decrease agreement on the communication section. This suggests that the speech section has adequate inter-rater reliability when used by trained raters. The communication section had poor inter-rater reliability which has been suggested as due to the nature of the questions involved. The inter-rater reliability of individual questions in this section was therefore investigated.

8.3.3.4 Investigation of Communication Section Questions

The communication section of the Speech Questionnaire was investigated to determine whether certain questions were contributing to the poor inter-rater reliability and therefore could be excluded.

8.3.3.4.1 Method

Each question from the communication section was considered separately for both experiments 7.2 and 7.3

8.3.3.4.2 Results

Kendall's co-efficient of concordance, W, was calculated for each question for experiments 7.2 and 7.3. The results are shown in table 53.

The results indicate that there was significant agreement between raters in experiment 7.2 in their answers to questions C3, C5 and C6. There was no significant agreement between raters in experiment 7.3 for any of the communication section questions.

8.3.3.4.3. Discussion of Results

Although no significant agreement occurred between raters in Experiment 7.3 for any of the questions,the W for questions C4 and C5 was nearly significant at the 5% level and higher than for other questions. Raters in experiment 7.2 showed agreement for question C4 which was also nearly significant at the 5% level. Therefore the questions which show some agreement between raters are C3, C4, C5 and C6. These were all predicted to have low inter-rater agreement as they involve inferences drawn from observed behaviour rather than direct observations of behaviour. Nevertheless, it seems that some raters can agree when recording this type of behaviour. The two questions which show most agreement between raters, when both experienced raters in experiment 7.2 and trained raters in experiment 7.3 are considered, are questions C4 and C5. Two of the questions which gave low inter-rater reliability also gave ambigious results. Questions C1 and C2 may be scored as 'never' either if a patient is severely aphasic and never uses gestures or writing to assist communication, or if the patient is so mildly aphasic that he never needs to use gestures and writing to facilitate communication.

Question C7, which shows poor agreement between raters, may be too difficult to judge with any consistency, owing to the complex and varied nature of the communication process involved for general conversation.

8.3.3.4.4. Conclusions

Investigation of separate questions in the communication section suggested that particular items should be excluded. Questions C4 and C5 showed the best agreement between different raters in experiments 7.2 and 7.3 and, therefore, are the only questions with adequate inter-rater reliability.

8.3.4 Test-Retest Reliability

Since the Speech Questionnaire was being used as a measure of change it needed to be reliable over time.

8.3.4.1 Experiment 7.4 Experienced raters from experiment 7.2

Experiment 7.2 had shown that experienced raters (Raters 4, 5 and 6) showed some significant agreement in scores. It was therefore necessary to determine whether they were also consistent over time.

8.3.4.1.1 Method

The raters in experiment 7.2 were asked to re-rate the same patients four weeks later. Two of the patients had been discharged from the unit in the intervening period and therefore had to be omitted. The patients had previously been selected as those who were unlikely to change in speech ability. This meant that any changes in score were unlikely to be due to changes in their aphasia.

8.3.4.1.2 Results

The scores obtained are shown in table 52.Kendall's tau was calculated to determine the reliability over time. The expected order of ratings was determined from the sum of ranks for each patient on initial assessment. The rank orders on retesting were compared with these rankings. The results obtained are shown in table 54.

8.3.4.1.3 Discussion of Results

Results indicate significant agreement between rankings on the two occasions for the speech section, but not for the communication section. This suggests that the communication section is unreliable over time but the interpretation of results is limited by the small number of subjects (n = 4) involved.

8.3.4.2. Experiment 7.5 Trained Raters from experiment 7.3.

Experiment 7.3 had shown that trained raters (raters 1, 2 and 3) showed some significant agreement in scores. It was therefore necessary to determine whether these raters were also consistent over time.

8.3.4.2.1 Method

The Speech Questionnaire ratings were repeated by trained raters in Experiment 7.3 (raters 1, 2 and 3) four weeks later. One of the seven patients had been readmitted to an acute hospital during the intervening period. Six patients were therefore available for reassessment.

8.3.4.2.2 Results

The scores obtained are shown in table 52. Kendall's tau was calculated in the same way as for Experiment 7.4. These results are shown in table 55.

8.3.4.2.3. Discussion of Results

Results indicate that the speech section was reliable over time but not the communication section. This is consistent with findings in Experiment 7.4, though the problem of the small number of subjects involved persists. However, the consistency of results in the two experiments (7.4 and 7.5) provides some indication that the poor reliability was not entirely due to small numbers of subjects. Also, the highly consistent results on the speech section even with small numbers of subjects, adds further doubt to the adequacy of the test-retest reliability of the communication section.

8.3.4.3. Test-Retest Reliability of Communication Section Questions

It was shown that only questions C4 and C5 had sufficient inter-rater reliability to make them suitable as measures of communication (see Section 8.3.3.4). The test -retest reliability of these scores was investigated by calculating Kendall's tau for each question given by experienced raters from Experiment 7.4 and trained raters from Experiment 7.5. The results are shown in table 56. These results indicate that experienced raters from Experiment 7.4 were reliable over time in their answers on both questions C4 and C5, whereas raters from Experiment 7.5 were not reliable over time in their answers to questions C4 and C5 of the communication section.

8.3.5 Discussion of Results on Speech Questionnaire

The Speech Questionnaire was designed as a measure of functional speech which could be administered by raters in different settings. When given by untrained raters the inter-rater reliability was low. However, it was adequate for the speech section when raters were trained or were experienced in using the questionnaire, but not for the communication section. It was also found that these raters were reliable over time when rating speech but not communication.

Investigation of the communication section question indicated that only two questions were suitable as measures of communication ability and even these did not have good reliability over time.

Results from the communication section as a whole in Experiments 1 to 4 are therefore difficult to interpret. The results obtained could have occurred due to the lack of reliability of the scores. The data was therefore also analysed considering only communication section questions 4 and 5 which are more reliable. Although these questions provide some measure of communication ability it would appear that development of a more detailed reliable measure of functional communication would be of value. The main alternative measure of functional communication is the FCP which does not include consideration of aspects such as anxiety about communicating and appreciating opportunities to communicate. These factors may be very important determinants of the extent to which patients put into practice the skills they acquire during treatment.

Although the speech section gives reliable data it would also be worth further developing the scale. At present the scoring on a 0 to 3 basis and adding the scores makes assumptions about the equal weighting of items. This may be inappropriate and should be further investigated. One possibility is that the speech section could be scaled in order of difficulty, using a procedure such as Guttman scaling. This has been shown to be appropriate for various disabilities (Williams, Johnston, Willis and Bennett 1976, Lincoln and Leadbitter 1979) and may also be suitable for recovery from aphasia following stroke.

8.3.6. Conclusions

The speech section of the Speech Questionnaire shows good inter-rater reliability when given by experienced or trained raters. These raters are reliable over time. The communication section does not have adequate inter-rater or test-retest reliability. Questions C4 and C5 are the most reliable questions of the communication section but even these are not very satisfactory as measures.

CHAPTER 9

DISCUSSION OF RESULTS AND IMPLICATIONS FOR FURTHER STUDIES

9.1 Comparisons of Language Treatment Methods

All four experiments, in which comparisons were made between various treatment procedures (Experiments 1 to 4), indicated that no differences occurred. This could be because individual attention produces recovery and the actual treatment procedure has little effect. Alternatively, it could be that occupational therapy and physiotherapy are producing sufficient change in language abilities, so that language treatment sessions add little above this. A third alternative is that the recovery of aphasics is entirely spontaneous and not due to any intervention.

The present studies provide no means of distinguishing between these alternatives. Although in Experiment 4 patients receiving individual language treatment are compared with others not receiving individual language treatment, there are other differences between the groups besides the presence or absence of individual language treatment (see section 7.4.1). In order adequately to answer this question, it is necessary for a group of patients to be randomly allocated to either a language treatment or a no language treatment group. The patients could all receive the general rehabilitation facilities of the hospital. However, if no differences occurred between these groups it would still be necessary to evaluate the effect of general rehabilitation, in particular occupational therapy, on language abilities.

Studies on spontaneous recovery have not excluded patients from all rehabilitation facilities and so the observed changes in performance may result from general stimulation rather than spontaneous recovery (Culton 1969, Kertesz and McCabe 1977). A recent study at Northwick Park Hospital has produced results to suggest that rehabilitation has an effect on functional abilities in activities of daily living (Meade 1979) and it may be that these incorporate some effect on language abilities.

Some of the few significant differences which did occur when comparing treatments were in unpredicted directions. Speech therapy improved non-verbal abilities of moderate aphasics (see section 5.3.1) and practice on non-verbal tasks improved a language ability, reading, for severe aphasics (see section 6.2.3.1). The question arises as to why practice on one type of task should produce improvement on another. A similar finding has been reported by Burland (1974) who trained 30 mentally handicapped cerebral palsied children on a programme which was essentially non-verbal and obtained improvement in language scores. However, neither he nor Newcombe (1975), who refers to this finding, suggest a possible underlying mechanism for its occurrence.

One might speculate that stimulation of the undamaged hemisphere, through non-verbal tasks, will improve features of performance such as concentration and this may have a carry-over effect onto language tasks. However, it would not explain why verbal practice improved non-verbal abilities in moderate aphasics.

The problem which arises in the interpretation of this latter finding is the extent to which the Progressive Matrices is a verbal or a non-verbal task. Reviews of the Progressive Matrices have indicated that the validity data is equivocal (Westby 1953, Burke 1958, Bortner 1965 and Blum 1978). Correlations with alternative non-verbal tests, such as the performance I.Q. of the W.A.I.S., have not been much greater than those with verbal I.Q. (McLaurin and Farrer 1973, Watson and Klett 1974) when non-brain damaged subjects are considered. One study on aphasics has also indicated relatively poor agreement between Progressive Matrices and W.A.I.S. Performance I.Q. (van Harskamp 1974). However, the agreement with verbal I.Q. is no better, so there is no reason to suppose that the Progressive Matrices has more verbal components than non-verbal. It is likely that it can be performed using either verbal or non-verbal strategies, as was suggested by Newcombe (1976).

The implications of these findings are that language treatments should incorporate more non-verbal material. Speech therapy incorporated more non-verbal material than either operant training or non-specific treatment and produced significantly more improvement on the Progressive Matrices. The attention placebo treatment in Experiment 3, which was almost entirely non-verbal, produced more improvement on two tasks than the operant training, even though this included pictures. There are various possibilities as to why the inclusion of non-verbal material might have a beneficial effect on language recovery.

Disturbances of non-verbal abilities in aphasics are frequently reported. Maly, Turnheim, Heiss and Gloning (1977), investigating cerebral blood flow in relation to neuropsychological test scores, found that most patients had non-verbal deficits as well as aphasia. Similarly, van Harskamp (1974) found severe aphasics had lower performance I.Q. than mild aphasics, and Orgass, Hartje, Kerschensteiner and Poeck (1974) found significant lowering of Performance I.Q. in an aphasic group, indicative of severe intellectual impairment. These non-verbal deficits may be improved by non-verbal practice, particularly if the extent of impairment is not very severe. Improvement of general intellectual level may enable aphasics to make better use of their language abilities and lead to improved language functioning. An alternative explanation is related to the possibility that recovery of language is mediated by transfer of function to the right hemisphere (see section 3.1.1.2.1). Non-verbal activities, usually mediated by the right hemisphere, may stimulate right hemisphere functioning and facilitate transfer of function.

A third possibility is that non-verbal practice encourages the use of non-verbal strategies to solve tasks which were previously solved using verbal strategies. If moderate aphasics used verbal strategies to solve the Progressive Matrices task initially, but because of practice with non-verbal material, were able to use non-verbal strategies, then recovery would be enhanced. The severe aphasics in Experiment 3 may have been trained to attend to perceptual details, such as orientation of lines, by the non-verbal practice which may have generalized to attending to perceptual components of individual letters on a reading task.

These alternatives are highly speculative but it would seem that the importance of non-verbal material in the treatment of aphasics may have practical consequences for the development of treatment methods and theoretical implications for the mechanism of recovery. It therefore seems that they warrant further investigation.

9.2 Change in Language Abilities over time

The results of Experiments 1 to 4 consistently show that aphasic patients change in language abilities over time. They appear to indicate that moderate aphasics change more than severe aphasics, since significant change was found on more tests. However, this could have occurred as a result of the selection of tests and the nature of the scoring systems of some tests.

The tests were initially selected for Experiment 1 for use with moderate aphasics and subsequently used with severe aphasics in Experiments 2 and 4. Some proved too difficult for severe aphasics and were excluded from Experiment 3, while other easier tests were added. The apparently greater improvement of moderate aphasics may have been because some tests were too difficult for severe aphasics. Even though the severe aphasics may have improved on these tasks, this might not have been sufficient for them to get above basal scores.

An additional problem when comparing improvement in moderate and severe aphasics on the PICA, is the lack of equal interval scale. The 16 point scale is probably not equal interval but has some large and some relatively small gaps between scores (Lincoln, Pickersgill and Valentine 1979). It is therefore more difficult to improve from some scores than it is from others. Many severe aphasics will be attempting to improve over the relatively large gaps of 5 to 6 and 6 to 7, whereas moderate aphasics will be improving over small gaps of 9 to 10 and 10 to 11. This could produce the finding that moderate aphasics improve more than severe aphasics.

The Token Test number correct score presents a similar problem. Improving from being able to do items in one part of the test to another may be more difficult than improving within a part of the test. However, as these relatively difficult transitions occur at four levels of ability, moderate and severe aphasics should be approximately equally affected.

Another consideration when comparing change over time in Experiments 1 to 4 is the time interval elapsed between initial and final assessment. Experiments 1 and 3 consider an eight week interval, whereas Experiments 2 and 4 consider a four week interval. Some tests might therefore be expected to show significant change in Experiments 1 and 3 but not in Experiments 2 and 4. This occurs on several tests. The only inconsistency to arise is on test X, on which patients in Experiment 2 show significant change over four weeks but patients in Experiment 3 show no significant change. This result for test X may just be a chance finding because all other test results are consistent with each other.

Comparison of tasks on which improvement occurs in treated and untreated patients shows no evidence of treatment consistently improving particular abilities and no treatment being associated with improvement on other abilities. The tasks which show significant change are largely determined by their relative difficulty. But there is also a tendency for expresssive verbal abilities to show more consistent change than auditory receptive abilities. This is the opposite from reports in the literature which generally indicate that reception improves more than expression (Kenin and Swisher 1972, Hanson 1974, Lomas and Kertesz 1978 and Prins, Snow and Wagenaar 1978). If improvement in reception had already occurred prior to inclusion in Experiment 1, then findings would be consistent. One would then expect the amount of change in expression to be correlated with months post onset, and this did not occur. Therefore, it seems unlikely that recovery of reception is complete, and that recovery of expression is still occurring.

The results generally suggest that the change in abilities observed is due to spontaneous recovery, and independent of treatment. Spontaneous recovery is expected to be marked early post stroke and gradually decrease with time. The time at which it is expected to cease varies from one author to another. Estimates are usually between three and six months (see section 3.1.2), but longer periods of 8 months (Hanson 1974) up to 6 years (Geschwind 1974) have been suggested. If spontaneous recovery was entirely to account for the observed change in language ability, change would be expected to correlate with months post onset. However, in Experiments 1 to 4 correlations were mostly non-significant. In Experiment 1 significant trends were recorded but these were only for expressive verbal abilities. This suggests that change in verbal expression occurs as a result of spontaneous recovery, whereas change on other language tasks may result from patients receiving rehabilitation. A mechanism to account for this discrepancy between recovery of expressive verbal abilities and other language abilities is not clear.

If the deficit of verbal expression can be accounted for in terms of impairment of non-verbal oral movements, then recovery might be expected on the basis that there is some ipsilateral control of motor function. Mateer and Kimura (1977) point out that oral apraxia is commonly associated with aphasia, generally non-fluent aphasia. They also point out that fluent aphasics also have oral apraxia if complex, rather than simple movements are assessed. Kimura (1977) suggested a major function of the left hemisphere is control of changes in articulatory posture and verbal functions are derived from that control. If these motor functions are more likely to recover spontaneously than sensory function, then expression would be expected to improve more than reception. One possible mechanism of recovery of motor function is ipsilateral control, so that the right hemisphere is controlling the right side of the body. If this ipsilateral control is adequate for complex oral movements, then recovery of these might be expected. A process of transfer from contralateral to ipsilateral control over time would be needed to account for the timing of spontaneous recovery. Sperry, Gazzaniga and Bogen (1969) report that there is strong bilateral representation of the head and neck in each hemisphere. This bilateral control of oral movements could mediate recovery of expressive abilities if these are largely due to impairment of oral movements.

The interpretation of sensory input would need to be lateralised and not under ipsilateral control, in order for spontaneous improvement of receptive verbal abilities not to occur. Sperry et al (1969) report that split brain patients show independence of the two visual fields with no cross integration. This also applies to tactile stimulation, but whether it also applies to auditory input is not clear. It is not reported whether auditory input to the left ear can be identified by the left hemisphere. However, Oxbury (1975) does present evidence to suggest that auditory pathways have bilateral representation in either hemisphere. This would need to be less than that of motor control of oral movements for recovery of reception to be slower than recovery of expression.

There are, however, limitations on generalizations which can be drawn from these studies of split-brain patients. The patients studied by Sperry et al (1969) had generalized convulsions which were presumed to stem from birth injury and therefore, may have resulted in a less than average amount of cerebral specialization. The amount of ipsilateral control observed in these patients may be more than is generally the case.

Another problem is that ipsilateral control may only be possible when the contralateral hemisphere is disconnected and not when it is malfunctioning. Split brain studies indicate that the right hemisphere has some linguistic ability (Sperry et al 1969), but this is not so consistently reported when there is left hemisphere damage since extensive damage usually produces a global aphasia. It may be that the right hemisphere cannot produce language if the left hemisphere is functioning, albeit poorly, but only when inhibitory influence is not possible due to sectioning of the corpus callosum.

Another consideration in relation to change in abilities is the implications it has for mechanisms of recovery. If recovery of function is occurring by transfer of language abilities to the right hemisphere, then most recovery would be expected in abilities which are within the right hemisphere's linguistic capabilities. Recovery might be expected in comprehension of spoken words and descriptions of objects and reading of words and object descriptions, but not in expression, both verbally and in writing. These differential recovery rates were not found in Experiments 1 to 4.

In addition, most recovery might be expected in severe aphasics since they have deficits which would be likely to transfer, whereas the more linguistically complex deficits of moderate aphasics would be less likely to transfer. Again, the present results do not support this expectation.

The results of the present experiments suggest that spontaneous recovery is occurring but do not support the possibility that it is due to transfer of function to the right hemisphere. It may result from continued normal operation of spared neural mechanisms, as put forward by LeVere (1975). Alternatively but probably less likely, it could be due to patients learning non-verbal strategies to cope with language situations.

9.3 Factors relating to Change in Ability

The relation between change in ability and biographical variables was investigated in Experiments 1 to 4, and certain consistencies in results occurred.

9.3.1. Age

Age showed no significant correlation with change, which is in accordance with recent studies (Smith 1971, Keenan and Brassel 1974, Messerli, Tissot and Rodriguez 1976 and Kertesz and McCabe 1977). However, the results only apply in the 18 to 65 year age group and differences may occur when older patients are included.

Johnson et al (1979) have recently shown that right hemisphere efficiency declines with age but left hemisphere efficiency does not. They suggest this accounts for the decline in spatial abilities without corresponding decline in verbal abilities with increasing age. It would also account for equivalent recovefy at different ages if the recovery is being mediated by the left hemisphere. Why, at a physiological level, such differences should occur seems unclear, and Johnson et al's results need further replication before any conclusions may be drawn.

9.3.2. Months-Post-Onset

Although a trend of decreasing change in expressive verbal abilities with increasing months post onset was found for moderate aphasics in Experiment 1, correlations between change in ability and months post onset were non-significant. This is surprising in view of the expected importance of spontaneous recovery. It may be that spontaneous recovery had ceased by the time most patients were referred for rehabilitation, in which case the spontaneous recovery stage would be much shorter than is commonly thought (see section 3.1.2). Alternatively it may be that attending a rehabilitation centre has a beneficial effect and it is this that produces change in abilities regardless of the stage at which patients are admitted to the unit.

9.3.3 Handedness

Handedness could only be measured adequately for moderate aphasics in Experiments 1 and 4. Severe aphasics in Experiments 2, 3 and 4 were unable to understand the questions of the Edinburgh Handedness Inventory or gave unclear answers. However, within the moderate groups, contrary to expectations, handedness did not relate to change in ability. However, the number of left handers was small and none of these was entirely left handed for all activities. Therefore, in common with other studies on handedness (see section 3.2.6), the small numbers of left handed aphasics limits interpretation of results.

9.3.4 Severity of Brain Damage

No attempt was made to assess the severity of brain damage in the present series of patients. An EMI scan, if it had been available, might have provided a means of estimating the extent and the locus of the lesion, but recording of these in quantifiable terms is difficult.

It is likely that the state of the 'unaffected' areas of the brain may determine the extent of recovery. Some patients may have had sub-clinical strokes due to small areas of infarction or haemorrhage which may exist without producing neurological signs, as well as their major stroke. These small areas of infarction or haemorrhage, while insufficient in themselves to produce observable deficits, could impede recovery in a particular patient.

The detailed analysis of the severity of the lesion and state of the 'intact' brain are likely to be clinically important and warrant further investigation. This has rarely been done in previous studies as few adequate measures are available. With the development of techniques for the physical evaluation of patients, such as the EMI scan and recordings of regional cerebral blood flow, it may become easier to consider the severity of the lesion in relation to recovery.

9.4 Implications of Results for Future Studies

9.4.1 Assessment Procedures

The assessment procedures were designed initially for Experiment 1 and used for Experiment 4. They proved adequate with moderate aphasics, but following a preliminary investigation of their appropriateness for severe aphasics (Experiment 2) various modifications of the procedure were adopted for Experiment 3.

The PICA was found acceptable in terms of standardized administration, scoring and reliability. It was also appropriate in level of difficulty for the patients seen. If longer intervals of reassessment had been used, then a ceiling effect might have occurred if patients improved markedly. Its main limitations are in relation to statistical analysis of results obtained. In the absence of any evidence to the contrary, the 16 point scoring scale was assumed to be an equal interval scale. This appears not to be the case (Lincoln, Pickersgill and Valentine 1979). Therefore interpretations of change in ability will be affected. This could possibly be overcome if a weighting system could be devised to allow for the relative sizes of the gaps between scores.

The Token Test provides a means of assessing less severe comprehension defects than the PICA tests VI and X. It is therefore appropriate for moderate aphasics. If severe aphasics are to be assessed, the inclusion of some simpler items may make the test more sensitive to change. Separate identification of the two shapes and five colours could be used as a preliminary part of the test. Shortening the test by dividing it into three parallel short forms may also have decreased its sensitivity to change. The number correct score failed to show significant change in Experiments 3 and 4 when it was apparent from other tests that changes in comprehension ability were occurring. This possible insensitivity might be reduced by using the full 62 item version of the test. Shortening could be achieved by stopping any part after a certain number of consecutive failures so that more severely impaired patients would not be presented with too many items they could not attempt. Results from the number correct and weighted scoring system were essentially the same, so the inclusion of the weighted scores may not be necessary. It has also been suggested (Salvatore, Strait and Brookshire 1978) that tape recorded presentation of instructions should be used as examiners vary in their rate of presentation of commands, and thid may affect performance.

The Object Naming Test provided a means of assessing milder naming deficits than the PICA test IV. However, even with the inclusion of practice items in Experiment 3, many severe aphasics obtained basal scores. Latencies of naming can be recorded, but this probably would not significantly reduce the number of patients with no score. An alternative would be to use the PICA 16 point scale, so that even attempts at the task could be scored, but problems in the statistical analysis of the 16 point scale then arise.

Fluency presents the same problem as the Object Naming Test when severe aphasics are to be assessed. However, with less severe patients it assesses an ability not generally included in language assessments. It is also used as a measure of frontal lobe functioning (Tow 1955) and in this context may provide useful additional information.

Picture Description was used as a measure of available vocabulary, on the basis that patients who produce more, different words will have improved. However, in the case of fluent aphasics, a reduction in the number of words produced within a given period may indicate improvement. It might be better to obtain a sample of normals' performance on the task and consider a change toward normal performance an improvement, regardless of whether it was an increase or decrease in word production.

The Eisenson visual agnosia sections scored using the PICA 16 point sclae provided a measure of low level comprehension for severe aphasics. The 16 point scale proved easy to apply and provided considerable information which otherwise would not have been recorded if the original incorrect or correct scoring, proposed by Eisenson (1954), had been used. However, if shape and colour identification were included as a preliminary part of the Token Test, then these could probably be excluded.

The Peabody Picture Vocabulary (Dunn 1965) was too simple, even for severe aphasics. It also includes various American words. However, it did provide success experiences which might have encouraged patients to persevere in their attempts on other tasks. A selection of items from the English Picture Vocabulary Test (Brimer and Dunn 1962), aimed at covering a wide range of difficulty, could be used as an alternative.

The Self-Rating was included to determine the effect of treatment on the patients' confidence to use their language abilities. It is, however, not known how the scale relates to what a patient actually does in a communication situation. A simpler method might be for the patient to rate their confidence on a five point scale. However, this method might be difficult with severe aphasics. Many severe aphasics can indicate 'yes' or 'no' to a simple question but can not produce more complex answers.

The Progressive Matrices was used as a measure of intelligence assessed non-verbally. It was straightforward to explain, and patients were mostly able to point to their selected answer. A few patients were so apraxic that they had difficult pointing, even using their non-hemiplegic hand. Field defects, if severe, could affect performance though Basso et al (1973) found this not to be the case in left hemisphere damaged patients, and it was not apparent with patients in these experiments. The policy of stopping each set after

3 consecutive failures for severe aphasics and 5 consecutive failures for moderate aphasics seemed to prevent an excessive number of difficult items being given. However, no data is available on the comparability of scores obtained by this method with the standard administration. There is also the problem about the content validity of the Progressive Matrices. The extent to which it measures a general intelligence factor or non-verbal abilities is open to question (see sections 2.4.3 and 9.1).

The Edinburgh Handedness Inventory was found unuseable with severe aphasics (see sections 6.1.2.2 and 7.3.4), but a suitable alternative is difficult to suggest. One possibility is to ask patients' relatives whether they were premorbidly right or left handed for writing. In this age group, many left handers may have been trained to use their right hand for writing and so this method might have been inadequate. The assessment of handedness in a hemiplegic group with problems of comprehension and expression is very difficult and therefore limits investigations. It may be possible, as an alternative, to consider brainedness (Buffery 1976) by presenting easy to verbalize and difficult to verbalize material to the undamaged hemisphere, or to consider eye and head turning responses when patients are presented with verbal and spatial problems (Kinsbourne 1972), or to measure variations in regional cerebral blood flow during automatic speech (Larsen, Skinhøj and Lassen 1978).

The Speech Questionnaire was used to assess functional speech. The speech section had good reliability (see Experiment 7, section 8.3) but no validation has been carried out. This could be done by observing patients speech in situations in which they are rated. This could not be so readily done for the communication section, but, as the reliability of this is poor (see section 8.3), an alternative assessment of these aspects of functional speech might be more suitable. The scoring of the assessment could be improved. In the present scoring all items are given equal weighting as they are added to provide a total score. An investigation of whether the questions fit a Guttman scale model might help overcome this scoring problem (see section 8.3). If the reliability and scoring could be improved, this assessment of functional speech might be of practical use. It has the advantages over the main alternative, the Functional Communication Profile, that it can be given by any person who comes into contact with the patient, provided he has some explanation of the use of the questionnaire, and it does not require special assessment time, but can be completed on the basis of day-to-day contact with the patient.

No special situation has to be created, and so the patient need not be aware that he is being assessed.

9.4.2 Treatment Procedures

9.4.2.1 Speech Therapy

Generally, greater specification of exactly what is done during a treatment session is required. The content of treatment sessions may then be related to outcome. This is being attempted by Enderby and David (1976) who specify during treatment the aims of each activity so that these may be related to changes in ability. However, apart from the actual activities used, one also needs to consider the effects of non-contingent encouragement, provision of cues and multi-modal as opposed to unimodal stimulation. Until the theoretical basis of speech therapy is clearly defined it is difficult to specify the precise nature of the content. However, preliminary investigations of various treatment techniques would be possible.

The main strategy of speech therapy is to give patients practice on verbal tasks in order to improve language abilities. It may be that this is inappropriate, since the present studies have not indicated a beneficial effect. An alternative would be to train patients to communicate by non-verbal means. Skelly, Schinksy, Smith and Fust (1974) have tried teaching aphasics American-Indian sign language as a means of communication and report favourable results. The advantage of this system over other sign languages is that 80% of normal people can understand it without formal tuition. However, there is some evidence to suggest that patients with language impairment would also have impairment of their ability to use signs to communicate (Duffy, Duffy and Pearson 1975).

A recent study on word finding ability suggests that speech therapy needs modification to take account of changing ideas on the basis of word finding difficulties. Howes (1964) showed that aphasics had words available but they were not produced. This, he suggests (1973), is due to an impairment in activation and reliability of access mechanisms to the lexicon. Therapy oriented towards gaining access to the lexicon rather than increasing vocabulary size should therefore yield better improvements. This was investigated by Seron, Deloche, Bastard, Chassun and Hermand (1979), who compared four patients, trained according to traditional methods using as wide a range of vocabulary as possible, with four patients trained only on a selection of forty words. This training used facilitating processes capable of eliciting the emission of the right word, such as cueing, gestures and lead-in phrases. Assessment after therapy showed that three experimental subjects improved on naming items which were not trained, whereas only one control improved in naming ability. The results suggest that specific procedures may be effective in treatment. However, the number of patients was small, and results may not be applicable to all types of aphasia.

9.4.2.2 Operant Training

The main requirement of the operant training procedure is for effective reinforcers to be available. Praise and feedback of progress were inadequate for most patients in Experiments 1 and 3. They may need to be supplemented with material rewards. In addition, procedures such as modelling, delayed reinforcement and self reinforcement, need investigation. Punishment was found by Kushner, Hubbard and Knox (1973) to produce faster learning in aphasics if used in conjunction with positive reinforcement. Incorporating any of these into the training programmes used may increase their effectiveness.

Operant training is based on trying to get a patient to use whatever language is available to him rather than increasing the available language. Reinforcement is used to encourage this. It may, therefore, be inappropriate to use operant training at a stage when the available language is increasing. This may account for the favourable results obtained by Goodkin et al (1973) with long term aphasics yet not replicated in Experiment 1 with recent aphasics.

9.4.2.3 Non-Specific Treatment

Attention placebo treatments in the form of general conversation or non-verbal tasks have not been used in previous studies. They proved practical and patients did not complain that they were unhelpful or inappropriate. Future studies could use these as control procedures, but the use of non-verbal material may need to be carefully documented to check that it is not having a specific therapeutic effect on language abilities.

9.4.2.4 No Treatment

A 'no treatment' group was only available by considering patients in hospitals where no speech therapy was available. This limited the conclusions that could be drawn in Experiment 4. The ethical problems of having a no treatment group for patients for whom speech therapy is available will be reduced if further studies like the present experiments indicate that present procedures produce no significant beneficial effect.

9.4.3 Methodological Considerations

9.4.3.1 Design of Studies

Most studies, including the present study, have compared various forms of treatment of language for aphasic patients (Sarno, Silverman and Sands 1970, Hagen 1973, Basso et al 1976, Enderby and David 1976 and Wechsler 1978). An alternative used by Boswell (1974) compared rate of improvement of a treated group with an empirically validated theoretical rate associated with non-treatment. However, this rate, based on the work on spontaneous recovery by Culton (1969), is not so well established and predictable that deviation from it can be attributed to the effects of treatment.

Another alternative, which does not seem to have been used, is a multiple baseline single case experiment. Various procedures might be used successively to treat different aspects of language performance such as auditory comprehension, reading, writing and verbal expression. These may not be entirely independent of each other, but if treatment of one following a stable baseline produces change in all, a reversal procedure could be used to determine whether abilities return to baseline levels or remain static when no treatment conditions are reintroduced. This would have practical implications, even if not demonstrating the practical efficacy of a particular procedure for a particular ability.

The advantage of single case designs would be that small numbers of patients could be studied. This is particularly important when one considers the problems of obtaining a large enough sample of patients in the present study. It took 4 years to assess 142 patients to obtain 37 moderate aphasics of which 24 completed 2 months treatment. Severe aphasics were easier to obtain, but even in this group failure to complete treatment occurred. The marked variability of patients' responses to different treatments would then not require such large differences between treatments in order to demonstrate significant differences, if they exist.

9.4.3.2 Selection of Patients

The present study has shown how various criteria, such as severity of aphasia, may restrict the number of subjects available for treatment. However, if certain treatments are appropriate for certain types of patient, then selection is necessary in order to evaluate the effectiveness of those treatments.

Patients in the present study were all aphasic due to cerebral vascular accidents. No subdivision was made within this group according to the cause of the stroke or the blood vessels affected.

Diagnostic criteria are difficult to determine, and recording of neurological state presents problems in the analysis of results. However, the inclusion of patients with diverse aetiologies produces large patient variability which may obscure treatment effects.

The classification of aphasia has no widely accepted divisions, but as various systems are available it is feasible that different types exist. The most acceptable classification is the fluent or non-fluent division. The only patient to respond well to operant training in Experiment 1 was a fluent aphasic, and therefore it might be appropriate for future studies to classify aphasics on this basis. However, Basso, Faglioni and Vignolo (1975), who did subdivide patients into Broca's and Wernicke's aphasics, found no significant differences in their response to speech therapy.

Other factors which may need to be considered in the selection of patients are intelligence and handedness, but these are beset with problems of assessment (see section 9.4.1). Side of hemiplegia could be considered but so few aphasic left hemiplegics occur that large numbers of patients would need to be available.

Therapists' reports of patients' response to treatment stress motivation as important. Those patients who want to improve and who work hard seem to improve more. But measurement of such characteristics is difficult. It may not be possible to assess until after treatment is completed, and even then, there are no clear indications of how it might be done.

9.4.3.3 Practical Problems

The practical problems encountered are unlikely to be specific to the present study and may be avoidable by adequate planning of future studies.

The allocation of therapist time limited the amount of independent assessments that could be done and the amount of treatment time. It would seem desirable that an independent assessor should give all assessments and should, ideally, have no knowledge of the treatment being given to the patient. This would virtually necessitate the assessor not being a member of the clinical staff of the hospital concerned, but being called in purely for the purpose of assessing a patient.

Although twelve half hour sessions in three and a half weeks is representative of typical treatment regimes given, it is obviously very little treatment time in relation to that available. A study of intensive treatment, of the order of an hour a day, over a more prolonged period, such as two or three months, would provide a means of assessing the effectiveness of treatment given under ideal circumstances. If this were effective, then it would indicate that language treatment resources need to be increased or therapist time more selectively allocated to certain patients who can benefit from treatment. However, if treatment under these circumstances seems to contribute little, then the whole content of language treatment needs to be either reconsidered or abandoned altogether.

Problems arose in the present study of patients not completing two months treatment. If intensive treatment were given over a longer period of time, the drop out rate would be likely to be higher. This could be partly avoided by only seeing patients local to the hospital concerned, thereby at least reducing the problems of homesickness which accounted for several of the present series of patients leaving the treatment trial.

9.5 Conclusions

Language treatment methods, both speech therapy and those based on operant conditioning, were ineffective in the rehabilitation of language of aphasic stroke patients. Recovery of language occurred but this was independent of the treatment received. It was also not influenced by the patients' age, handedness or months post onset. It appears to be largely due to spontaneous recovery and the pattern of this recovery varied according to the ability under consideration.

The language rehabilitation of aphasic patients at Rivermead Rehabilitation Centre is ineffective in its present form. Further studies are needed to consider the possible effectiveness of intensive treatment, and variables which may be used to select an appropriate treatment for a particular patient. However, if the present results are applicable to language treatment methods in general or to aphasic patients as a group then the process of treatment of aphasia needs serious reconsideration. In the meantime, aphasic patients will continue to be treated but it may only provide psychological support with no effect on language abilities, or even serve nothing more than to fill in time in a patient's day.

REFERENCES

Aaronson M., Shatin L. and Cook J., Socio-psychotherapeutic approach to the treatment of aphasic patients, J. Speech Hear. Disord. 21 352-364 1956.

Alajouanine T. and Lhermitte F., Acquired aphasia in children, Brain 88 653-662 1965.

Albert M.L., Aspects de la compréhension auditive du language après lésion cérébrale,
Langages 7 37-51 1972.

Albert M.L., Auditory sequencing and left cerebral dominance for language,
Neurospychologia 10 245-248 1972.

Albert M.L., Sparks R.W. and Helm N.A., Melodic Intonation Therapy for aphasia, Arch. Neurol. 29 130-131 1973.

Anastasi A., Psychological Testing,
Fourth Edition, Collier Macmillan Publishers, London 1976.

Archibald Y.M., Wepman J.M. and Jones L.V.,
Non-verbal cognitive performance in aphasic and non-aphasic brain-damaged patients, Cortex 3 275-294 1967.

Armitage P., Statistical Methods in Medical Research, Blackwell Scientific Publications, Oxford, 1971.

Basser L.S., Hemiplegia of early onset and the faculty of speech with special reference to the effects of hemispherectomy,
Brain 85 427-460 1962.

Basso A., DeRenzi E., Faglioni P., Scotti G.and Spinnler H.,
Neurospychological evidence for the existence of cerebral areas critical to the performance of intelligence tasks,
Brain 96 715-728 1973.

Basso A., Faglioni P. and Vignolo L.A.,
Etude controlée de la ré-éducation du langage dans l'aphasie: comparison entre aphasiques traités et non-traités.
Revue Neurol. (Paris) 131 607-614 1975.

Baum M., Rapid extinction of an avoidance response following a period of response prevention in the avoidance apparatus,
Psych. Rep. 18 59-64 1966.

Bay E., Classification of disorders of speech,
Cortex 3 26-31 1967.

Bein E.S. and Stoliavova I.G.,
Spontaneous and specific rehabilitation of speech in cases of aphasia caused by haemorrhagic or ischaemic injury,
Rehabilitation 67 63-65 1968.

Benson D.F., Fluency in aphasia: correlation with radioactive scan localization,
Cortex 3 373-394 1967.

Benton A.L., Revised Visual Retention Test,
Psychological Corporation, New York, 1963.

Benton A.L., Problems of test construction in the field of aphasia,
Cortex 3 32-58 1967.

Benton A.L., Development of a multi-lingual aphasia battery: progress and problems,
J. Neurol. Sci. 9 39-48 1969.

Benton A.L., Meyers R. and Polder G.J.,
Some aspects of handedness,
Psychiat. Neurol. 144 321-327 1962.

Berlin C.I., On Melodic Intonation Therapy for aphasia by R.W. Sparks and A.L. Holland,
J.Speech Hear.Disord. 41 298-300 1976.

Beyn E.S. and Shokhov-Trotskaya M.K.,
The preventative method of speech rehabilitation in aphasia,
Cortex 2 96-108 1966.

Birbaumer N., Gloning I., Glóning K. and Hift E.,
Sequence analysis of restrictive associative responses in aphasia,
Neuropsychologia 10 119-123 1972.

Bloom L.M., A rationale for group treatment of aphasics,
J. Speech Hear. Disord. 27 11-16 1962.

Blum J.M., Pseudoscience and mental ability: the origins and fallacies of the IQ controversy,
Monthly Review Press, London 1978.

Boller F. and Vignolo L.A., Latent sensory aphasia in hemisphere damaged patients: an experimental study with the Token Test,
Brain 88 815-830 1966.

Bollinger R.L. and Stout C.E., Response contingent small step treatment performance based communication intervention,
J. Speech Hear. Disord. 41 40-51 1976.

Borkowski J.G., Benton A.L. and Spreen O., Word Fluency and brain damage,
Neuropsychologia 5 135-140 1967.

Bortner M., Review of Progressive Matrices test in Buros O.K. (Ed.)
Mental Measurements Yearbook, Gryphon Press, New Jersey, 1965.

Boswell N.S., The effectiveness of language retraining in improving language skills of adult aphasics,
Asha 16 563 1974.

Botez M.I., Aphasia: a multidisciplinary approach,
Europ. Neurol. 3 50-62 1970.

Bouquet J.D., Premorbid personality as a predictor of right hemiplegic aphasic stroke patient rehabilitation,
Dissertation Abstracts 32 6636 1972.

Braun J.J., Time and recovery from brain damage, in Finger S. (Ed.), Recovery from brain damage, Plenum Press, New York, 1978.

Brimer M.A. and Dunn L.M., Manual for the English Picture Vocabulary Tests, Educational Evaluation Enterprizes, Bristol, 1962.

Brocklehurst J.C., Andrews K., Richards B. and Laycock P.J., How much physical therapy for patients with stroke?, Brit. Med. J. 1 1307-1310 1978.

Broida H., Language therapy effects in long term aphasia, Arch. Phys. Med. Rehabil. 58 248-253 1977.

Brookshire R.H., Visual discrimination and response reversal learning by an aphasic subject, J. Speech Hear. Res. 11 677-692 1968.

Brookshire R.H., Probability learning by aphasic subjects, J. Speech Hear. Res. 12 857-864 1969.

Brookshire R.H., Effects of trial time and inter-trial interval on naming by aphasic subjects, J. Commun. Disord. 3 289-301 1971a.

Brookshire R.H., Effects of delay of reinforcement on probability learning by aphasic subjects, J. Speech Hear. Res. 14 92-105 1971b.

Brookshire R.H., Effects of task difficulty on naming performance of aphasic subjects, J. Speech Hear. Res. 15 551-558 1972.

Brookshire R.H., The use of consequences in speech pathology: incentive and feedback function, J. Commun. Disord. 6 88-92 1973.

Brown J.R. and Simonson J., A clinical study of 100 aphasic patients, Neurology 7 777-783 1957.

Brust J.C.M., Shafer S.Q., Richter R.W. and Brunn B., Aphasia in acute stroke, Stroke 7 167-174 1976.

Bryden M.P., Measuring handedness with questionnaires, Neuropsychologia 15 617-624 1977.

Buffery A.W.H., Sex differences in the neuropsychological development of verbal and spatial skills, in Knights R. and Bakker D.J. (Eds.), The Neuropsychology of Learning Disorders: Theoretical Approaches, University Park Press, Baltimore, 1976.

Buffery A.W.H., Clinical neuropsychology: a review and preview in Rachman S. (Ed.), Contributions to medical psychology Vol. 1, Pergammon Press, London, 1977.

Burke H.R., Raven's Progressive Matrices: a review and critical evaluation,
J. Genet. Psychol. 93 199-228 1958.

Burland R., The education of the multihandicapped child,
in Gunzberg H.C. (Ed.), Experiments in the Rehabilitation of the Mentally Handicapped, Butterworths, London, 1974.

Butfield E. and Zangwill O.L., Re-education in Aphasia: a review of 70 cases,
J. Neurol. Neurosurg. Psychiat. 9 75-79 1946.

Campbell D. and Oxbury J., Recovery from unilateral visuospatial neglect?,
Cortex 12 303-312 1976.

Carroll D., The disability in hemiplegia caused by cerebrovascular disease: serial studies of 98 cases,
J. Chron. Dis. 15 179-188 1962.

Carson D.H., Carson F.E. and Tikofsky R.S., On learning characteristics of the adult aphasic,
Cortex 4 92-112 1968.

Cauthen N.R., Verbal fluency: normative data,
J. Clin. Psychol. 34 126-129 1978.

Colonna A. and Faglioni P., The performance of hemisphere damaged patients on spatial intelligence tasks,
Cortex 2 293-307 1966.

Corbin M.L., Group speech therapy for motor aphasia and dysarthria,
J. Speech Hear. Disord. 16 21-34 1951.

Costa L.D., Interset variability of Raven's coloured Progressive Matrices as an indicator of specific ability deficit in brain-lesioned patients,
Cortex 12 31-40 1976.

Costello J.M., Programmed instruction,
J. Speech Hear. Disord. 42 3-28 1977.

Coupar A.M. ,Detection of mild aphasia: a study using the Token Test,
Brit. Jour. Med. Psychol. 49 141-144 1976.

Crawford J.E. and Crawford D.M.,
Crawford Small Parts Dexterity Test,
The Psychological Corporation, New York, 1956.

Critchley M., Aphasiology and Other Aspects of Language,
Edward Arnold, London, 1970.

Crockett D.J., A comparison of empirically derived groups of aphasic patients on Neurosensory Center Comprehensive Examination for Aphasia,
J. Clin. Psychol. 33 194-198 1977.

Culton G.L., Spontaneous recovery from aphasia,
J. Speech Hear. Res. 12 825-832 1969.

Darley F.L., The efficacy of language rehabilitation in aphasia,
J. Speech Hear. Disord. 37 3-21 1972.

Darley F.L., Treatment of acquired aphasia, in. Friedlander W.J., (Ed.), Advances in Neurology, vol. 7, Raven Press, New York, 1975.

David R., Paper presented at Aphasia Research Meeting, Frenchay Hospital, Bristol, 2 October 1978.

Davies C.L. and Grunwell P., A new approach to the treatment of severe dysphasia: a case study,
Brit. J. Disord. Commun. 10 142-147 1975.

DeRenzi E. and Faglioni P., Normative data and screening power of a shortened version of the Token Test,
Cortex 14 41-49 1978.

DeRenzi E. and Vignolo L.A., The Token Test: a sensitive test to detect receptive disturbances in aphasics,
Brain 85 665-678 1962.

Devine-Smith M., Operant conditioning of syntax in aphasia,
Neuropsychologia 12 403-406 1974.

Dinsmoor J.A., Operant conditioning, in Sidowski J.B. (Ed.),
Experimental Methods and Instrumentation in Psychology,
McGraw Hill, New York, 1966.

DiSimoni F.G., Practicality of shortening the Porch Index of Communicative Ability,
J. Speech Hear. Res. 18 491-497 1975.

Duffy R.J., Duffy J.R. and Pearson K.L., Pantomime recognition in aphasics,
J. Speech Hear. Res. 18 115-132 1975.

Duffy R.J. and Ulrich S.R., A comparison of impairments in verbal comprehension, speech, reading and writing in adult aphasics,
J. Speech Hear. Disord. 41 110-119 1976.

Dunn L.M., Peabody Picture Vocabulary Test: Expanded Manual,
American Guidance Service, Minneapolis, 1965.

Edwards A.E., Automated training for a "matching-to-sample" task in aphasia,
Jour. Speech Hear. Res. 8 39-42 1965.

Edwards S., Ellams J. and Thompson J., Language and intelligence in dysphasia: Are they related?
Brit. J. Disord. Commun. 11 83-94 1976.

Eisenson J., Prognositc factors related to language rehabilitation in aphasic patients,
J. Speech Hear. Disord. 14 262-264 1949.

Eisenson J., Examining for Aphasia,
Psychological Corporation, New York, 1954.

Eisenson J., Aphasia: a point of view as to the nature of the disorder and factors that determine prognosis for recovery,
Int. J. Neurol. 4 287-295 1964.

Eisenson J., Aphasia in adults: basic considerations,
in Travis L.E., Handbook of Speech Pathology and Audiology,
Appleton Century Crofts, New York, 1971.

Eisenson J., Adult Aphasia: Assessment and Treatment, Prentice Hall, Englewood Cliffs, 1973.

Enderby P. and David R., Proposed evaluation of speech therapy for acquired aphasia, Brit. J. Disord. Commun. 11 144-148 1976.

Ettlinger G. and Moffett A.M., Learning in dysphasia, Neuropsychologia 8 465-474 1970.

Feldman D.J., Lee P.R., Unterecker J., Lloyd K., Rusk H.A. and Toole A., A comparison of functionally oriented medical care and formal rehabilitation in the management of patients with hemiplegia due to cerebrovascular disease, J. Chron. Dis. 15 297-310 1962.

Filby Y. and Edwards A.E., An application of automated teaching methods to test and teach form discrimination to aphasics, J. Prog. Inst. 2 25-33 1963.

Fillenbaum S., Jones L.V. and Wepman J.M., Some linguistic features of speech from aphasic patients, Language Speech 4 91-108 1961.

Gainotti G., Caltagirone C. and Miceli G., Poor performance of right brain damaged patients on Raven's Coloured Progressive Matrices: derangement of general intelligence or of specific abilities, Neuropsychologia 15 675-680 1977.

Gardner H., Zurif E.B., Berry T. and Baker E., Visual communication in aphasia, Neuropsychologia 14 275-292 1976.

Gazzaniga M.S., Is seeing believing: notes on clinical recovery, in Finger S. (Ed.), Recovery from Brain Damage, Plenum Press, New York, 1978.

Gazzaniga M.S., Bogen J.E. and Sperry R.W., Dyspraxia following division of the cerebral commisures, Arch. Neurol. 16 606-612 1967.

Gazzaniga M.S., and Sperry R.W., Language after section of the cerebral commisures, Brain 90 131-148 1967.

Geschwind N. Aphasia, New Eng. J. Med. 284 654-656 1971.

Geschwind N., Late changes in the nervous system: an overview, in Stein D.G., Rosen J.J. and Butters N. (Eds.), Plasticity and Recovery of Function in the Central Nervous System, Academic Press, New York, 1974.

Glass A.V., Gazzaniga M.S. and Premack D., Artificial language training in global aphasics, Neuropsychologia 11 95-104 1973.

Godfrey C.M. and Douglass E., The recovery process in aphasia, Cand. Med. Ass. J. 80 618-624 1959.

Gollin E.S., Developmental studies of visual recognition of incomplete objects, Percept. Motor Skills 11 289-298 1960.

Goodglass H. and Kaplan E., The Assessment of Aphasia and Related Disorders,
Lea and Febiger, Philadelphia, 1972.

Goodkin R., Use of concurrent response categories in evaluating talking behaviour in aphasic patients,
Percept. Motor Skills 26 1035-1040 1968.

Goodkin R., Changes in word production, sentence production and relevance in an aphasic through verbal conditioning,
Behav. Res. Ther. 7 93-99 1969.

Goodkin R., Diller L. and Shah N., Training sponses to improve the functional speech of aphasic patients, in Lahey B.B. (Ed.),
The modification of Language Behaviour, C.C. Thomas, Illinois, 1973.

Gordon M.L., An experiment in audio and audio-visual group therapy,
Brit. J. Disord. Commun. 4 83-88 1969.

Granger C.V., Sherwood C.C. and Green D.S.,
Functional status measures in a comprehensive stroke care programme,
Arch. Phys. Med. Rehabil. 58 555-561 1977.

Grant D.A. and Berg E.A., A behavioural analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card sorting problem,
J. Exp. Psychol. 38 404-411 1948.

Griffiths V.E., Volunteer scheme for dysphasia and allied problems in stroke patients,
Brit. Med. J. 3 633-635 1975.

Hagen C., Communication abilities in hemiplegia: effect of speech therapy,
Arch. Phys. Med. Rehabil. 54 454-463 1973.

Hanson W.R., Time, amount and pattern of language improvement in adult aphasics,
Asha 16 517 1974.

Hartje W., Kerschensteiner M., Poeck K. and Orgass B.,
A cross validation study on the Token Test,
Neuropsychologia 11 119-122 1973.

Hays W.L., Statistics for Psychologists,
Holt, Rinehart and Winston, New York, 1965.

Head H., Aphasia and Kindred Disorders of Speech,
MacMillan, Cambridge, 1926.

Helmick J.W., Watamori T.S. and Palmer J.M.,
Sponses understanding of the communication disabilities of aphasic patients,
J. Speech Hear. Disord. 41 238-243 1976.

Helmick J.W. and Wipplinger M., Effects of stimulus repetition on the naming behaviour of an aphasic adult: a clinical report,
J. Speech Hear. Disord. 8 23-29 1975.

Holland A., Case studies in aphasia rehabilitation using programmed instruction,
J. Speech Hear. Disord. 35 377-390 1970.

Holland A., Some applications of behavioural principles to clinical speech problems,
J. Speech Hear. Disord. 32 11-18 1967.

Holland A., Case studies in aphasia rehabilitation using programmed instruction,
J. Speech Hear. Disord. 35 377-390 1970.

Holland A. and Harris A., Aphasia rehabilitation using programmed instruction, in Sloane N. and MacAulay B., (Eds.), Operant Procedures in Remedial Speech and Language Training,
Houghton Mifflin, Boston, 1968.

Holland A. and Sonderman J.C., Effects of a program based on the Token Test for teaching auditory comprehension skills to aphasics,
J. Speech Hear. Res. 17 589-598 1974.

Hopkins A., The need for speech therapy for dysphasia following stroke,
Health Trends 7 58-60 1975.

Howes D., Word frequency concept in aphasia,
in deRueck A. and O'Connor M. (Eds.), Disorders of Language, Ciba Foundation Symposium, Churchill, London, 1964.

Howes D., A word count of spoken English,
J. Verb. Learn. Verb. Behav. 5 572-604 1966.

Howes D., Some experimental investigations of language in aphasia,
in Goodglass H. and Blumstein S., Psycholinguistics and Aphasia,
John Hopkins University Press, London, 1973.

Howes D. and Geschwind N., Quantitative Studies of aphasic language in Rioch D.M. and Weinstein E.A. (Eds.)
Disorders of Communication,
Williams and Wilkins, Baltimore, 1964.

Hutchinson E.C., Cerebrovascular disease, in Matthews W.B. (Ed.),
Recent Advances in Clinical Neurology, vol. 1,
Churchill Livingstone, London, 1975.

Johnson D. and Almli C.R., Age, brain damage and performance,
in Finger S. (Ed.), Recovery from Brain Damage,
Plenum Press, New York, 1978.

Johnson R.C., Cole R.E., Bowers J.K., Foiles S.V., Nikaido A.M., Patrick J.W. and Woliver R.E., Hemispheric efficiency in middle and later adulthood,
Cortex 15 109-119 1979.

Johnstone M., Restoration of Motor Function in the Stroke Patient,
Churchill Livingstone, Edinburgh, 1978.

Jonckheere A.R., A distribution free k-sample test against ordered alternatives,
Biometrika 41 133-145 1954.

Keenan J.S., A method for eliciting naming behaviour from aphasic patients,
J. Speech Hear. Disord. 31 261-266 1966.

Keenan J.S. and Brassel E.G., A study of factors related to prognosis for individual aphasic patients,
J. Speech Hear. Disord. 39 257-269 1974.

Keith R.L. and Darley F.L., Use of a specific electric board in the rehabilitation of the aphasic patient,
J. Speech Hear. Disord. 32 148 1967.

Kenin M. and Swisher L.P., A study of pattern of recovery in aphasia, Cortex 8 56-68 1972.

Kertesz A. and McCabe P., Intelligence and aphasia: performance of aphasics on Raven's Coloured Progressive Matrices, Brain Lang. 2 387-395 1975.

Kertesz A. and McCabe P., Recovery patterns and prognosis in aphasia, Brain 100 1-18 1977.

Kertesz A. and Phipps J.B., Numerical taxonomy of aphasia, Brain Lang. 4 1-10 1977.

Kimura D., Acquisition of a motor skill after left hemisphere damage, Brain 100 527-542 1977.

Kinsbourne M., The minor cerebral hemisphere as a source of aphasic speech, Arch. Neurol. 25 302-306 1971.

Kinsbourne M., Eye and head turning indicates cerebral lateralisation, Science 176 539-541 1972.

Kinsbourne M., Mechanisms of hemisphere interaction in man, in Kinsbourne M. and Smith W.L. (Eds.), Hemispheric Disconnection and Cerebral Function, C.C. Thomas, Illinois, 1974.

Kushner D. and Winitz H., Extended comprehension practice applied to an aphasic patient, J. Speech Hear. Disord. 42 296-306 1977.

Kushner H., Hubbard D.J. and Knox A.W., Effects of punishment on learning by aphasic subjects, Percept. Motor Skills 36 283-289 1973.

LaPointe L., Base 10 programmed stimulation: task specification, scoring and plotting performance in aphasia therapy, J. Speech Hear. Disord. 42 90-105 1977.

Larsen B., Skinhøj E. and Lassen N.A., Variations in regional cortical blood flow in right and left hemisphere during automatic speech, Brain 101 193-209 1978.

Lashley K.S., Brain Mechanisms and Intelligence, University of Chicago Press, Chicago, 1929.

Laurence S. and Stein D.G., Recovery after brain damage and the concept of localization of function, in Finger S. (Ed.), Recovery from Brain Damage, Plenum Press, New York, 1978.

Leche P., Speech therapy and cerebral vascular diseases, Proc. Roy. Soc.Med. 65 85-88 1972.

Lehman J.F., DeLateur B.J., Fowler R.S., Warren C.G., Arhold R., Schertzer G., Hurka R., Whitmore J.J., Masock A.J. and Chambers K.H., Stroke: does rehabilitation affect outcome?, Arch. Phys. Med. Rehabil. 56 383-389 1975.

Lesser R. and Watt M., Untrained community help in the rehabilitation of stroke sufferers with language disorder, Brit. Med. J. 2 1045-1048 1978.

LeVere T.E., Neural stability, sparing and behavioural recovery following brain damage,
Psych. Rev. 82 344-358 1975.

Lincoln N.B., and Leadbitter D., Assessment of motor function in stroke patients,
Physiotherapy 65 48-51 1979.

Lincoln N.B., Pickersgill M.J. and Valentine J.D., Is the PICA an equal interval scale?,
In preparation, 1979.

Lomas J. and Kertesz A., Patterns of spontaneous recovery in aphasic groups: a study of adult stroke patients,
Brain Lang 5 388-401 1978.

Love R.J. and Webb W.G., The efficacy of cueing techniques in Broca's aphasia,
J. Speech Hear. Disord. 42 170-178 1977.

Luria A.R., Restoration of Function after Brain Injury, Macmillan, New York, 1963.

Luria A.R., Factors and forms of aphasia in DeRueck A. and O'Connor M. (Eds.),
Disorders of Language, Churchill, London, 1964.

Luria A.R., Higher Cortical Functions in Man,
Basic Books, New York, 1966.

Luria A.R., Traumatic Aphasia: its syndromes, psychology and treatment,
Mouton, The Hague, 1970.

Luria A.R., Restoration of Function after Brain Injury,
Pergammon Press, Oxford, 1973.

Luria A.R. and Hutton J.T., A modern assessment of the basic forms of aphasia,
Brain Lang. 4 129-151 1977.

Maly J., Turnheim M., Heiss W.D. and Gloning K.,
Brain perfusion and neuropsychological test scores: a correlation study in aphasics,
Brain Lang. 4 78-94 1977.

Marie P., Revision de la question de l'aphasie,
Semaine Medicale Paris 26 241-247 1906.

Marks M., Taylor M., Rusk H., Rehabilitation of the aphasic patient,
Neurology 7 837-843 1957.

Martin A.D., Aphasia testing: a second look at the Porch Index of Communicative Ability,
J. Speech Hear. Res. 42 547-562 1977.

Martino A.A., Pizzamiglio L. and Razzano C.,
A new version of the Token Test for aphasics: a concrete objects form,
J. Commun. Disord. 9 1-5 1976.

Mateer C. and Kimura D., Impairment of non-verbal oral movements in aphasia,
Brain Lang. 4 262-276 1977.

McDearmon J.R. and Potter R.E., The use of representational prompts in aphasia therapy,
J. Commun. Disord. 8 199-206 1975.

McGlone J., Sex differences in the cerebral organisation of verbal functions in patients with unilateral brain lesions,
Brain 100 775-793 1977.

McLaurin W.A. and Farrar W.E., Validities of the Progressive Matrices Tests against I.Q. and grade point average,
Psych. Rep. 32 803-806 1973.

McNeil M.R., Prescott T.E. and Chang E.C.,
A measure of PICA ordinality, in Brookshire R.H. (Ed.), Clinical Aphasiology, Conference Proceedings,
BRK Publishers, Minneapolis, 1975.

McReynolds L.V., Contingencies and consequences in speech therapy,
J. Speech Hear. Disord. 35 12-24 1970.

Meade T., Results in the Northwick Park Stroke Trial,
Rational Therapy and Rehabilitation in Stroke Conference, Northwick Park Hospital, 7-8 July 1979.

Messerli P., Tissot A. and Rodriguez J.,
Recovery from Aphasia: some factors of prognosis,
in Lebrun Y. and Hoops R., Recovery in Aphasics, Neurolinguistics 4,
Swets and Zeitlinger, Amsterdam, 1976.

Meyer D.R., Access to emgrams,
Amer. Psychologist 27 124-133 1972.

Milner B., Interhemispheric differences in the localization of psychological processes in man, in Summerfield A. (Ed.), Cognitive Psychology,
Brit. Med. Bull. 27 272-277 1971.

Milner B., Branch C. and Rasmussen T., Observations on cerebral dominance, in deRueck A. and O'Connor M. (Eds.), Disorders of Language,
Ciba Symposium, Churchill, London, 1964.

Naeser M.A., A structured approach to teaching aphasics basic sentence types,
Brit. Jour. Disord. Commun. 10 70-76 1975.

Newcombe F., Oldfield R.C. and Wingfield A.,
Object naming by dysphasic patients,
Nature 207 1217-1218 1965.

Newcombe F., Missile wounds of the Brain: a Study of Psychological Deficits,
Oxford University Press, Oxford, 1969.

Newcombe F., Fact and theory in recovery from the aphasias,
in Outcome of Severe Damage to the Central Nervous System,
Ciba Foundation Symposium, Excerpta Medica, Elsevier, 1975.

Newcombe F., Comments on Smith M.
Intellectual capacity in aphasia, in Lebrun Y. and Hoops R. (Eds.), Recovery in Aphasics, Swets and Zeitlinger, Amsterdam, 1976.

Newman M., The process of recovery after hemiplegia, Stroke 3 702-710 1972.

Nielsen J.M., Agnosia, Apraxia, Aphasia: their value in Cerebral Localisation, Hoeber, New York, 1946.

Oldfield R.C., The assessment and analysis of handedness: the Edinburgh Inventory, Neuropsychologia 9 97-113 1971.

Oldfield R.C., A series of pictures for use in object naming, M.R.C. Psycholinguistics Research Unit, Special report No. PLU/65/19, Oxford 1965.

Oldfield R.C., Response latencies in naming objects, Q.J. Exp. Psychol. 17 273-281 1965.

Orgass B., Hartje W., Kerschensteiner M. and Poeck K., Impairment of aphasics versus non-aphasic brain damaged patients in non-verbal intelligence tests, in Lebrun Y. and Hoops R. (Eds.), Intelligence and Aphasia, Neurolinguistics vol 2, Swets and Zeitlinger, Amsterdam, 1974.

Orgass B. and Poeck K., Clinical validation of a new test for aphasia: an experimental study on the Token Test, Cortex 2 222-243 1966.

Orgass B., and Poeck K., Assessment of aphasia by psychometric methods, Cortex 5 317-330 1969.

Oxbury J.M., Campbell D. and Oxbury S.M., Unilateral spatial neglect and impairments of spatial analysis and visual perception, Brain 97 551-564 1974.

Oxbury J.M., Problems of research in speech therapy: a neurologist's view, Conference on speech therapy research, London, 14 July 1975.

Oxbury J.M., The right hemisphere and hemisphere disconnection in Matthews W.B. (Ed.), Recent Advances in Clinical Neurology, Churchill Livingstone, Edinburgh, 1975.

Pease M. and Goodglass H., The effects of cueing on picture naming in aphasia, Cortex 14 178-189 1978.

Peck D.F., The conversion of Progressive Matrices and Mill Hill Vocabulary raw scores into deviation I.Q's, J. Clin. Psychol. 26 67-70 1970.

Perret E., The left frontal lobe of man and the suppression of habitual responses in verbal categorical behaviour, Neuropsychologia 12 323-330 1974.

Perry P., The comparative effectiveness of language training and spontaneous recovery in improving the spoken language vocabulary comprehension of adult aphasics,
Paper presented at 47th Annual Convention of American Speech and Hearing Association, San Fransisco, 1972, quoted in Darley F.L. Treatment of Acquired Aphasia in Friedlander W.J. (Ed.), Advances in Neurology 7, Raven Press, New York, 1975.

Peterson D.D. and Butt D.S., Factors in a programmed approach to therapy,
J. Speech Hear. Res. 15 667-668 1972.

Phillips P.P. and Halpin G., Language impairment evaluation in aphasic patients: developing more efficient measures,
Arch. Phys. Med. Rehabil. 59 327-330 1978.

Pickersgill M.J. and Pank P., Relation of age and mongolism to lateral preferences in severely subnormal patients,
Nature 228 1342-1344 1970.

Poeck K., Kerschensteiner M. and Hartje W., A quantitative study on language understanding in fluent and non-fluent aphasia,
Cortex 8 299-304 1972.

Porch B.E., Porch Index of Communicative Ability,
Consulting Psychologists Press, Palo Alto 1967.

Porch B.E., A comparison of unilateral and bilateral PICA profiles on brain damaged adults,
Paper presented at 47th Annual Convention of American Speech and Hearing Association, Chicago, 1971 quoted in Darley F.L., Treatment of Acquired Aphasia, in Friedlander W.J. (Ed.), Advances in Neurology 7, Raven Press, New York, 1975.

Porch B.E., Comments on Silverman's psychometric problem,
J. Speech Hear. Disord. 39 226-227 1974.

Powell G.E., Clark E. and Bailey S.,
Categories of aphasia: a cluster analysis of Schuell test profiles,
In Press 1979.

Prins R.S., Snow C.E. and Wagenaar E.,
Recovery from aphasia: spontaneous speech versus language comprehension,
Brain Lang. 6 192-211 1978.

Provins K.A. and Cunliffe P., The reliability of some motor performance tests of handedness,
Neuropsychologia 10 199-206 1972.

Raczkowski D., Kalat J. and Nebes R., Reliability and validity of some handedness questionnaire items,
Neuropsychologia 12 43-47 1974.

Ratcliff G., Aspects of disordered space perception,
Doctoral thesis, University of Oxford, 1970.

Raven J.C., Standard Progressive Matrices,
H.K. Lewis, London, 1958.

Rey A., Le test de copie de figure complexe,
Editions centre de psychologie appliquée, Paris, 1959.

Rosen J.J., Stein D.G. and Butters N.,
Recovery of function after serial ablation of prefrontal cortex in rheusus monkeys,
Science 173 353-356 1971.

Rosenberg B., The performance of aphasics on automated visuo-perceptual discrimination, training and transfer tasks,
J. Speech Hear. Res. 8 165-184 1965.

Rosenberg B. and Edwards A.E., The performance of aphasics on three automated perceptual discrimination programs,
J. Speech Hear. Res. 7 295-297 1964.

Rosner B.S., Brain functions,
Ann. Rev. Psychol. 21 555-594 1970.

Russell W.R. and Espir M.L.E.,
Traumatic Aphasia, Oxford University Press, London 1961.

Salvatore A.P., Strait M. and Brookshire R.H.,
Effects of patient characteristics on delivery of Token Test Commands by experienced and inexperienced examiners,
J. Commun. Disorders 11 325-333 1978.

Sands E., Sarno M.T. and Shankweiler D., Long term assessment of language function in aphasia due to stroke,
Arch. Phys. Med. Rehabil. 50 202-206 1969.

Sarno J.E., Sarno M.T. and Levita E.,
Evaluating language improvement after completed stroke,
Arch. Phys. Med. Rehabil. 52 73-78 1971.

Sarno M.T., The functional communication profile: manual of directions,
Rehabilitation Monograph 42, Institute of Rehabilitation Medicine, New York, 1969.

Sarno M.T. and Levita E., Natural course of recovery in severe aphasia,
Arch. Phys. Med. Rehabil. 52 175-179 1971.

Sarno M.T. and Sands E., An objective method for the evaluation of speech therapy in aphasia,
Arch. Phys. Med. Rehabil. 51 49-54 1970.

Sarno M.T., Silverman M. and Levita E.
Psychosocial factors and recovery in geriatric patients with severe aphasia,
J. Amer. Geriat. Soc. 18 405-409 1970.

Sarno M.T., Silverman M. and Sands E., Speech therapy and language recovery in severe aphasia,
J. Speech Hear. Res. 13 607-623 1970.

Satz P., Achenbach K. and Fennel E.,
Correlations between assessed manual laterality and predicted speech laterality in a normal population,
Neuropsychologia 5 295-310 1967.

Schaie K.W. and Strother C.R., A cross-sequential study of age changes in cognitive behaviour,
Psych. Bull. 70 671-680 1968.

Schneider G.E. and Jhaveri S.R., Neuroanatomical correlates of spared or altered function after brain lesion in newborn hamster, in Stein D.G., Rosen J.J. and Butters N. (Eds.), Plasticity and Recovery of function in the Central Nervous System, Academic Press, London, 1974.

Schuell H., Minnesota Test for Differential Diagnosis of Aphasia, University of Minnesota Press, Minneapolis, 1965.

Schuell H. and Jenkins J., The nature of language deficit in aphasia, Psych. Rev. 66 45-67 1959.

Schuell H., Jenkins J.J. and Carroll J.B., A factor analysis of the Minnesota Test for the Differential Diagnosis of Aphasia, J. Speech Hear. Res. 5 349-369 1962.

Schuell H., Jenkins J. and Jiminez-Pabon E., Aphasia in Adults: Diagnosis, Prognosis and Treatment, Harper and Row, London, 1964.

Scott C.M., Editorial comment on Kushner and Winitz paper, J. Speech Hear. Disord. 42 305-306 1977.

Searleman A., A review of right hemisphere linguistic capabilities, Psychol. Bull. 84 503-528 1977.

Seligman M.P. and Hager J.L., Biological Boundaries of Learning, Appleton Century Crofts, New York, 1972.

Seron X., Deloche G., Bastard V., Chassun G. and Hermand N., Word finding difficulties and learning transfer in aphasic patients, Cortex 15 149-155 1979.

Shaw D.J., Estimating WAIS IQ from Progressive Matrices scores, Jour. Clin. Psychol. 23 184-185 1967.

Shelton R.L., Arndt W.B. and Miller J., Learning principles and teaching of speech and language, J. Speech Hear. Disord. 26 368-376 1961.

Sies L.F., Aphasia theory and Therapy: Selected Lectures and Papers of Hildred Schuell, University Park Press, Baltimore, 1975.

Skelly M., Schinsky L., Smith R.W. and Fust R.S., American Indian Sign (Amerind) as a facilitator of verbalization for the oral apraxic patient, J. Speech Hear. Disord. 39 445-456 1974.

Smith A., Objective indices of severity of chronic aphasia in stroke patients, J. Speech Hear. Disord. 36 167-207 1971.

Smith A., Champoux R., Leri J., London R. and Muraski A., Diagnosis, Intelligence and Rehabilitation of Chronic Aphasics Final Report, Dept. of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, 1972.

Smith D.S., The Northwick Park Hospital Stroke Rehabilitation Study, Rheumatology and Rehabilitation 15 163 1976.

Sommerville J.G., Rehabilitation of the hemiplegic patient, Rehab. 64 5-10 1968.

Sparks R., Helm N. and Albert M., Aphasia rehabilitation resulting from melodic intonation therapy, Cortex 10 303-317 1974.

Sparks R. and Holland A., Method: melodic intonation therapy for aphasia, J. Speech Hear. Disord. 41 287-297 1976.

Spellacy F.J. and Spreen O., A short form of the Token Test, Cortex 5 390-397 1969.

Sperry R.W., Gazzaniga M.S. and Bogen J.E., Inter-hemispheric relationships: the neocortical commisures; syndromes of hemisphere disconnection, in Vinken P.J. and Bruyn G.W. (Eds.), Handbook of Clinical Neurology, vol. 4, Disorders of Speech, Perception and Symbolic Behaviour, North Holland, Amsterdam, 1969.

Stoicheff M.L., Motivating instructions and language performance of dysphasic subjects, J. Speech Hear. Res. 3 75-85 1960.

Subirana A., The prognosis in aphasia in relation to cerebral dominance and handedness, Brain 81 415-425 1958.

Swisher L.P. and Sarno M.T., Token Test Scores of three matched patient groups, Cortex 5 264-273 1969.

Thompson J., Is all your Schuell really necessary?, Paper presented at Aphasia Research Meeting, Frenchay Hospital, Bristol, 2 October 1978.

Tikofsky R.S., Verbal learning in aphasia, Cortex 7 105-125 1971.

Tikofsky R.S., Kooi K. and Thomas M., Electro-encephalographic findings and recovery from aphasia, Neurology 10 154-156 1960.

Tikofsky R.S. and Reynolds G.L., Preliminary Study: non-verbal learning and aphasia, J. Speech Hear. Res. 5 133-143 1962.

Tikofsky R.S. and Reynolds G.L., Further studies of non-verbal learning and aphasia, J. Speech Hear. Res. 6 329-337 1963.

Tow P.M., Personality Changes following Frontal Leucotomy, Oxford University Press, London, 1955.

Trombly C.A. and Scott A.D., Occupational Therapy for Physical Dysfunction, Williams and Wilkins, Baltimore, 1977.

Ullatowska H.K. and Richardson S.M., A longitudenal study of an adult with aphasia: considerations for research and therapy, Brain Lang. 1 151-166 1974.

vanDongen H.R. and vanHarskamp F., The Token Test: A preliminary evaluation of a method to detect aphasia, Psychiat. Neurol. Neurochir. 75 129-134 1972.

van Harskamp F., Some considerations concerning the utility of intelligence tests in aphasic patients, in Lebrun Y. and Hoops R. (Eds.), Intelligence and Aphasia, Neurolinguistics 2, Swets and Zeitlinger, Amsterdam, 1974.

van Harskamp F. and van Dongen H.R., Construction and validation of different short forms of the Token Test, Neuropsychologia 15 467-470 1977.

Vignolo L.A., Evolution of aphasia and language rehabilitation: a retrospective exploratory study, Cortex 1 344-367 1964.

Wagenaar E., Snow C. and Prins R., Spontaneous speech of aphasic patients: a psycholinguistic analysis, Brain Lang. 2 281-303 1975.

Wall P.D., Plasticity in the adult mammalian nervous system, in Corner M.A. and Swaab D.F., Perspectives in Brain Research, Progress in Brain Research 5, Elsevier, Amsterdam, 1976.

Wallace A., Comments on scales for the measurement of language function, Speech Pathol. Ther. 7 22-29 1964.

Watson C.G. and Klett W.G., Are non-verbal I.Q. tests adequate substitutes for the WAIS?, J. Clin. Psychol. 30 55-57 1974.

Wechsler D., Wechsler Adult Intelligence Scale, Psychological Corporation, New York, 1955.

Wechsler E., Paper presented at Aphasia Research Meeting, Frenchay Hospital, Bristol, 2nd October 1978.

Weigl-Crump C. and Koenigsknecht R.A., Tapping the lexical store of the adult aphasic: analysis of improvement made in word retrieval skills, Cortex 9 410-417 1973.

Weisenburg T.H. and McBride K.E., Aphasia: a Clinical and Psychological Study, Commonwealth Fund, New York, 1935.

Wepman J.M., Recovery from Aphasia, Ronald, New York, 1951.

Wepman J.M., A conceptual model for processes involved in recovery from aphasia, J. Speech Hear. Disord. 18 4-13 1953.

Wepman J.M., The relation between self-correction and recovery from aphasia, J. Speech Hear. Disord. 23 302-305 1958.

Wepman J.M., Aphasia therapy: some "relative" comments and some purely personal prejudices,
in Sarno M.T. (Ed.), Aphasia: Selected Readings,
Appleton, New York, 1972.

Wepman J.M. and Jones L.V., Studies in Aphasia: an approach to testing,
Education Industry Service, Chicago, 1961.

Wepman J.M. and Jones L.V., Five aphasias: comment on aphasia as a regressive linguistic phenomenon, in Rioch D.M., and Weinstein E.A. (Eds.), Disorders of Communication,
Williams and Wilkins, Baltimore, 1964.

West J.A., Auditory comprehension in aphasic adults: improvement through training,
Arch. Phys. Med. Rehabil. 54 78-86 1973.

West R.W., Kennedy L. and Carr A., The rehabilitation of speech,
Harper, New York, 1947.

Westby G., Review of the Progressive Matrices Test,
in Buros O.K., Mental Measurements Yearbook, Fourth Edition,
Gryphon Press, New Jersey, 1953.

Williams H.G.A., Johnston M., Willis L.A. and Bennett A.E.,
Disability: a model and measurement technique,
Brit. J. Prevent. Soc. Med. 30 71-78 1976.

Williams M., The measurement of memory in clinical practice,
Brit. J. Soc. Clin. Psychol. 7 19-34 1968.

Winer B.J., Statistical Principles in Experimental Design,
Second Edition, McGraw-Hill, New York, 1971.

Zangwill O.L., Cerebral Dominance and its Relation to Psychological Function, Oliver and Boyd, Edinburgh, 1960.

Zangwill O.L., Current Status of cerebral dominance, in Rioch D.M. and Weinstein E.A. (Eds.), Disorders of Communication,
Williams and Wilkins, Baltimore, 1964.

Zangwill O.L., Intelligence in aphasia, in deRueck A. and O'Connor M.,
Disorders of Language, Ciba Foundation Symposium, Little, Brown,
Boston 1964.

TABLE I

Aphasic Patients referred to Speech Therapy Department

Number	Admission	Group	Outcome
1	03.12.73	Severe. Experiment 2	Completed
2	10.12.73	Severe. Experiment 2	Completed
3.	07.01.74	Too good	Excluded
4.	07.01.74	Severe	Left early
5	07.01.74	Not classified	Left early
6	28.01.74	Too good	Excluded
7	04.02.74	Severe. Experiment 2	Completed
8	11.02.74	Too good	Excluded
9	28.02.74	Moderate. Experiment 1	Completed
10	11.03.74	Too good	Excluded
11	19.03.74	Moderate. Experiment 1	Left early
12	16.04.74	Too good	Excluded
13	22.04.74	Moderate. Experiment 1	Completed
14	29.04.74	Moderate. Experiment 1	Left early
15	29.04.74	Too good	Excluded
16	13.05.74	Severe. Experiment 2	Completed
17	20.05.74	Too good	Excluded
18	28.05.74	Severe. Experiment 2	Completed
19	28.04.74	Severe. Experiment 2	Completed
20	24.06.74	Moderate. Expierment 1	Completed
21	01.07.74	Severe. Experiment 2	Completed
22	24.08.74	Moderate. Experiment 1	Completed
23	24.08.74	Not classified	Left early
24	02.09.74	Too good	Excluded
25	02.09.74	Severe	Left early
26	09.09.74	Severe. Experiment 2	completed
27	16.09.74	Moderate. Experiment 1	Completed
28	23.09.74	Severe. Experiment 2	Completed
29	14.10.74	Severe. Experiment 2	Completed
30	14.10.74	Severe. Experiment 2	Completed
31	28.10.74	Moderate. Experiment 1	Left early
32	04.11.74	Moderate. Experiment 1	Completed
33	11.11.74	Severe. Experiment 2	Completed
34	14.11.74	Severe	Left early
35	11.11.74	Too good	Excluded
36	18.11.74	Not classified	Left early
37	18.11.74	Not classified	Left early
38	30.12.74	Too good	Excluded
39	13.01.75	Too good	Excluded
40	13.01.75	Severe. Experiment 2	Completed
41	20.01.75	Severe	Left early
42	03.02.75	Severe. Experiment 2	Completed
43	03.02.75	Not classified	Left early
44	17.02.75	Severe. Experiment 2	Completed
45	17.02.75	Severe. Experiment 2	Completed
46	28.08.75	Severe. Experiment 2	Completed
47	28.08.75	Moderate. Experiment 1	Left early
48	01.09.75	Severe. Experiment 2	Completed
49	01.09.75	Too good	Excluded
50	08.09.75	Moderate. Experiment 1	Completed.

TABLE I continued

Number	Admission	Group	Outcome
51	08.09.75	Severe	Excluded
52	08.09.75	Severe	Excluded
53	29.09.75	Moderate. Experiment 1	Completed
54	05.10.75	Severe	Excluded
55	05.10.75	Severe	Excluded
56	13.10.75	Also head injury	Excluded
57	13.10.75	Also head injury	Excluded
58	25.11.75	Severe	Excluded
59	03.12.75	Also head injury	Excluded
60	03.12.75	Moderate. Experiment 1	Completed
61	08.12.75	Severe	Excluded
62	08.12.75	Severe	Excluded
63	30.12.75	Too good	Excluded
64	30.12.75	Severe	Excluded
65	05.01.76	Moderate. Experiment 1	Left early
66	12.01.76	Too good	Excluded
67	09.02.76	Too good	Excluded
68	23.02.76	Too good	Excluded
69	02.03.76	Severe. Experiment 3	Completed
70	15.03.76	Moderate. Experiment 1	Left early
71	15.03.76	Too good	Excluded
72	23.03.76	Not classified	Left early
73	23.03.76	Moderate. Experiment 1	Left early
74	29.03.76	Moderate. Experiment 1	Completed
75	05.04.76	Too good	Excluded
76	05.04.76	Too good	Excluded
77	21.04.76	Too good	Excluded
78	26.04.76	Too good	Excluded
79	03.05.76	Dysarthric	Excluded
80	10.05.76	Dysarthric	Excluded
81	24.05.76	Severe. Experiment 3	Completed
82	24.05.76	Severe. Experiment 3	Died
83	07.06.76	Severe. Experiment 3	Completed
84	14.06.76	Moderate. Experiment 1	Completed
85	28.06.76	Moderate. Experiment 1	Completed
86	25.07.76	Too good	Excluded
87	02.08.76	Moderate. Experiment 1	Left early
88	09.08.76	Moderate. Experiment 1	Left early
89	08.08.76	Severe. Experiment 3	Completed
90	16.08.76	Too good	Excluded
91	23.08.76	Severe. Experiment 3	Completed
92	23.08.76	Dysarthric	Excluded
93	30.08.76	Moderate. Experiment 1	Completed
94	30.08.76	Poor English	Excluded
95	20.09.76	Severe. Experiment 3	Completed
96	20.09.76	Anarthric	Excluded
97	27.09.76	Too good	Excluded
98	25.10.76	Moderate. Experiment 1	Completed
99	22.11.76	Deaf	Excluded
100	29.11.76	Moderate. Experiment 1	Completed.

TABLE I continued

Number	Admission	Group	Outcome
101	29.11.76	Moderate. Experiment 1	Left early
102	29.11.76	Too good	Excluded
103	29.11.76	Severe. Experiment 3	Completed
104	04.01.77	Moderate. Experiment 1	Completed
105	10.01.77	Severe. Experiment 3	Left early
106	10.01.77	Too good	Excluded
107	14.01.77	Severe. Experiment 3	Left early
108	17.01.77	Severe. Experiment 3	Left early
109	27.01.77	Severe. Experiment 3	Left early
110	30.01.77	Deaf	Excluded
111	28.02.77	Too good	Excluded
112	28.02.77	Too good	Excluded
113	07.03.77	Severe. Experiment 3	Completed
114	28.03.77	Moderate. Experiment 1	Completed
115	18.04.77	Not classified	Left early
116	18.04.77	Moderate. Experiment 1	Completed
117	02.05.77	Moderate. Experiment 1	Completed
118	08.05.77	Severe. Experiment 3	Completed
119	16.05.77	Too good	Excluded
120	17.05.77	Severe. Experiment 3	Completed
121	30.05.77	Too good	Excluded
122	30.05.77	Severe. Experiment 3	Left early
123	13.06.77	Moderate. Experiment 1	Left early
124	27.06.77	Not classified	Left early
125	27.06.77	Severe. Experiment 3	Left early
126	05.07.77	Severe. Experiment 3	Completed
127	01.07.77	Too old	Excluded
128	18.07.77	Too good	Excluded
129	18.07.77	Deaf	Excluded
130	25.07.77	Severe. Experiment 3	Completed
131	01.08.77	Moderate. Experiment 1	Completed
132	15.08.77	Too good	Excluded
133	22.08.77	Moderate. Experiment 1	Completed
134	12.09.77	Severe	Excluded
135	19.09.77	Moderate. Experiment 1	Completed
136	26.09.77	Too good	Excluded
137	26.09.77	Moderate. Experiment 1	Left early
138	04.10.77	Moderate. Experiment 1	Completed
139	14.11.77	Too good	Excluded
140	14.11.77	Moderate. Experiment 1	Completed
141	28.11.77	Also head injury	Excluded
142	28.11.77	Severe	Excluded

TABLE 2

Summary of Patients Referred to Speech Therapy Department

Total				142
"Too good"			33	
"Moderate"	Experiment 1	24		
	Left early	13	37	
"Severe"	Experiment 2	18		
	Experiment 3	12		
	Left early	10	51	
	Died	1		
	Excluded	10		
Excluded before classification			21	

TABLE 3

Characteristics of Moderate Aphasics in Experiment 1

Patient Number	Admission Date	Age	Months Post Onset	Handedness % R.	Sex	Side of hemiplegia
9	28.02.74	57	2	70	F	R
13	22.04.74	52	5	100	F	R
20	24.06.74	39	5	67	M	R
22	24.08.74	52	2	86	M.	R
27	16.09.74	39	2	100	M	R
32	04.11.74	55	5	83	M	R
50	08.09.75	52	36	100	M	R
53	29.09.75	51	3	92	M	R
60	03.12.75	47	10	83	F	R
74	29.03.76	61	1	64	M	L
84	14.06.76	55	3	100	M	R
85	28.06.76	48	5	not tested	F	L
93	30.08.76	18	5	67	M	R
98	25.10.76	60	1	100	M.	R
100	29.11.76	54	2	33	M	R
104	04.01.77	45	5	86	M	R
114	28.03.77	64	1	92	M	R
116	18.04.77	58	3	92	M	R
117	02.05.77	57	1	100	M	R
131	01.08.77	63	1	100	M	R
133	22.08.77	28	8	100	F	R
135	19.09.77	63	1	92	F	R
138	04.10.77	63	2	58	F	R
140	14.11.77	53	8	75	M	R
	Mean	51.42	4.87	84.35		
	S.D.	11.25	7.09	14.60		

TABLE 4

Assessment and Treatment Procedure for Moderate Aphasics in Experiment 1

Patient Number	Treatment Group	Number of Sessions ST	OP	NS	Speech Therapist	Assessor *	Treatment Interval 1+	2+
9	3	12	12	-	1	2	25	24
13	1	12	-	12	1	2	21	27
20	1	12	-	12	1	2	26	24
22	4	12	12	-	1	2	26	23
27	2	11	-	11	1	2	27	24
32	4	11	11	-	1	2	22	19
50	2	12	-	12	3	1	25	15
53	4	11	11	-	3	1	19	21
60	1	9	-	9	3	1	27	22
74	4	12	12	-	3	1	27	23
84	3	11	11	-	1	3	25	29
85	3	10	10	-	3	1	22	22
93	2	11	-	11	3	1	25	15
98	2	11	-	11	1	3	26	21
100	1	12	-	12	3	1	36	26
104	3	11	11	-	3	1	16	26
114	4	12	12	-	3	1	27	22
116	3	12	10	-	1	3	22	14
117	2	12	-	12	1	3	20	35
131	1	12	-	12	1	3	27	30
133	2	11	-	11	3	1	27	27
135	3	12	12	-	3	1	27	27
138	4	10	10	-	1	3	26	16
140	1	11	-	11	3	1	16	14
Mean		11.33	11.16	11.33			24.33	22.75
S.D.		0.81	0.83	0.88			4.22	5.36

* The assessor specified is the main assessor on the P.I.C.A. for that patient (see section 5.2.3.2.)

\+ Interval 1 is days between assessments 1 and 2
Interval 2 is days between assessments 2 and 3

TABLE 5

Order of Parallel Forms of Assessments given on three testing occasions for Moderate Aphasics in Experiment 1

Test	Token Test			Object Naming Test					
Assessor	Assessor CP			Assessor CP			Independent Assessor		
Test Occasion	1	2	3	1	2	3	1	2	3
Patient Number									
9	C	B	A	1	2	3	3	1	2
13	C	B	A	1	2	3	3	1	2
20	B	A	C	2	3	1	1	2	3
22	B	A	C	2	3	1	1	2	3
27	A	C	B	3	1	2	2	3	1
32	C	B	A	1	2	3	3	1	2
50	C	B	A	1	2	3	3	1	2
53	A	C	B	3	1	2	2	3	1
60	A	C	B	3	1	2	2	3	1
74	C	B	A	3	2	1	1	3	2
84	B	C	A	3	1	2	2	3	1
85	B	A	C	2	3	1	1	2	3
93	B	A	C	2	1	3	3	2	1
98	B	A	C	2	3	1	1	2	3
100	C	B	A	3	2	1	1	3	2
104	A	C	B	1	3	2	2	1	3
114	B	A	C	2	1	3	-	-	-
116	C	B	A	3	2	1	-	-	-
117	A	C	B	1	3	2	-	-	-
131	B	A	C	2	1	3	-	-	-
133	C	B	A	3	2	1	-	-	-
135	A	C	B	1	3	2	-	-	-
138	B	A	C	1	3	2	-	-	-
140	A	C	B	2	1	3	-	-	-

- Test not given due to unavailability of independent assessor

TABLE 6

Test Scores of Moderate Aphasics in Experiment 1 (n = 24)

	Assessment	Patient 9			Patient 13		
	Treatment		ST	OP	ST		NS
	Assessment	1	2	3	1	2	3
1.	Token test No, Correct	8	13	8	4	2	6
2.	Token test Weighted Score	61	71	69	36	46	64
3.	Object Naming	4	6	10	12	16	17
4.	Progressive Matrices	30	34	26	22	24	27
5.	Fluency	3	12	12	7	8	22
6.	Picture Description	52	67	56	6	11	22
7.	Self Rating	7	7	8	1	5	5
8.	Independent Object Naming	-	-	-	15	-	18
9.	P.I.C.A. I	6.9	6.8	8.7	4.7	6.9	6.0
10.	IV	5.3	10.5	11.1	10.6	12.1	11.6
11.	XI	8.8	11.7	13.7	7.0	7.5	7.1
12.	XII	14.7	14.9	15.0	12.7	13.1	14.9
13.	Verbal	8.93	11.22	12.23	8.75	9.90	9.90
14.	II	8.5	9.0	9.4	6.2	8.5	8.7
15.	III	7.4	7.0	7.5	7.3	8.9	9.0
16.	V	10.6	12.3	11.9	8.0	7.6	7.2
17.	VI	14.6	14.6	14.8	8.7	11.3	9.8
18.	VII	11.6	12.4	11.9	11.0	10.7	11.0
19.	VIII	15.0	15.0	15.0	11.6	13.2	13.2
20.	X	12.1	14.6	14.2	12.5	12.3	11.6
21.	XI	15.0	15.0	15.0	15.0	15.0	15.0
22.	Gestural	11.85	12.46	12.46	10.03	10.93	10.68
23.	A	5.0	4.5	5.0	5.0	5.0	5.0
24.	B	5.0	4.4	6.1	5.0	6.4	5.8
25.	C	5.0	5.3	6.9	5.0	7.4	6.8
26.	D	5.0	6.9	5.0	5.0	5.0	7.4
27.	E	8.7	10.0	9.9	9.4	11.0	13.4
28.	F	12.7	11.5	12.8	13.2	12.8	13.9
29.	Graphic	6.90	7.01	7.61	7.10	8.00	8.70
30	Overall	9.55	10.41	10.77	8.77	9.72	9.85
31.	Ward S	29. 5	29	31	22.5	19	25
32.	Physiotherapy S	33	31	31	26	29	28
33.	Occupational Therapy S	30	33	32	18.5	25.5	24
34.	Ward C	18	16	15	9	7	12
35.	Physiotherapy C	16	16	13	11	10	8
36.	Occupational Therapy C	11	13	13	7	11	10
37.	Ward C (4+5)	5	4	4	2	1	4
38.	Physiotherapy C (4+5)	4	4	2	1	1	1
39.	Occupational Therapy C (4+5)	4	3	4	2	4	4

TABLE 6 . contd.

	Patient 20			Patient 22			Patient 27		
Treatment	ST	NS		OP		ST	NS		ST
Assessment	1	2	3	1	2	3	1	2	3
1	11	9	7	6	7	14	15	14	14
2	64	67	66	57	77	77	74	85	83
3	18	18	17	2	3	9	15	22	21
4	11	18	10	15	23	32	25	30	-
5	24	21	19	11	19	25	20	32	22
6	53	62	58	29	34	27	19	22	35
7	7	6	7	5	6	8	4	5	6
8	19	17	19	4	9	12	18	17	-
9	11.3	11.7	12.9	6.1	8.3	7.4	9.9	11.5	9.5
10	13.1	11.7	13.4	6.4	8.2	11.4	13.8	13.13	13.15
11	12.1	13.5	13.7	10.5	10.4	12.1	11.8	12.8	13.9
12	13.8	13.6	15.0	14.4	14.3	15.0	14.3	14.5	15.0
13	12.57	12.63	13.75	9.35	10.30	11.48	12.45	13.03	12.98
14	11.7	11.1	11.5	10.0	9.3	11.1	13.0	12.0	11.5
15	12.6	11.0	11.0	11.5	11.9	12.4	12.3	12.0	11.1
16	12.5	11.8	13.0	10.7	11.9	11.7	10.8	11.8	11.9
17	14.2	13.4	14.8	12.2	14.3	14.2	14.6	14.1	13.2
18	12.0	12.3	12.2	10.9	12.0	11.7	12.0	11.9	11.8
19	15.0	15.0	15.0	15.0	14.3	15.0	14.8	15.0	15.0
20	14.5	15.0	14.3	12.6	14.8	13.9	14.6	15.0	14.8
21	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
22	13.57	13.08	13.32	12.24	12.94	13.13	13.38	13.35	13.04
23	5.2	6.2	6.1	5.0	5.4	4.9	6.7	6.4	7.3
24	6.1	8.1	7.0	5.0	6.0	5.8	8.7	7.3	8.4
25	6.3	7.7	6.3	5.0	6.3	7.6	8.0	8.4	7.4
26	7.0	9.3	11.0	5.0	6.7	9.6	9.3	7.5	7.7
27	10.2	12.3	11.1	8.3	9.1	11.8	10.8	8.3	10.5
28	11.9	13.0	13.3	13.0	13.0	12.7	12.9	13.3	13.3
29	7.78	9.43	9.13	6.88	7.75	8.73	9.40	8.53	9.10
30	11.39	12.50	12.03	9.81	10.62	11.29	11.85	11.65	11.71
31	32	34	33	22	29	36	10	26.5	25
32	32	32	34	27	27	30	26	27	28
33	33	33	34	28	27	28	19	26	25
34	15	17	15	10	15	15	10	15	12
35	16	16	16	14	15	15	14.	14	12
36	16	13	16	11	10	15	7	13	10
37	4	6	4	3	4	5	4	3	2
38	4	4	4	3	3	3	3	3	3
39	5	4	4	4	2	4	3	4	3

TABLE 6. contd.

	Patient 32			Patient 50			Patient 53		
Treatment	OP	ST		NS	ST		OP	ST	
Assessment	1	2	3	1	2	3	1	2	3
1	1	0	0	3	0	1	18	19	17
2	23	26	28	44	39	42	85	88	89
3	2	3	5	10	11	7	1	9	14
4	17	18	17	14	14	18	43	49	57
5	1	0	0	14	24	22	0	8	8
6	8	15	11	37	39	42	9	7	5
7	4	4	5	6	5	7	4	3	4
8	5	4	9	9	15	13	11	11	14
9	5.2	5.1	5.0	7.4	8.4	7.2	5.2	4.9	5.2
10	5.0	5.1	5.0	10.6	11.1	10.7	8.0	11.0	10.2
11	7.3	7.4	7.7	11.0	11.1	10.4	8.8	9.5	9.8
12	10.5	8.5	10.6	13.0	14.4	14.2	11.3	10.5	12.8
13	7.00	6.52	7.07	10.52	11.25	10.62	8.32	8.98	9.50
14	7.7	8.0	9.2	10.0	10.5	10.9	10.9	12.0	12.9
15	12.1	11.2	10.5	10.3	10.5	11.2	11.4	11.5	12.6
16	5.0	5.0	9.2	11.6	11.3	10.5	12.2	14.0	13.0
17	13.5	11.6	11.4	14.2	14.4	14.6	14.6	15.0	14.8
18	8.1	10.3	8.1	11.7	9.8	11.3	12.2	14.5	14.4
19	14.6	13.9	14.8	15.0	15.0	15.0	15.0	15.0	15.0
20	10.7	10.4	13.3	13.6	12.2	14.0	13.8	14.4	13.4
21	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.9
22	10.83	10.67	11.43	12.67	12.33	12.81	13.13	13.93	13.88
23	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.55	4.9
24	5.0	5.0	5.0	5.0	5.0	5.0	7.6	5.0	9.0
25	4.0	5.0	5.0	5.0	5.0	5.0	9.3	8.3	11.1
26	4.9	5.2	5.0	5.0	5.0	5.0	9.9	10.6	11.7
27	7.1	8.5	8.3	8.5	9.9	11.9	12.7	9.9	11.8
28	10.0	11.5	12.6	12.3	12.4	13.2	12.9	12.7	12.5
29	6.00	6.70	6.81	6.80	7.05	7.51	9.56	8.67	10.17
30	8.37	8.42	8.92	10.23	10.32	10.56	10.87	11.07	11.67
31	21	35	35	26	36	34	6.5	2	14
32	21	19	9	38	34	31	8	24	30
33	23.5	24	18	27	23	28	11	12	10
34	13	14	16	12	17	14	14	14	16
35	10	11	9	17	17	16	14	13	15
36	13	14	10	17	11	19	16	13	13
37	2	4	5	1	3	3	3	3	3
38	2	2	4	6	6	5	2	2	3
39	4	4	3	5	3	6	5	5	3

TABLE 6 contd.

	Patient 60			Patient 74			Patient 84		
Treatment	ST	NS		OP	ST		ST		OP
Assessment	1	2	3	1	2	3	1	2	3
1.	7	8	7	9	7	9	7	5	16
2	61	66	70	70	57	43	35	63	85
3	10	14	10	18	22	21	9	5	19
4	25	34	29	23	23	18	11	17	27
5	7	11	14	15	22	18	3	4	11
6	33	41	39	30	57	51	62	65	62
7	7	6	5	6	8	7	4	8	4
8	12	14	13	23	23	22	13	7	21
9	8.8	7.8	6.4	8.5	9.8	8.2	7.0	7.3	10.9
10	8.4	7.4	7.9	10.7	11.2	12.6	7.3	9.7	13.2
11	9.9	7.9	9.4	9.7	13.2	11.2	9.7	11.5	12.6
12	13.2	13.2	13.3	13.2	12.6	13.4	13.7	13.8	14.8
13	10.07	9.08	9.25	10.52	11.70	11.35	9.43	10.58	12.88
14	13.2	11.3	10.8	6.9	8.7	7.6	7.6	7.2	10.8
15	12.6	12.0	12.5	7.5	9.7	8.7	13.7	9.0	11.2
16	8.0	8.1	10.3	9.0	11.3	13.2	11.6	8.1	12.2
17	11.3	12.2	12.7	10.7	14.0	13.5	13.0	13.0	15.0
18	11.6	9.2	9.9	13.3	13.6	13.6	13.2	13.0	14.8
19	15.0	14.8	15.0	15.0	15.0	15.0	14.3	15.0	15.0
20	13.0	12.9	13.0	13.0	14.6	12.9	14.1	13.1	15.0
21	15.0	14.3	15.0	15.0	15.0	15.0	13.8	14.1	15.0
22	12.46	11.85	12.40	11.30	12.73	12.43	12.66	11.56	12.88
23	5.0	5.0	5.0	4.9	6.4	5.2	4.0	4.2	6.3
24	5.1	5.0	4.7	7.0	6.9	7.9	4.1	4.4	9.4
25	4.8	5.0	5.0	11.9	6.0	9.4	4.3	5.5	7.9
26	5.4	5.2	5.0	7.7	8.1	6.8	4.6	7.0	7.7
27	9.2	7.5	7.2	10.2	6.8	8.5	5.5	11.9	10.6
28	12.2	12.2	12.3	10.79	12.4	13.9	9.4	13.6	14.4
29	6.95	6.65	6.53	8.76	7.76	8.62	5.32	7.77	9.38
30	10.09	9.50	9.74	10.30	10.85	10.92	9.49	10.08	11.21
31	36	35	-	22	32	35	24	14	33
32	34	32	35	11	29	34	27	27	33
33	29	26	31	25	32	30	15	0	30
34	14	14	-	10	14	16	12	11	15
35	13	13	14	18	15	18	12	11	13
36	12	10	12	8	12	12	9	9	12
37	3	2	-	4	5	5	3	3	5
38	2	3	3	3	5	6	5	4	5
39	2	2	3	2	5	6	5	2	4

TABLE 6 contd. - = missing data

	Patient 85			Patient 93			Patient 98		
Treatment	ST	OP		NS		ST	NS		ST
Assessment	1	2	3	1	2	3	1	2	3
1	6	3	5	4	6	8	7	10	12
2	65	47	53	55	55	65	72	71	71
3	4	6	10	15	18	19	5	15	18
4	5	0	8	31	33	48	15	17	18
5	8	7	14	20	25	30	7	14	19
6	24	44	34	26	21	28	12	37	38
7	4	5	5	3	4	5	6	5	7
8	-	-	-	20	19	23	18	21	22
9	9.3	10.0	11.3	9.4	8.9	9.8	5.5	11.3	10.5
10	8.4	9.4	10.5	13.6	13.5	14.3	7.5	8.7	13.8
11	9.4	11.3	11.8	13.0	12.1	13.0	6.0	10.3	13.8
12	9.9	10.8	12.3	15.0	15.0	15.0	9.3	14.8	14.0
13	9.25	10.38	11.48	12.75	12.38	12.47	7.8	11.28	13.0
14	7.3	7.9	7.9	8.0	11.4	11.9	8.2	9.0	10.0
15	7.6	9.7	9.9	10.5	11.5	11.6	6.8	9.2	11.2
16	7.1	10.4	10.7	11.9	11.9	12.0	9.6	13.6	12.9
17	11.1	13.4	13.5	14.6	14.8	15.0	8.1	14.6	14.4
18	11.4	10.3	10.6	11.9	12.0	12.0	6.0	14.3	14.7
19	15.0	14.1	15.0	15.0	15.0	15.0	13.0	14.3	14.8
20	14.6	13.2	13.9	15.0	13.3	15.0	12.6	14.8	14.8
21	15.0	13.2	15.0	15.0	15.0	15.0	15.0	15.0	15.0
22	11.14	11.53	12.06	12.74	13.11	13.44	9.91	13.10	13.48
23	5.0	3.0	5.0	5.0	4.7	5.2	4.6	5.1	5.8
24	4.0	4.6	3.4	7.2	9.9	10.7	4.1	7.4	8.7
25	5.0	3.0	3.0	6.9	7.7	10.2	4.6	11.3	8.8
26	4.0	4.3	3.4	5.8	9.0	11.4	5.6	10.1	12.2
27	4.0	5.0	3.4	12.0	11.1	12.8	7.1	12.7	12.3
28	6.2	5.0	4.1	13.8	14.1	14.3	11.1	12.1	12.9
29	4.70	4.15	3.71	8.45	9.42	10.80	6.95	9.78	10.12
30	8.57	8.81	9.15	11.31	11.72	12.47	8.29	11.58	12.26
31	24	23	19	29	35	34	15.5	13.0	-
32	26	26	24	20	28.5	31	24	21	24
33	20	26	20	15	23	25	22	22	29
34	10	10	8	10	13	17	12	11	-
35	10	13	12	13	14	17	9	10	10
36	6	8	6	11	11	17	14	15	14
37	1	1	2	3	5	6	3	2	-
38	5	5	3	4	6	6	3	4	3
39	2	3	1	2	2	4	6	6	5

Table 6 contd.

	Patient 100			Patient 104			Patient 114		
Treatment	ST		NS	ST		OP	OP		ST
Assessment	1	2	3	1	2	3	1	2	3
1	2	4	1	0	0	2	19	19	18
2	39	55	45	38	44	50	91	90	87
3	5	12	13	1	1	0	17	18	23
4	2	7	6	29	27	34	-	17	11
5	5	13	16	0	0	0	22	21	32
6	34	16	29	19	25	22	19	33	37
7	8	8	7	4	8	8	4	5	2
8	8	11	14	3	5	1	-	-	-
9	6.1	7.3	8.6	5.0	5.0	5.0	10.9	10.8	11.3
10	8.9	11.9	12.5	5.0	5.3	5.8	11.3	12.2	13.0
11	11.3	11.4	10.9	10.2	11.5	10.3	11.5	13.3	12.8
12	13.8	10.6	10.3	13.7	14.2	14.5	14.0	13.7	14.1
13	10.3	10.3	10.57	8.48	9.00	8.90	11.93	12.50	12.85
14	5.2	5.0	7.5	9.8	9.0	9.1	10.5	11.1	9.5
15	6.4	6.4	7.7	8.9	8.9	10.4	9.8	12.9	10.6
16	5.9	10.0	10.5	5.0	9.9	10.0	13.2	13.6	14.1
17	12.5	13.2	14.4	12.6	13.9	14.6	14.6	15.0	14.8
18	10.2	10.6	10.7	9.4	11.9	10.3	13.8	13.9	14.5
19	14.8	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
20	10.8	12.9	13.2	14.2	15.0	12.8	11.5	14.6	15.0
21	13.6	15.0	13.2	15.0	15.0	15.0	13.8	15.0	15.0
22	9.93	11.01	11.75	11.23	12.33	12.15	13.20	13.89	13.56
23	5.0	5.0	5.0	5.0	5.0	5.0	4.6	4.4	5.0
24	5.0	5.0	5.0	5.0	5.0	5.0	6.6	5.5	6.7
25	5.0	5.0	5.0	5.0	5.0	5.0	7.6	7.4	4.9
26	5.0	5.2	6.5	4.9	5.0	5.0	7.8	7.9	5.5
27	8.8	12.1	12.1	8.4	12.9	12.4	9.5	8.8	5.5
28	9.0	10.4	9.5	11.4	12.9	13.6	9.8	12.2	9.5
29	6.30	7.11	7.18	6.61	7.63	7.67	7.65	7.70	6.18
30	8.74	9.56	9.90	9.08	10.02	9.93	11.13	11.52	10.94
31	28	17	27	29	27	28	23	27	21
32	31	31	26	33	31	30	19.5	21.5	20.0
33	19.5	28	30	29	22.5	29	15	27	26
34	13	11	14	15	13	15	13	12	8
35	10	12	8	12	10	10	11	13	9
36	13	15	14	15	11	16	8	16	9
37	4	1	5	3	4	4	4	3	1
38	3	3	2	3	4	3	4	3	1
39	6	6	6	5	5	6	3	5	2

TABLE 6 contd. — = missing data

	Patient 116			Patient 117			Patient 131		
Treatment	ST	OP		NS		ST	ST		NS
Assessment	1	2	3	1	2	3	1	2	3
1	5	5	6	1	7	12	2	18	15
2	56	54	66	53	71	77	36	79	82
3	9	10	11	13	19	21	8	19	23
4	16	11	14	22	24	26	2	10	12
5	7	3	3	9	19	21	3	19	22
6	26	22	38	15	29	37	14	21	25
7	7	5	6	4	6	7	5	5	4
8	-	-	-	-	-	-	-	-	-
9	8.6	8.8	8.2	6.8	10.9	12.9	5.0	8.5	11.8
10	10.9	9.7	9.3	10.5	12.0	11.7	7.4	7.6	12.1
11	12.5	12.8	11.8	13.3	13.5	13.1	8.8	13.7	14.0
12	13.6	14.1	12.6	13.6	14.4	14.7	11.0	13.4	13.3
13	11.40	11.35	10.48	11.05	12.70	13.10	8.05	10.80	12.80
14	6.9	7.9	8.9	12.8	12.0	11.1	8.9	11.8	13.0
15	9.6	10.6	12.1	13.6	13.0	11.7	8.3	11.5	14.3
16	10.6	10.7	11.6	12.1	14.7	14.5	10.0	13.3	14.3
17	14.4	9.5	13.7	13.9	15.0	15.0	10.6	14.1	14.3
18	11.4	14.1	12.6	14.7	15.0	14.5	13.3	12.0	15.0
19	14.8	15.0	15.0	14.3	15.0	15.0	14.8	15.0	14.8
20	12.7	14.5	14.6	15.0	15.0	15.0	12.7	13.0	13.5
21	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
22	11.93	12.16	12.96	13.93	14.34	13.98	11.70	13.25	14.28
23	5.0	5.0	5.0	5.0	5.8	10.3	4.0	6.5	7.3
24	5.0	5.0	5.0	5.0	7.7	10.4	4.4	7.2	10.4
25	5.0	5.0	5.0	5.6	7.8	11.5	4.7	9.5	9.1
26	7.5	10.7	9.1	4.2	9.6	12.8	7.2	8.1	13.1
27	11.1	9.8	12.0	7.6	10.9	12.9	5.1	9.7	10.8
28	12.0	11.8	13.3	13.2	13.3	13.3	11.0	13.0	13.6
29	7.60	7.88	8.23	6.77	9.18	11.87	6.07	9.00	10.72
30	10.39	10.55	10.83	10.90	12.26	13.08	9.01	11.29	12.76
31	23	30	29	33	36	-	14	10	-
32	25	23	26	18	30	35	6	-	-
33	22.5	20	28	22	27	31	26	29	24.5
34	12	16	13	15	13	-	8	9	-
35	16	17	17	11	14	15	16	-	-
36	12	10	11	10	11	16	11	15	15
37	2	4	3	5	5	-	1	3	-
38	6	6	6	3	5	5	5	-	-
39	4	3	3	3	2	5	4	5	5

TABLE 6 contd.

Treatment	Patient 133 NS	ST		Patient 135 ST	OP		Patient 138 OP	ST	
Assessment	1	2	3	1	2	3	1	2	3
1	6	7	7	8	14	16	1	6	4
2	58	56	60	59	79	84	25	61	51
3	16	16	18	4	11	13	5	5	5
4	31	29	37	6	7	9	8	4	4
5	31	30	30	0	16	13	2	4	4
6	42	36	40	9	30	21	6	9	7
7	7	8	8	3	3	5	4	6	6
8	-	-	-	-	-	-	-	-	-
9	8.7	8.5	8.3	7.2	11.6	11.4	8.6	9.9	7.7
10	13.5	13.7	13.2	9.6	12.1	11.2	10.4	9.3	9.0
11	12.9	11.6	12.1	9.6	12.5	13.0	10.2	10.6	10.5
12	14.9	13.2	14.5	13.6	12.3	12.3	14.2	12.5	14.8
13	12.50	11.83	12.03	10.00	12.13	11.98	10.85	10.58	10.08
14	7.6	7.8	9.1	9.2	9.7	8.7	8.5	7.6	7.7
15	8.8	7.4	10.8	12.6	12.4	11.1	9.1	10.5	9.7
16	11.5	11.5	10.9	11.6	11.9	11.2	7.1	7.2	8.2
17	12.5	12.5	14.6	14.8	15.0	14.8	13.2	12.8	13.4
18	11.9	12.0	12.0	13.6	11.7	12.2	6.9	10.1	7.8
19	15.0	15.0	15.0	14.8	15.0	15.0	12.5	14.8	13.8
20	12.5	13.4	14.8	15.0	15.0	15.0	13.1	13.5	12.9
21	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.8
22	11.85	11.83	12.78	13.30	13.21	12.90	10.68	11.44	11.04
23	6.0	6.2	6.7	5.0	5.0	4.9	5.0	5.0	5.0
24	9.8	9.3	13.5	5.0	7.0	5.0	5.0	5.0	5.0
25	8.5	8.0	11.9	5.0	6.7	5.0	5.0	5.0	5.0
26	9.0	9.3	12.6	5.7	8.0	9.4	5.0	5.0	5.0
27	11.7	11.5	13.2	5.4	12.3	11.2	5.0	5.0	5.0
28	12.6	12.6	13.5	9.0	11.7	12.5	5.7	6.1	7.1
29	9.60	9.48	11.90	5.85	8.45	8.08	5.12	5.18	5.35
30	11.24	11.03	12.32	10.09	11.38	11.09	8.86	9.16	8.93
31	17	37	32	11	20.5	-	0	11	6
32	30	35	32	15	29	27	18	19	21
33	30	29	29	6	24	27	7	19	18
34	12	16	13	13	12	-	6	7	8
35	15	17	14	12	11	8	11	10	9
36	13	13	14	8	8	10	10	9	9
37	3	4	3	4	3	-	1	0	1
38	6	6	3	3	3	2	2	2	2
39	4	3	4	2	3	3	2	2	2

TABLE 6
contd.

Patient	140		
Treatment	ST		NS
Assessment	1	2	3
	0	0	0
	30	37	35
	0	0	1
	11	15	15
	0	2	6
	11	16	11
	7	6	6
	-	-	-
	5.0	5.5	5.0
	5.6	7.2	5.0
	9.2	9.1	6.2
	12.1	13.6	13.4
	7.98	8.85	7.40
	9.7	9.3	10.7
	10.1	11.6	11.9
	9.5	10.0	11.1
	13.4	13.9	14.8
	11.7	11.9	11.8
	15.0	15.0	15.0
	11.8	11.6	11.6
	15.0	15.0	15.0
	12.03	12.29	12.74
	5.0	5.0	5.0
	5.0	5.0	5.0
	5.0	5.0	5.0
	5.0	5.0	5.0
	11.82	12.2	12.3
	10.4	10.6	9.8
	7.03	7.13	7.02
	9.46	9.81	9.64
	25	30	26
	23	27	23
	17	19	20.5
	11	11	12
	7	7	8
	11	6	7
	2	4	4
	3	3	3
	3	3	2

TABLE 7

Analysis of Variance table for Experiment 1

Block	Group	Subject	Treatment 1 1st 4 weeks	Interval 2 2nd 4 weeks
1	1	1 ... n	x_1 S.T. a	x_2 N.S. b
	2	... 2n	N.S. c	S.T. d
2	3	... 3n	S.T. e	Op. f
	4	... 4n	Op. g	S.T. h

Source Variance	degress of freedom
Between subject	23
Block (N.S. + S.T. v. Op. + S.T.)	1
Groups within blocks	2
Subjects within Groups	20
Within Subject	24
Interval	1
Interval x Block	1
Treatment x Block	
Block 1 N.S. v. S.T.	1
Block 2 Op. v. S.T.	1
Residual (Interval x subjects within Groups)	20
Total	47

Key

Treatments S.T. Speech Therapy
N.S. Non-specific
Op. Operant training

x_1 change score during first treatment interval
i.e. Assessment 2 - Assessment 1

x_2 change score during second treatment interval
i.e. Assessment 3 - Assessment 2

TABLE 8

Missing change scores inserted in analysis of variance in Experiment 1

Assessment	Patient	Interval	Change Score
Progressive Matrices	27	2	10.2
	114	2	-6.0
Independent Object Naming	9	1	-2.0
	9	2	5.0
	13	1	1.0
	13	2	1.3
	27	2	-2.7
	85	1	-2.0
	85	2	5.0
Ward S	60	2	3.6
	98	2	-18.0
	117	2	-12.5
	131	2	0.6
	135	2	14.2
Ward C	60	2	2.2
	98	2	-6.5
	117	2	-7.5
	131	2	1.3
	135	2	-0.8
Ward C(4+5)	60	2	0.3
	98	2	-2.3
	117	2	-1.3
	131	2	3.3
	135	2	-1.0
Physiotherapy S	131	1	1.0
	131	2	-1.0
Physiotherapy C	131	1	0.2
	131	2	-0.8
Physiotherapy C (4+5)	131	1	0.4
	131	2	-0.4

TABLE 9

Average change in test score within each group and Treatment for Moderate Aphasics in Experiment 1

Assessment	Group 1 ST n	Group 1 ST mean change	Group 1 NS n	Group 1 NS mean change	Group 2 NS n	Group 2 NS mean change	Group 2 ST n	Group 2 ST mean change
Token test No. correct	6	2.50	6	-0.83	6	1.33	6	1.67
Token test Weighted score	6	14.00	6	2.00	6	3.50	6	3.50
Object Naming	6	4.33	6	0.33	6	4.50	6	0.50
Progressive Matrices	6	5.83	6	-1.50	6	1.50	5	6.00
Fluency	6	4.67	6	5.83	6	7.17	6	0.00
Picture Description	6	1.00	6	4.50	6	5.50	6	6.00
Self Rating	6	0.17	6	-0.33	6	0.50	6	1.17
Independent Object Naming	3	1.00	3	1.33	4	1.75	3	1.00
PICA I	6	1.13	6	0.50	6	1.95	6	-0.22
IV	6	0.65	6	0.77	6	0.47	6	0.82
IX	6	0.80	6	-0.30	6	0.57	6	0.82
XII	6	0.15	6	0.45	6	1.03	6	0.18
Verbal	6	0.69	6	0.35	6	1.02	6	0.29
II	6	0.35	6	0.87	6	0.52	6	0.30
III	6	0.68	6	0.83	6	0.22	6	0.67
V	6	1.15	6	0.93	6	1.22	6	-0.35
VI	6	1.23	6	0.45	6	1.25	6	0.23
VII	6	-0.52	6	0.65	6	1.13	6	0.22
VIII	6	0.30	6	0.00	6	0.37	6	0.08
X	6	0.40	6	-0.08	6	0.07	6	0.78
XI	6	0.12	6	-0.18	6	0.00	6	0.00
Gestural	6	0.45	6	0.47	6	0.60	6	0.25
A	6	0.58	6	0.12	6	0.15	6	1.18
B	6	1.02	6	0.20	6	1.13	6	1.68
C	6	1.47	6	-0.40	6	1.60	6	1.10
D	6	0.53	6	1.70	6	1.93	6	1.87
E	6	1.72	6	0.35	6	1.12	6	1.53
F	6	0.72	6	0.07	6	0.32	6	0.45
Graphic	6	1.02	6	0.33	6	0.91	6	1.31
Overall	6	0.82	6	0.26	6	0.79	6	0.64
Ward S	6	-2.08	4	2.75	6	8.83	4	-2.38
C	6	-0.17	4	1.75	6	2.33	4	-1.25
C (4+5)	6	0.17	4	1.25	6	0.50	4	-0.25
Physiotherapy S	5	1.00	5	-1.00	6	3.25	6	0.92
C	5	0.20	5	-0.80	6	1.17	6	-0.33
C (4+5)	5	0.40	5	-0.40	6	0.83	6	-0.83
Occupational S	6	1.25	6	2.25	6	2.50	6	2.83
C	6	0.00	6	0.67	6	0.33	6	2.67
C(4+5)	6	0.33	6	0.00	6	-0.50	6	1.17

TABLE 9 contd.

	Group 3				Group 4			
		ST		Op		Op		ST
Assessment	n	mean change	n	mean change	n	mean change	n	mean change
	6	1.00	6	2.17	6	0.67	6	0.67
	6	7.33	6	8.17	6	8.00	6	-4.00
	6	1.33	6	4.00	6	2.50	6	2.83
	6	-0.17	6	3.67	5	2.20	6	0.83
	6	3.50	6	1.83	6	3.83	6	2.17
	6	10.17	6	-3.33	6	9.00	6	-2.83
	6	1.17	6	0.00	6	0.83	6	0.00
	2	-2.00	2	5.00	4	1.00	4	2.50
	6	0.92	6	1.00	6	0.72	6	-0.67
	6	1.70	6	0.73	6	0.87	6	0.70
	6	1.85	6	0.32	6	1.07	6	-0.05
	6	0.15	6	0.23	6	-0.92	6	1.43
	6	1.20	6	0.55	6	0.44	6	0.29
	6	0.23	6	0.68	6	0.37	6	0.22
	6	-0.37	6	0.77	6	1.05	6	-0.53
	6	1.13	6	0.72	6	0.97	6	1.07
	6	-0.18	6	1.17	6	0.65	6	-0.10
	6	0.47	6	-0.17	6	1.53	6	-0.72
	6	0.03	6	0.15	6	0.15	6	0.10
	6	0.45	6	0.02	6	1.27	6	-0.15
	6	-0.25	6	0.45	6	0.20	6	-0.05
	6	0.19	6	0.36	6	0.70	6	-0.02
	6	-0.38	6	0.75	6	0.37	6	-0.28
	6	0.38	6	0.58	6	-0.47	6	1.00
	6	0.20	6	0.38	6	-0.80	6	0.83
	6	1.70	6	-0.38	6	0.53	6	0.02
	6	3.13	6	-0.40	6	-0.78	6	0.47
	6	0.97	6	0.70	6	0.97	6	0.07
	6	0.99	6	0.30	6	-0.04	6	0.35
	6	0.68	6	0.29	6	0.38	6	0.17
	6	0.50	5	3.40	6	6.92	6	1.83
	6	-0.33	5	0.00	6	1.67	6	0.50
	6	0.17	5	0.40	6	0.33	6	0.17
	6	1.33	6	0.67	6	5.83	6	0.75
	6	0.00	6	-0.83	6	-0.17	6	-0.33
	6	0.00	6	-0.83	6	0.17	6	0.33
	6	0.50	6	6.75	6	5.25	6	-1.83
	6	-0.33	6	1.50	6	1.33	6	-1.00
	6	-0.50	6	0.33	6	0.50	6	-0.50

TABLE 10

Average change in test score for each treatment and each interval for Moderate aphasics in Experiment 1

Assessment	n	Speech Therapy Block 1 mean change	n	Speech Therapy Block 2 Mean change	n	Speech Therapy Total Group mean change
Token test no. correct	12	2.09	12	0.84	24	1.46
Token test weighted score	12	8.75	12	1.67	24	5.21
Object Naming	12	2.42	12	2.08	24	2.25
Progressive Matrices	11	5.92	12	0.33	23	3.00
Fluency	12	2.33	12	2.83	24	2.58
Picture Description	12	3.50	12	3.67	24	3.58
Self Rating	12	0.67	12	0.59	24	0.63
Independent Object Naming	6	1.00	6	1.00	12	1.00
PICA I	12	0.46	12	0.13	24	0.29
IV	12	0.74	12	1.20	24	0.97
IX	12	0.81	12	0.90	24	0.85
XII	12	0.17	12	0.79	24	0.48
Verbal	12	0.49	12	0.75	24	0.61
II	12	0.33	12	0.23	24	0.28
III	12	0.68	12	-0.45	24	0.11
V	12	0.40	12	1.10	24	0.75
VI	12	0.73	12	-0.14	24	0.30
VII	12	-0.15	12	-0.13	24	-0.14
VIII	12	0.19	12	0.07	24	0.13
X	12	0.59	12	0.15	24	0.37
XI	12	0.06	12	-0.15	24	-0.05
Gestural	12	0.35	12	-0.09	24	0.22
A	12	0.88	12	-0.33	24	0.28
B	12	1.35	12	0.69	24	1.02
C	12	1.29	12	0.52	24	0.90
D	12	1.20	12	0.86	24	1.03
E	12	1.63	12	1.80	24	1.71
F	12	0.59	12	0.52	24	0.55
Graphic	12	1.17	12	0.67	24	0.92
Overall	12	0.73	12	0.43	24	0.58
Ward S	10	-2.20	12	1.17	22	-0.36
C	10	-0.60	12	0.09	22	-0.23
C(4+5)	10	0.00	12	0.17	22	0.09
Physiotherapy S	11	0.96	12	1.04	23	1.00
C	11	0.09	12	-0.17	23	-0.13
C(4+5)	11	-0.27	12	0.17	23	0.04
Occupational therapy S	12	2.04	12	-0.67	24	0.69
C	12	1.34	12	-0.67	24	0.33
C(4+5)	12	0.75	12	-0.50	24	0.13

TABLE 10
contd.

Treatment				Interval			
Non Specific		Operant Training		1		2	
n	mean change	n	mean change	n	mean change	n	mean change
12	0.25	12	1.42	24	1.38	24	0.92
12	2.75	12	8.08	24	8.21	24	2.42
12	2.42	12	3.25	24	3.17	24	1.92
12	0.00	11	3.00	23	2.35	23	2.09
12	6.50	12	2.83	24	4.79	24	2.46
12	5.00	12	2.83	24	6.42	24	1.09
12	0.08	12	0.42	24	0.67	24	0.21
7	1.57	6	2.33	13	0.77	12	2.25
12	1.23	12	0.86	24	1.18	24	0.15
12	0.62	12	0.80	24	0.92	24	0.76
12	0.13	12	0.69	24	1.07	24	0.20
12	0.74	12	-0.34	24	0.10	24	0.57
12	0.69	12	0.49	24	0.84	24	0.37
12	0.69	12	0.53	24	0.37	24	0.52
12	0.53	12	0.91	24	0.40	24	0.44
12	1.08	12	0.84	24	1.12	24	0.59
12	0.85	12	0.91	24	0.74	24	0.44
12	0.89	12	0.68	24	0.70	24	-0.01
12	0.18	12	0.15	24	0.21	24	0.25
12	-0.01	12	0.64	24	0.55	24	0.14
12	-0.09	12	0.33	24	0.02	24	0.06
12	0.53	12	0.53	24	0.49	24	0.22
12	0.13	12	0.56	24	0.18	24	0.44
12	0.67	12	0.06	24	0.52	24	0.87
12	0.60	12	-0.21	24	0.62	24	0.63
12	1.82	12	0.08	24	1.17	24	0.80
12	0.73	12	-0.59	24	1.30	24	0.49
12	0.19	12	0.83	24	0.75	24	0.32
12	0.62	12	0.13	24	0.64	24	0.57
12	0.52	12	0.34	24	0.67	24	0.34
10	6.40	11	5.32	24	3.54	19	1.53
10	2.10	11	0.91	24	0.88	19	0.26
10	0.80	11	0.36	24	0.29	19	0.40
11	1.32	12	3.25	23	2.93	23	0.39
11	0.27	12	-0.50	23	0.30	23	-0.56
11	0.27	12	-0.33	23	0.61	23	-0.69
12	2.38	12	6.00	24	2.38	24	2.50
12	0.50	12	1.42	24	0.33	24	0.96
12	-0.25	12	0.42	24	0.04	24	0.25

TABLE 11

F -values obtained from Analysis of Variance of results in Experiment 1

Test / Source Variance (df.)	Blocks NS v. Op. (1)	Group within Block (2)	Interval (1)
Token Test no.Correct	0.00	0.35	0.13
Token Test Weighted score	0.06	1.09	3.27
Object Naming	0.06	0.01	1.44
Progressive Matrices(18)[x]	1.27	0.43	0.10
Fluency	1.83	0.53	1.51
Picture Description	0.29	0.67	2.85
Self Rating	0.13	1.87	0.64
Independent Object Naming(8)[x]	0.52	0.05	0.74
PICA I	0.52	0.93	4.82*
IV	0.41	0.19	0.11
IX	0.44	0.54	4.65*
XII	0.50	0.24	1.21
Verbal	0.01	0.48	3.83
II	0.13	0.12	0.16
III	0.77	0.15	0.01
V	0.36	0.63	0.80
VI	1.27	0.11	0.25
VII	0.05	0.65	1.28
VIII	0.47	0.13	0.36
X	0.14	0.59	0.88
XI	1.94	0.08	0.03
Gestural	0.46	0.04	0.94
A	2.26	0.43	1.01
B	2.31	0.99	0.46
C	3.29	0.99	0.04
D	3.44	0.60	1.02
E	1.20	2.18	1.30
F	0.76	0.23	1.51
Graphic	2.12	0.94	0.29
Overall	1.22	0.37	3.01
Ward S (15)	1.79	0.16	1.27
Ward C (15)	0.03	1.04	1.55
Ward C(4+5) (15)	0.07	0.91	0.01
Physiotherapy S (18)	0.35	0.70	3.47
Physiotherapy C (18)	0.75	0.66	1.75
Physiotherapy C(4+5)(18)	0.06	1.04	9.54**
Occupational therapy S	0.13	0.68	0.00
Occupational therapy C	1.05	1.38	0.23
Occupational therapy C(4+5)	0.98	0.10	0.33

* Significant at $p<0.05$ (two-tailed)
** Significant at $p<0.01$ (two-tailed)
x Residual df given in brackets for tests with missing data

TABLE 11
contd.

Interval x Block 1	Treatment x Block 1 NS vST 1	Treatment x Block 2 Op v ST 1
0.65	1.01	0.10
0.00	1.76	2.01
6.97*	0.00	0.63
1.24	10.95**	1.02
0.12	2.41	0.00
5.38*	0.11	0.03
0.90	0.52	0.04
1.39	0.12	0.87
0.64	1.35	1.23
0.63	0.03	0.32
1.23	1.38	0.13
3.03	0.90	3.50
0.08	0.35	0.57
0.00	0.47	0.32
0.30	0.05	3.98
0.39	0.66	0.10
0.98	0.02	1.51
1.81	1.60	0.96
0.57	0.00	0.08
1.46	0.97	0.65
0.73	0.23	2.34
0.06	0.32	1.90
0.01	4.14	5.85*
0.87	0.87	0.75
2.17	0.46	0.52
6.21*	1.38	2.23
0.22	0.79	5.70*
0.22	0.65	0.43
0.00	1.96	1.90
0.02	0.59	0.11
1.10	8.09*	1.91
0.46	10.50**	0.33
0.01	2.70	0.01
0.07	0.01	1.33
0.32	0.07	0.13
3.15	1.46	1.94
0.04	0.01	3.07
0.45	0.20	1.27
0.54	1.91	1.61

* Significant at $p<0.05$ (two-tailed)
** Significant at $p<0.01$ (two-tailed)
x Residual df given in brackets for tests with missing data

TABLE 12

Mean and standard deviations of test scores for Moderate Aphasics in Experiment 1

Occasion Assessment	n (1)	Mean (1)	S.D. (1)	n (2)	Mean (2)	S.D. (2)	n (3)	Mean (3)	S.D. (3)
Token Test no. correct	24	6.25	5.25	24	7.62	5.91	24	8.54	5.72
Token Test Weighted Score	24	53.62	18.23	24	61.83	16.88	24	64.25	17.52
Object Naming	24	8.45	5.89	24	11.62	6.78	24	13.54	6.80
Progressive Matrices	23	18.00	10.64	24	20.20	11.32	23	21.86	13.47
Fluency	24	9.12	8.75	24	13.91	9.40	24	16.37	9.60
Picture description	24	24.79	15.77	24	31.20	18.01	24	32.29	15.48
Self Rating	24	5.04	1.73	24	5.62	1.55	24	6.00	1.56
Independent Object Naming	14	12.71	6.37	13	13.30	6.06	13	15.46	6.26
PICA I	24	7.38	1.99	24	8.56	2.17	24	8.72	2.53
IV	24	9.24	2.76	24	10.16	2.44	24	10.92	2.70
IX	24	10.19	1.92	24	11.26	1.88	24	11.31	2.15
XII	24	13.06	1.58	24	13.27	1.63	24	13.74	1.36
Verbal	24	9.97	1.73	24	10.80	1.55	24	11.17	1.82
II	24	9.10	2.15	24	9.46	1.85	24	9.98	1.61
III	24	10.03	2.26	24	10.43	1.82	24	10.82	1.53
V	24	9.80	2.41	24	10.91	2.37	24	11.50	1.81
VI	24	12.83	1.90	24	13.57	1.38	24	14.00	1.25
VII	24	11.41	2.09	24	11.66	2.75	24	12.06	1.99
VIII	24	14.55	0.89	24	14.77	0.47	24	14.85	0.43
X	24	13.17	1.29	24	13.71	1.26	24	13.85	1.04
XI	24	14.84	0.43	24	14.86	0.42	24	14.91	0.37
Gestural	24	11.99	1.17	24	12.47	0.99	24	12.73	0.87
A	24	5.00	0.52	24	5.18	0.80	24	5.62	1.25
B	24	5.61	1.48	24	6.13	1.57	24	7.00	2.54
C	24	5.90	1.89	24	6.51	1.87	24	6.99	2.49
D	24	6.06	1.68	24	7.24	2.06	24	8.04	3.11
E	24	8.67	2.45	24	9.97	2.27	24	10.45	2.75
F	24	10.85	2.93	24	11.84	2.13	24	12.16	2.47
Graphic	24	7.09	1.34	24	7.78	1.31	24	8.38	1.99
Overall	24	9.91	1.07	24	10.58	1.07	24	10.92	1.22
Ward S	24	21.77	8.77	24	25.33	9.87	19	27.52	7.85
Ward C	24	11.95	2.61	24	12.83	2.83	19	13.37	2.79
Ward C(4+5)	24	2.92	1.21	24	3.20	1.47	19	3.63	1.42
Physiotherapy S	24	23.81	8.30	23	27.52	4.51	23	27.91	5.99
Physiotherapy C	24	12.83	2.80	23	13.00	2.71	23	12.43	3.36
Physiotherapy C (4+5)	24	3.54	1.38	23	3.83	1.37	23	3.39	1.49
Occupational therapy S	24	21.25	7.30	24	23.62	7.53	24	26.12	5.50
Occupational therapy C	24	11.21	3.05	24	11.54	2.55	24	12.50	3.25
Occupational therapy C (4+5)	24	3.63	1.34	24	3.58	1.31	24	3.83	1.40

TABLE 13

Change in test scores between initial and final assessments for Moderate Aphasics in Experiment 1

Assessment	Mean change+	t*	df.	p (two tailed)
Token test No.correct	2.29	2.38	20	$p < 0.05$
Token test weighted score	10.63	3.03	20	$p < 0.01$
Object Naming	5.08	4.87	20	$p < 0.001$
Progressive Matrices	4.68	3.16	18	$p < 0.01$
Fluency	7.25	6.19	20	$p < 0.01$
Picture Description	7.50	4.06	20	$p < 0.001$
Self Rating	0.88	2.57	20	$p < 0.02$
Independent Object Naming	3.15	3.21	9	$p < 0.02$
PICA I	1.33	2.76	20	$p < 0.02$
IV	1.68	3.30	20	$p < 0.01$
IX	1.27	2.58	20	$p < 0.02$
XII	0.68	2.09	20	$p < 0.05$
Verbal	1.21	3.17	20	$p < 0.01$
II	0.88	2.35	20	$p < 0.05$
III	0.83	1.97	20	N.S.
V	1.71	4.41	20	$p < 0.001$
VI	1.18	3.24	20	$p < 0.01$
VII	0.65	1.58	20	N.S.
VIII	0.29	2.57	20	$p < 0.02$
X	0.69	2.51	20	$p < 0.05$
XI	0.07	0.95	20	N.S.
Gestural	0.75	3.87	20	$p < 0.001$
A	0.62	2.36	20	$p < 0.05$
B	1.38	3.32	20	$p < 0.01$
C	1.10	2.53	20	$p < 0.02$
D	1.98	3.52	20	$p < 0.01$
E	1.78	3.39	20	$p < 0.01$
F	1.06	3.22	20	$p < 0.01$
Graphic	1.29	3.82	20	$p < 0.01$
Overall	1.01	4.52	20	$p < 0.001$
Ward S	5.76	4.84	15	$p < 0.001$
Ward C	1.53	2.31	15	$p < 0.05$
Ward C (4+5)	0.79	2.01	15	N.S.
Physiotherapy S	3.33	1.80	19	N.S.
Physiotherapy C	-0.26	0.58	19	N.S.
Physiotherapy C(4+5)	-0.08	0.27	19	N.S.
Occupational therapy S	4.88	3.78	20	$p < 0.001$
Occupational therapy C	1.29	2.45	20	$p < 0.05$
Occupational therapy C (4+5)	0.21	0.71	20	N.S.

+ Assessment 3 - Assessment 1

$$* \; t = \frac{\text{Mean change in Score}}{\sqrt{\frac{\text{within Group Mean Square}}{\text{No. of subjects}}}}$$ (Armitage 1971)

TABLE 14

Average number of tokens earned in each operant training session for moderate Aphasics in Experiment 1

Patient number	Reinforcement Category	Sessions 1	2	3	4	5	6	7	8
9	Clear relevant sentences	11.4	9.9	10.6	10.1	13.1	12.0	11.4	11.7
22	Clear non perseverative words and phrases	4.6	7.9	6.8	4.6	5.2	M	7.1	9.6
32	Clear non perseverative words & phrases	0.2	M	M	M	M	M	M	1.6
53	Clear non perseverative words & phrases	5.6	4.1	2.3	3.0	2.6	4.3	2.5	1.5
74	Clear relevant phrases & sentences	5.6	6.6	M	4.1	3.6	6.6	7.6	7.5
84	Clear non perseverative words & phrases	2.8	4.0	4.6	4.8	2.7	5.0	4.2	3.7
85	Clear relevant words & phrases	4.7	6.1	7.9	6.9	7.1	9.2	7.1	8.5
104	Clear relevant sentences	5.3	6.1	5.5	6.0	6.6	5.2	7.2	8.6
114	Clear relevant sentences	5.6	5.0	6.1	7.6	4.8	6.9	7.0	6.6
116	Clear relevant phrases & sentences	2.9	6.2	5.6	6.4	7.8	7.0	7.2	6.7
135	Clear relevant words & phrases	6.7	5.3	8.3	7.4	7.2	6.6	6.6	7.7
138	Clear non perseverative words & phrases	3.4	4.8	4.6	5.7	5.3	5.8	6.0	5.0

Key M Missing information
– No treatment session given

TABLE 14

contd.

Patient Number	Reinforcement category	Sessions 9	10	11	12
9	Clear relevant sentences	M	7.3	12.4	10.9
22	Clear non-perseverative words & phrases	6.6	8.5	8.0	10.7
32	Clear non-perseverative words & phrases	M	M	M	-
53	Clear non-perseverative words & phrases	2.4	2.8	2.1	6.4
74	Clear relevant phrases & sentences	6.6	4.0	9.2	M
84	Clear non-perseverative words & phrases	3.3	4.1	4.7	-
85	Clear relevant words and phrases	7.3	9.0	-	-
104	Clear relevant sentences	8.7	8.1	8.4	-
114	Clear relevant sentences	6.9	6.6	6.6	9.0
116	Clear relevant phrases and sentences	5.4	7.0	-	-
135	Clear relevant words & phrases	8.6	8.3	9.4	9.2
138	Clear non-perseverative words & phrases	5.9	6.6	-	-

Key M Missing information

- No treatment session given

TABLE 15

Correlation between change in number of tokens earned in operant training sessions and change in test scores for Moderate Aphasics in Experiment 1

Assessment	n	Correlation co-efficient	p
Token test no. correct	12	0.33	N.S.
Token test weighted score	12	0.35	N.S.
Object Naming	12	-0.15	N.S.
Progressive Matrices	11	0.50	N.S.
Fluency	12	0.37	N.S.
Picture Description	12	0.38	N.S.
Self Rating	12	0.14	N.S.
Independent Object Naming	6	0.42	N.S.
PICA I	12	0.21	N.S.
IV	12	0.00	N.S.
IX	12	-0.16	N.S.
XII	12	0.14	N.S.
Verbal	12	0.07	N.S.
II	12	-0.09	N.S.
III	12	0.26	N.S.
V	12	0.25	N.S.
VI	12	0.49	N.S.
VII	12	-0.02	N.S.
VIII	12	0.05	N.S.
X	12	0.53	N.S.
XI	12	0.30	N.S.
Gestural	12	0.46	N.S.
A	12	0.20	N.S.
B	12	0.06	N.S.
C	12	-0.09	N.S.
D	12	0.32	N.S.
E	12	0.14	N.S.
F	12	-0.18	N.S.
Graphic	12	0.02	N.S.
Overall	12	0.41	N.S.
Ward S	11	0.11	N.S.
Ward C	11	0.27	N.S.
Ward C (4+5)	11	-0.07	N.S.
Physiotherapy S	12	-0.07	N.S.
Physiotherapy C	12	0.34	N.S.
Physiotherapy C (4+5)	12	0.27	N.S.
Occupational therapy S	12	0.13	N.S.
Occupational therapy C	12	0.09	N.S.
Occupational therapy C (4+5)	12	-0.33	N.S.

TABLE 16

Correlation of Biographical variables with change between initial and final assessment in Experiment 1

Test	Age	Correlation of change in test score with Months Post Onset	Right Handedness
Token test No. correct	0.26	-0.33	0.36
Token test weighted score	0.16	-0.20	0.30
Object Naming	0.32	-0.53 *	0.26
Progressive Matrices	-0.39	0.00	0.31
Fluency	0.25	-0.10	0.12
Picture Description	0.35	-0.20	0.40 *
Self Rating	-0.19	-0.04	0.17
Independent Object Naming	0.21	-0.01	0.13
PICA I	0.35	-0.33	0.24
IV	0.30	-0.31	0.05
IX	0.32	-0.36	0.23
XII	0.09	0.06	0.55 *
Verbal	0.37	-0.31	0.32
II	-0.12	-0.03	-0.01
III	0.10	-0.01	0.07
V	0.28	-0.35	-0.33
VI	0.14	-0.12	0.07
VII	0.23	-0.24	0.18
VIII	0.29	-0.19	0.17
X	0.21	-0.13	-0.03
XI	0.17	-0.09	0.37
Gestural	0.21	-0.22	-0.03
A	0.15	-0.21	0.36
B	-0.06	-0.21	0.37
C	-0.15	-0.12	0.38
D	-0.12	-0.21	0.24
E	0.15	0.02	0.30
F	0.25	-0.12	0.12
Graphic	0.00	-0.16	0.36
Overall	0.19	-0.27	0.27
Ward S	-0.15	0.06	0.37
Ward C	-0.32	-0.01	0.08
Ward C (4+5)	-0.18	0.29	-0.07
Physiotherapy S	-0.31	0.05	-0.07
Physiotherapy C	0.23	-0.27	-0.10
Physiotherapy C (4+5)	-0.03	-0.13	-0.13
Occupational therapy S	0.02	-0.35	0.06
Occupational therapy C	-0.17	-0.08	0.14
Occupational therapy C (4+5)	-0.06	0.08	-0.09

* Sig $p < 0.05$ (two-tailed)

TABLE 17

Results from Jonckheere's test for decreasing change with increasing months post onset for Moderate Aphasics in Experiment 1

Assessment	S	Z	Significance
Token Test no. Correct	50	1.27	N.S.
Token Test Weighted Score	36	0.92	N.S.
Object Naming	126	3.20	$p<0.001$
Progressive Matrices	-42	-1.21	N.S.
Fluency	86	2.19	$p<0.05$
Picture Description	82	2.08	$p<0.05$
Self Rating	-14	-0.36	N.S.
Independent Object Naming	7	0.44	N.S.
PICA I	88	2.24	$p<0.05$
IV	100	2.54	$p<0.01$
IX	120	3.05	$p<0.001$
XII	-20	-0.51	N.S.
Verbal	110	2.80	$p<0.01$
II	-16	-0.41	N.S.
III	-16	-0.41	N.S.
V	62	1.58	N.S.
VI	8	0.20	N.S.
VII	66	1.68	$p<0.05$
VIII	-40	-1.02	N.S.
X	40	1.02	N.S.
XI	-148	-3.76	N.S.
Gestural	22	0.56	N.S.
A	2	0.05	N.S.
B	34	0.86	N.S.
C	-14	-0.36	N.S.
D	36	0.92	N.S.
E	42	1.07	N.S.
F	30	0.76	N.S.
Graphic	36	0.92	N.S.
Overall	72	1.83	$p<0.05$
Ward S	4	0.14	N.S.
Ward C	-4	-0.14	N.S.
Ward C (4+5)	-76	-2.75	N.S.
Physiotherapy S	60	2.14	$p<0.05$
Physiotherapy C	-60	-2.14	N.S.
Physiotherapy C (4+5)	-28	-1.00	N.S.
Occupational therapy S	72	1.83	$p<0.05$
Occupational therapy C	46	1.17	N.S.
Occupational therapy C (4+5)	-20	-0.51	N.S.

TABLE 18

The agreement between nurses, physiotherapists and occupational therapists in ratings of patient's functional speech in Experiment 1

Speech Questionnaire Variable	Assessment Occasion *	Kendall Co-efficient of concordance W.	df.	p.
Speech	1	0.69	23	$p<0.01$
	2	0.65	22	$p<0.01$
	3	0.73	18	$p<0.01$
Communication	1	0.49	23	N.S.
	2	0.62	22	$p<0.01$
	3	0.64	18	$p<0.02$
Communication (questions 4+5)	1	0.38	23	N.S.
	2	0.35	22	N.S.
	3	0.60	18	$p<0.05$

* Assessments were completed before treatment (1) after the first treatment interval (2) and after the second treatment interval (3)

TABLE 19

Correlations between test scores and functional ratings of speech significant at the 5% level for Moderate Aphasics in Experiment 1

Test Score	Functional Rating	Correlation Co-efficient	n	Significance
Token test No.Correct	Occupational therapy C	0.55	24	$p<0.01$
Fluency	Occupational therapy C	0.47	24	$p<0.05$
Self Rating	Occupational therapy C	0.42	24	$p<0.05$
Self Rating	Occupational therapy C (4+5)	0.42	24	$p<0.05$
PICA I	Occupational therapy C	0.42	24	$p<0.05$
II	Ward C	0.49	24	$p<0.05$
II	Ward C (4+5)	0.68	24	$p<0.01$
A	Physiotherapy C	0.47	23	$p<0.05$
A	Occupational therapy C	0.48	24	$p<0.05$
B	Physiotherapy C	0.50	23	$p<0.05$
B	Occupational therapy C	0.47	24	$p<0.05$
C	Physiotherapy C	0.42	23	$p<0.05$
D	Ward C	0.52	19	$p<0.05$
D	Ward C (4+5)	0.50	19	$p<0.05$
D	Physiotherapy C	0.48	23	$p<0.05$
D	Occupational therapy C	0.45	24	$p<0.05$
E	Ward C (4+5)	0.59	19	$p<0.01$
Graphic	Ward C	0.50	19	$p<0.05$
Graphic	Ward C (4+5)	0.52	19	$p<0.05$
Graphic	Occupational therapy C	0.50	24	$p<0.05$
Overall	Ward C (4+5)	0.48	19	$p<0.05$

TABLE 20

Characteristics of Severe Aphasics in Experiment 2

n = 18

Patient Number	Age in years	Sex	Months Post onset	Admission date	Handedness % right	Side Hemiplegia	No. Sessions Speech Therapy
1	41	M	3	3.12.73	-	R	13
2	43	F	4	10.12.73	17	R	6
7	47	F	1	4.2.74	67	R	10
16	59	M	4	13.5.74	100	R	10
18	45	M	1	28.5.74	15	R	15
19	49	M	2	28.5.74	71	R	17
21	49	M	8	1.7.74	69	R	10
26	51	M	2	9.9.74	-	R	14
28	40	M	4	13.9.74	-	R	13
29	64	F	2	14.10.74	23	R	24
30	47	M	9	14.10.74	45	R	7
33	54	F	3	11.11.74	92	L	12
40	64	M	3	13.1.75	100	R	15
42	57	M	2	3.2.75	100	R	6
44	56	F	6	17.2.75	83	R	6
45	41	M	13	17.2.75	-	R	15
46	39	M	2	28.8.75	-	R	15
48	48	F	8	1.9.75	92	R	11
Mean	49.6		4.8		67.23		12.2
S.D.	7.9		4.9		32.17		4.6

TABLE 21

Test Scores of Severe Aphasics in Experiment 2

n = 18

Patient	1		2		7	
Assessment / Patient Assessment	1	2	1	2	1	2
Token test. No correct	1	1	3	8	0	0
Token test Weighted score	6	11	51	51	25	17
Object naming. No. correct	3	2	6	6	0	0
Progressive Matrices score	30	35	9	12	4	0
Fluency	0	4	2	4	0	0
Picture Description	11	12	2	4	0	0
Self Rating	2	4	7	6	1	7
PICA I	4.4	6.0	6.8	-	3.0	3.2
IV	4.0	4.7	8.4	-	3.0	3.0
XI	4.2	5.9	9.7	-	3.0	3.0
XII	4.0	8.1	8.5	-	3.0	3.4
Verbal	4.15	6.17	8.36	-	3.00	3.15
II	10.1	8.8	11.5	-	5.5	9.15
III	11.3	10.0	12.7	-	7.1	11.6
V	7.3	8.0	14.0	-	6.0	9.5
VI	9.3	8.6	14.5	-	7.5	8.5
VII	10.8	9.0	13.9	-	6.0	9.5
VIII	14.1	14.8	15.0	-	14.4	14.1
X	13.0	12.6	15.0	-	7.0	8.0
XI	14.8	14.4	15.0	-	14.8	14.4
Gestural	11.23	10.77	13.95	-	6.03	10.58
A	5.0	5.0	5.2	-	5.0	5.0
B	5.0	4.5	5.0	-	4.7	5.2
C	4.9	4.9	5.6	-	5.0	5.0
D	5.0	5.0	7.1	-	5.0	4.9
E	5.1	6.8	6.6	-	7.5	10.2
F	8.1	11.1	11.6	-	10.2	10.9
Graphic	5.52	6.21	6.85	-	6.23	6.87
Overall	7.80	7.73	10.33	-	5.42	7.72
Ward S	10	24	28.5	21.5	8.5	15.0
Physiotherapy	17	18.5	24	28	9	15
Occupational therapy	19	23	19	26	0	6.5
Ward C	15	16	15	15	12	13
Physiotherapy	16	15	17	18	5	14
Occupational therapy	15	14	15	16	5	8
Ward C (4+5)	3	4	3	4	1	3
Physiotherapy C(4+5)	6	5	6	6	3	4
Occupational therapy C(4+5)	6	5	5	5	3	1

- = missing data

TABLE 21 contd.

16		18		19		21	
1	2	1	2	1	2	1	2
2	1	1	4	1	0	2	1
25	25	23	55	6	19	18	23
3	5	0	2	0	1	1	0
25	29	19	25	19	12	27	27
4	5	0	7	0	0	0	0
21	20	26	42	3	3	9	10
1	5	5	6	3	4	7	4
5.0	5.1	4.0	6.8	4.0	4.8	5.0	5.3
5.0	6.1	6.0	5.0	4.0	4.2	6.2	6.3
9.1	7.9	5.6	7.6	4.7	3.9	6.2	9.8
12.6	10.8	8.6	11.4	5.0	5.7	10.6	11.8
7.95	7.47	6.05	7.70	4.43	4.65	7.00	8.30
7.2	5.3	10.3	10.2	5.0	5.7	10.5	9.2
7.1	6.5	12.6	12.4	4.9	5.4	10.6	11.1
5.2	5.0	7.5	8.3	8.7	5.0	5.0	7.4
5.8	5.8	14.8	14.5	13.8	8.5	10.3	7.9
6.1	6.5	6.8	10.4	10.9	5.0	8.0	10.1
14.0	13.6	15.0	14.8	14.6	14.8	14.8	15.0
7.8	10.1	13.9	13.9	14.1	14.3	12.6	11.6
15.0	15.0	15.0	15.0	15.0	15.0	14.4	15.0
8.52	8.52	11.98	12.44	10.88	9.21	10.76	10.91
3.3	5.0	5.0	4.6	4.8	5.0	5.0	5.0
5.0	5.0	4.9	5.8	5.0	5.0	5.0	5.0
3.5	4.8	6.0	7.5	5.0	5.0	5.0	5.0
5.0	5.0	5.0	7.1	5.0	5.0	5.2	6.3
3.4	4.7	8.4	13.4	9.1	10.4	7.5	7.0
12.3	10.7	12.9	13.8	13.3	11.4	12.9	11.8
5.41	5.86	6.20	8.70	5.36	5.30	6.96	6.68
7.36	7.55	8.73	9.86	7.60	7.45	8.66	8.92
25.5	23	30	32	13.5	15	19	14.0
21	21	31	29	9	15	13	18.5
23	23	33	31	9	6	22	25
12	12	16	18	11	13	12	10
12	12	11	12	5	14	11	12
10	11	15	15	11	8	10	14
4	1	5	6	3	3	3	2
4	4	4	4	1	4	3	3
4	5	5	4	4	3	3	4

TABLE 21 contd.

26		28		29	
1	2	1	2	1	2
2	1	1	0	1	1
14	6	28	21	20	29
0	1	0	0	0	0
6	14	29	40	8	10
0	0	0	0	0	0
1	1	0	1	1	1
5	6	5	5	6	6
5.0	4.5	5.0	4.0	5.0	4.1
5.0	5.8	5.0	4.9	4.8	4.3
5.8	5.2	4.9	4.6	3.0	5.0
4.7	6.6	4.4	4.7	3.0	4.0
5.12	5.52	4.83	4.55	3.95	4.35
6.6	6.7	9.1	7.2	7.4	10.0
5.9	9.0	11.1	9.6	9.1	11.5
5.0	6.6	6.0	6.9	9.2	8.6
9.1	10.4	7.9	10.2	10.3	12.3
7.6	10.5	9.1	8.3	10.6	11.3
14.1	14.6	14.0	15.0	11.5	14.8
11.0	13.1	8.7	10.8	12.6	12.6
14.4	15.0	14.8	15.0	11.7	15.0
9.2	10.73	10.09	10.38	10.30	12.01
4.0	4.9	5.0	5.0	5.1	5.0
4.8	5.0	5.0	5.0	5.0	5.0
4.7	5.0	5.0	5.2	5.0	4.9
4.8	5.1	5.0	4.9	6.0	5.2
4.7	6.8	6.2	11.1	9.0	9.0
4.9	9.7	11.1	10.8	11.4	12.9
4.64	6.08	6.22	7.00	6.92	7.0
6.95	8.02	7.03	7.91	7.76	8.64
21	28	13	8.5	10	18
7	22	7	14	7.5	17.5
12	22	3	2	6	4
13	11	14	10	7	11
10	11.5	10	12	9	11
9	10	11	12	8	18
3	3	5	3	1	2
2	2	2	3	3	3
4	2	4	3	3	6

TABLE 21 contd.

30		33		40		42	
1	2	1	2	1	2	1	2
2	0	4	5	4	4	3	2
21	10	54	61	62	56	29	48
1	0	1	3	0	0	1	1
33	38	8	13	4	2	15	0
0	0	1	6	0	0	0	0
16	5	44	54	2	3	2	2
3	3	6	7	4	4	6	4
5.0	5.0	5.6	6.7	4.0	4.9	4.2	4.1
5.0	5.0	6.4	8.0	4.3	4.9	5.9	5.8
6.2	5.8	5.6	6.3	3.8	5.1	4.2	5.2
12.0	11.4	9.0	11.3	4.0	9.8	5.1	9.6
7.05	6.80	6.65	8.08	4.03	5.68	4.85	6.15
11.0	11.0	8.1	9.7	9.1	10.6	9.0	10.3
11.8	12.3	10.1	9.6	11.2	11.4	9.5	11.4
8.8	10.8	9.0	9.2	6.0	6.0	5.6	9.1
10.7	13.0	9.4	11.4	12.6	15.0	11.4	12.2
10.3	12.9	9.6	11.0	6.5	6.0	9.3	11.5
15.0	14.8	15.0	14.6	12.9	13.9	14.8	14.8
11.8	12.2	12.9	14.6	14.4	15.0	12.8	15.0
15.0	15.0	15.0	14.8	14.8	15.0	15.0	15.0
11.80	12.75	11.14	11.86	7.18	11.61	10.93	12.20
5.0	5.0	5.0	-	3.0	5.0	5.0	5.0
5.8	5.3	5.0	-	3.5	5.0	5.0	5.8
5.7	5.6	5.0	-	3.6	5.1	6.9	6.1
5.4	5.0	6.4	-	4.0	5.0	6.8	6.3
13.7	12.9	9.1	-	5.0	6.2	12.2	9.5
14.2	13.9	11.9	-	6.5	8.4	12.0	13.0
8.30	7.95	7.07	-	4.27	5.78	7.98	7.62
9.57	9.83	8.79	-	7.18	8.46	8.59	9.33
19.5	26	32	34	3	10	6	24
23	32	30	33	6.5	10	10	9.5
15	25	34	33	5	14.5	4	10.5
11	15	14	15	12	12	14	13
8	14	13	13	12	11	17	14
12	10	13	15	12	15	14	15
3	5	4	4	3	3	3	3
2	3	3	3	2	1	5	4
3	4	3	5	4	5	6	6

TABLE 21 contd.

44		45		46		48	
1	2	1	2	1	2	1	2
1	2	0	0	1	2	5	3
26	36	0	14	21	36	40	30
0	2	0	0	0	0	0	0
18	17	38	45	18	32	4	2
0	0	0	0	0	1	0	0
20	17	23	18	21	24	2	5
5	4	-	6	7	8	5	4
5.0	5.0	5.0	5.0	5.0	5.0	4.5	4.5
6.6	5.2	5.0	5.0	5.0	5.0	4.9	4.5
6.4	6.9	5.1	5.0	5.5	8.3	5.0	4.0
9.8	10.6	7.0	9.0	12.5	13.9	4.8	5.2
6.95	6.42	5.33	6.00	7.00	8.05	4.80	4.55
4.6	5.3	5.0	7.7	5.0	5.0	8.7	7.1
6.5	5.6	9.6	11.2	5.0	5.0	9.3	10.9
9.4	8.7	5.0	7.4	5.0	5.0	5.0	6.0
8.8	10.1	6.8	8.9	7.0	7.9	9.3	8.8
12.1	11.4	7.5	11.2	5.0	5.0	5.1	5.2
14.4	13.9	15.0	15.0	9.3	14.6	9.1	5.1
9.7	8.8	10.9	12.9	9.0	10.7	10.2	11.0
13.0	15.0	14.4	14.8	14.8	15.0	5.6	5.0
9.81	9.85	9.28	11.14	7.38	8.52	7.78	7.39
-	5.0	5.0	5.0	5.0	-	5.0	5.0
-	5.0	5.0	5.0	5.0	-	4.9	4.9
-	5.0	5.2	5.0	5.0	-	5.0	5.0
-	5.0	5.0	5.0	5.0	-	4.5	5.0
-	7.1	10.5	14.3	12.4	-	6.8	8.8
-	5.7	13.4	13.5	12.5	-	8.4	6.4
-	5.47	7.35	7.73	8.98	-	5.77	5.85
-	7.71	7.80	8.94	7.33	-	6.45	6.22
26	26.5	18	32	28	24	15	11
21.5	26	19	27	24	31	3.5	4.0
19	30	23.5	26	9	27	4.5	11.5
11	15	9	16	14	9	14	9
9	11	7	12	9	10	13	9
4	13	7	13	10	16	15	15
2	3	2	3	2	0	2	1
3	4	2	3	2	2	3	3
1	5	2	4	4	5	6	4

TABLE 22

Mean and Standard Deviations of Test Scores for Severe Aphasics in Experiment 2

Assessment	Initial Assessment			Final Assessment		
	n	Mean	S.D.	n	Mean	S.D.
Token test No. correct	18	1.89	1.41	18	1.94	2.15
Token test Weighted score	18	26.06	16.62	18	30.44	17.38
Object Naming	18	0.89	1.61	18	1.28	1.81
Progressive Matrices	18	17.44	10.95	18	21.00	13.20
Fluency	18	0.39	1.04	18	1.50	2.46
Picture Description	18	11.33	12.36	18	12.33	15.08
Self Rating	17	4.59	1.97	18	5.17	1.38
PICA I	18	4.76	0.80	17	4.94	0.92
IV	18	5.25	1.21	17	5.16	1.07
IX	18	5.44	1.76	17	5.85	1.77
XII	18	7.14	3.35	17	8.66	3.17
Verbal	18	5.64	1.53	17	6.09	1.52
II	18	7.98	2.29	17	8.19	2.07
III	18	9.19	2.53	17	9.68	2.51
V	18	7.09	2.40	17	7.50	1.74
VI	18	9.96	2.64	17	10.24	2.51
VII	18	8.62	2.52	17	9.11	2.61
VIII	18	13.72	1.87	17	14.01	2.34
X	18	11.52	2.37	17	12.09	1.99
XI	18	14.03	2.27	17	14.32	2.41
Gestural	18	9.90	1.98	17	10.64	1.52
A	17	4.73	0.65	15	4.97	0.10
B	17	4.92	0.43	15	5.10	0.33
C	17	5.06	0.78	15	5.27	0.70
D	17	5.31	0.81	15	5.32	0.67
E	17	8.07	2.91	15	9.21	2.85
F	17	11.04	2.60	15	10.93	2.52
Graphic	17	6.47	1.27	15	6.67	1.00
Overall	17	7.84	1.18	15	8.29	0.98
Ward S	18	17.64	9.54	18	20.92	8.72
C	18	12.56	2.26	18	12.94	2.65
C (4+5)	18	2.80	1.13	18	2.94	1.43
Physiotherapy S	18	15.72	8.70	18	20.61	8.49
C	18	10.78	3.57	18	12.53	2.07
C(4+5)	18	3.11	1.40	18	3.38	1.14
Occupational therapy S	18	14.44	10.22	18	19.22	10.07
C	18	10.89	3.39	18	13.22	2.84
C(4+5)	18	3.88	1.36	18	4.22	1.30

TABLE 23

Comparison of Initial and Final Test Scores using t tests for related data for Severe Aphasics in Experiment 2

Assessment		n*	t	p(two tailed)
PICA	II	17	1.07	N.S.
	III	17	1.76	N.S.
	V	17	1.91	N.S.
	VI	17	1.11	N.S.
	VII	17	1.35	N.S.
	VIII	17	0.80	N.S.
	X	17	2.98	$p<0.01$
	XI	17	1.50	N.S.
	Gestural	17	2.52	$p<0.05$
	A	14	1.61	N.S.
	B	14	1.42	N.S.
	C	14	1.40	N.S.
	D	14	0.98	N.S.
	E	14	2.73	$p<0.05$
	F	14	0.93	N.S.
	Graphic	14	2.44	$p<0.05$
	Overall	14	3.81	$p<0.01$
	Ward S	18	1.51	N.S.
	Ward C	18	0.51	N.S.
	Ward C(4+5)	18	0.16	N.S.
Physiotherapy	S	18	4.90	$p<0.001$
	C	18	2.10	N.S.
	C(4+5)	18	1.22	N.S.
Occupational Therapy	S	18	3.54	$p<0.01$
	C	18	2.80	$p<0.05$
	C(4+5)	18	0.80	N.S.

* missing data occurred due to patients refusing to complete some items and due to assessors having insufficient time to complete the graphics scale of the PICA

TABLE 24

Correlation between Change in Ability and Biographical Variables for Severe Aphasics in Experiment 2.

		Correlation between change in ability and					
Assessment	n	Age	p+	Months Post Onset	p+	Number of sessions speech therapy	p+
Token test No. correct	18	-0.19	N.S.	-0.35	N.S.	-0.08	N.S.
Token test Weighted score	18	-0.05	N.S.	-0.39	N.S.	0.22	N.S.
Object Naming	18	0.32	N.S.	-0.40	$p<0.05$	0.02	N.S.
Progressive Matrices	18	-0.54	$p<0.05$	-0.14	N.S.	0.07	N.S.
Fluency	18	-0.20	N.S.	0.18	N.S.	0.07	N.S.
Picture Description	18	-0.06	N.S.	-0.13	N.S.	0.23	N.S.
Self Rating	17	-0.07	N.S.	-0.43	$p<0.05$	0.16	N.S.
PICA I	17	-0.15	N.S.	-0.25	N.S.	0.01	N.S.
IV	17	0.10	N.S.	-0.15	N.S.	0.04	N.S.
IX	17	-0.04	N.S.	-0.16	N.S.	0.22	N.S.
XII	17	0.15	N.S.	-0.37	N.S.	0.12	N.S.
Verbal	17	-0.06	N.S.	-0.38	N.S.	0.22	N.S.
II	17	0.24	N.S.	-0.28	N.S.	0.26	N.S.
III	17	0.16	N.S.	-0.12	N.S.	0.12	N.S.
V	17	-0.22	N.S.	0.24	N.S.	-0.46	$p<0.05$
VI	17	0.16	N.S.	0.05	N.S.	-0.06	N.S.
VII	17	-0.06	N.S.	0.14	N.S.	-0.22	N.S.
VIII	17	-0.05	N.S.	-0.46	$p<0.05$	0.50	$p<0.05$
X	17	-0.16	N.S.	-0.17	N.S.	0.10	N.S.
XI	17	0.48	$p<0.05$	-0.04	N.S.	0.41	$p<0.05$
Gestural	17	0.27	N.S.	-0.20	N.S.	0.07	N.S.
A	14	0.59	$p<0.05$	-0.12	N.S.	-0.02	N.S.
B	14	0.46	$p<0.05$	-0.04	N.S.	0.04	N.S.
C	14	0.26	N.S.	-0.25	N.S.	0.19	N.S.
D	14	-0.25	N.S.	0.16	N.S.	-0.05	N.S.
E	14	-0.55	$p<0.05$	-0.16	N.S.	0.31	N.S.
F	14	0.11	N.S.	-0.49	$p<0.05$	0.22	N.S.
Graphic	14	0.07	N.S.	-0.25	N.S.	0.29	N.S.
Overall	14	0.09	N.S.	-0.40	N.S.	0.10	N.S.
Ward S	18	0.11	N.S.	-0.17	N.S.	0.15	N.S.
C	18	0.20	N.S.	0.10	N.S.	0.14	N.S.
C(4+5)	18	-0.01	N.S.	0.01	N.S.	-0.05	N.S.
Physiotherapy S	18	-0.09	N.S.	0.07	N.S.	0.31	N.S.
C	18	-0.22	N.S.	-0.01	N.S.	0.14	N.S.
C (4+5)	18	-0.24	N.S.	0.14	N.S.	0.09	N.S.
Occupational therapy S	18	-0.12	N.S.	0.16	N.S.	-0.37	N.S.
C	18	0.67	N.S.	0.01	N.S.	0.26	N.S.
C(4+5)	18	0.41	N.S.	0.24	N.S.	0.05	N.S.

+ Significance tests are two-tailed.

TABLE 25

Comparison of Patients receiving more speech therapy with those receiving less speech therapy for Severe Aphasics in Experiment 2

Assessment	Initial Assessment n	t	p	Final Assessment n	t	p
Token test no. correct	18	1.76	N.S.	18	0.98	N.S.
Token test weighted score	18	1.62	N.S.	18	0.72	N.S.
Object Naming	18	1.53	N.S.	18	1.61	N.S.
Progressive matrices	18	-0.59	N.S.	18	-0.92	N.S.
Fluency	18	1.67	N.S.	18	0.28	N.S.
Picture description	18	0.52	N.S.	18	0.18	N.S.
Self Rating	17	-0.07	N.S.	18	-0.84	N.S.
PICA I	18	0.82	N.S.	17	-0.32	N.S.
IV	18	1.71	N.S.	17	-0.16	N.S.
IX	18	1.83	N.S.	17	-0.23	N.S.
XII	18	1.64	N.S.	17	0.72	N.S.
Verbal	18	1.95	N.S.	17	0.68	N.S.
II	18	0.87	N.S.	17	0.42	N.S.
III	18	0.36	N.S.	17	0.29	N.S.
V	18	0.81	N.S.	17	1.68	N.S.
VI	18	-0.34	N.S.	17	-0.79	N.S.
VII	18	0.51	N.S.	17	0.97	N.S.
VIII	18	0.75	N.S.	17	-1.31	N.S.
X	18	-0.77	N.S.	17	-1.86	N.S.
XI	18	-0.71	N.S.	17	-1.08	N.S.
Gestural	18	0.37	N.S.	17	-0.32	N.S.
A	17	0.49	N.S.	15	1.26	N.S.
B	17	1.25	N.S.	15	0.77	N.S.
C	17	0.71	N.S.	15	-0.29	N.S.
D	17	1.85	N.S.	15	0.19	N.S.
E	17	0.36	N.S.	15	-0.76	N.S.
F	17	1.01	N.S.	15	-0.84	N.S.
Graphic	17	1.10	N.S.	15	-0.08	N.S.
Overall	17	0.94	N.S.	15	-0.36	N.S.
Ward S	18	1.05	N.S.	18	-0.73	N.S.
C	18	0.41	N.S.	18	0.08	N.S.
C(4+5)	18	0.40	N.S.	18	-0.15	N.S.
Physiotherapy S	18	0.72	N.S.	18	0.08	N.S.
C	18	1.06	N.S.	18	0.96	N.S.
C(4+5)	18	-1.37	N.S.	18	1.49	N.S.
Occupational therapy S	18	0.47	N.S.	18	0.81	N.S.
C	18	0.00	N.S.	18	-0.52	N.S.
C(4+5)	18	0.33	N.S.	18	0.35	N.S.

TABLE 26

Intercorrelations between Different Measures of Ability for Severe Aphasics in Experiment 2.

n = 18

Assessment	Occasion	Token Test No.Correct r	p+	Token Test Weighted Score r	p+	Object Naming r	p+
PICA I	1	0.25	N.S.	0.24	N.S.	0.60	$p<0.01$
	2	0.58	$p<0.05$	0.41	N.S.	0.51	$p<0.05$
IV	1	0.33	N.S.	0.38	N.S.	0.51	$p<0.05$
	2	0.48	N.S.	0.40	N.S.	0.51	$p<0.05$
IX	1	0.19	N.S.	0.18	N.S.	0.69	$p<0.001$
	2	0.24	N.S.	0.23	N.S.	0.35	N.S.
XII	1	0.01	N.S.	0.01	N.S.	0.25	N.S.
	2	0.40	N.S.	0.40	N.S.	0.32	N.S.
Verbal	1	0.17	N.S.	0.17	N.S.	0.52	$p<0.05$
	2	0.42	N.S.	0.37	N.S.	0.43	N.S.
II	1	0.45	N.S.	0.37	N.S.	0.51	$p<0.05$
	2	0.25	N.S.	0.29	N.S.	-0.26	N.S.
III	1	0.28	N.S.	0.36	N.S.	0.38	N.S.
	2	0.11	N.S.	0.07	N.S.	-0.38	N.S.
V	1	0.06	N.S.	0.30	N.S.	0.56	$p<0.05$
	2	0.00	N.S.	0.05	N.S.	-0.10	N.S.
VI	1	0.27	N.S.	0.28	N.S.	0.20	N.S.
	2	0.48	N.S.	0.52	$p<0.05$	-0.23	N.S.
VII	1	-0.07	N.S.	0.00	N.S.	0.49	$p<0.05$
	2	-0.10	N.S.	-0.07	N.S.	-0.01	N.S.
VIII	1	-0.25	N.S.	-0.13	N.S.	0.28	N.S.
	2	-0.27	N.S.	-0.05	N.S.	0.09	N.S.
X	1	0.34	N.S.	0.22	N.S.	0.28	N.S.
	2	0.41	N.S.	0.36	N.S.	0.00	N.S.
XI	1	-0.42	N.S.	-0.13	N.S.	0.23	N.S.
	2	-0.22	N.S.	0.01	N.S.	0.18	N.S.
Gestural	1	0.05	N.S.	-0.03	N.S.	0.54	$p<0.05$
	2	0.12	N.S.	0.22	N.S.	-0.13	N.S.
A	1	-0.27	N.S.	-0.28	N.S.	0.02	N.S.
	2	-0.50	N.S.	-0.40	N.S.	-0.21	N.S.
B	1	-0.27	N.S.	-0.48	N.S.	0.19	N.S.
	2	0.31	N.S.	0.55	$p<0.05$	0.00	N.S.
C	1	-0.09	N.S.	-0.16	N.S.	0.02	N.S.
	2	0.49	N.S.	0.57	$p<0.05$	0.08	N.S.
D	1	0.13	N.S.	0.21	N.S.	0.54	$p<0.05$
	2	0.47	N.S.	0.55	$p<0.05$	0.09	N.S.
E	1	-0.16	N.S.	-0.20	N.S.	-0.28	N.S.
	2	-0.21	N.S.	-0.06	N.S.	-0.44	N.S.
F	1	-0.33	N.S.	-0.25	N.S.	0.08	N.S.
	2	-0.35	N.S.	-0.13	N.S.	-0.09	N.S.
Graphic	1	-0.17	N.S.	-0.13	N.S.	0.02	N.S.
	2	0.00	N.S.	0.14	N.S.	-0.22	N.S.
Overall	1	0.20	N.S.	0.16	N.S.	0.57	p 0.05
	2	0.06	N.S.	0.25	N.S.	-0.15	N.S.

+ Significance tests are two-tailed.

TABLE 26 contd.

Page 2

Assessment	Occasion	Progressive Matrices r	Progressive Matrices p+	Fluency r	Fluency p+	Picture Description r	Picture Description p+	Self Rating r	Self Rating p+
PICA I	1	0.12	N.S.	0.45	N.S.	0.25	N.S.	0.54	p<0.05
	2	0.22	N.S.	0.79	p<0.001	0.84	p<0.001	0.03	N.S.
IV	1	-0.02	N.S.	0.30	N.S.	0.28	N.S.	0.69	p<0.05
	2	0.11	N.S.	0.45	N.S.	0.60	p<0.05	0.05	N.S.
IX	1	0.19	N.S.	0.75	p<0.001	0.28	N.S.	0.13	N.S.
	2	0.37	N.S.	0.40	N.S.	0.50	p<0.05	0.06	N.S.
XII	1	0.40	N.S.	0.45	N.S.	0.63	p<0.01	0.16	N.S.
	2	0.36	N.S.	0.39	N.S.	0.60	p<0.01	0.02	N.S.
Verbal	1	0.27	N.S.	0.58	p<0.05	0.51	p<0.05	0.33	N.S.
	2	0.38	N.S.	0.54	p<0.05	0.70	p<0.01	0.07	N.S.
II	1	0.08	N.S.	0.10	N.S.	-0.11	N.S.	0.19	N.S.
	2	-0.13	N.S.	0.10	N.S.	0.00	N.S.	-0.16	N.S.
III	1	0.19	N.S.	-0.01	N.S.	0.05	N.S.	0.17	N.S.
	2	-0.04	N.S.	-0.01	N.S.	-0.12	N.S.	-0.15	N.S.
V	1	-0.15	N.S.	0.19	N.S.	0.06	N.S.	0.19	N.S.
	2	0.07	N.S.	0.04	N.S.	0.09	N.S.	-0.09	N.S.
VI	1	-0.26	N.S.	-0.17	N.S.	-0.20	N.S.	0.28	N.S.
	2	-0.25	N.S.	0.06	N.S.	0.08	N.S.	-0.14	N.S.
VII	1	0.13	N.S.	0.03	N.S.	-0.07	N.S.	0.18	N.S.
	2	0.25	N.S.	0.03	N.S.	0.12	N.S.	-0.05	N.S.
VIII	1	0.35	N.S.	0.15	N.S.	0.19	N.S.	-0.22	N.S.
	2	0.44	N.S.	0.12	N.S.	0.12	N.S.	0.20	N.S.
X	1	-0.10	N.S.	0.16	N.S.	-0.02	N.S.	0.37	N.S.
	2	-0.13	N.S.	0.24	N.S.	0.23	N.S.	-0.12	N.S.
XI	1	0.34	N.S.	0.17	N.S.	0.23	N.S.	-0.14	N.S.
	2	0.37	N.S.	0.13	N.S.	0.13	N.S.	0.19	N.S.
Gestural	1	0.30	N.S.	0.11	N.S.	0.16	N.S.	0.34	N.S.
	2	0.12	N.S.	0.13	N.S.	0.12	N.S.	-0.06	N.S.
A	1	-0.20	N.S.	-0.41	N.S.	0.07	N.S.	0.38	N.S.
	2	-0.03	N.S.	-0.68	p<0.01	-0.74	p<0.01	-0.36	N.S.
B	1	0.19	N.S.	0.08	N.S.	0.26	N.S.	0.04	N.S.
	2	-0.06	N.S.	0.19	N.S.	0.31	N.S.	0.13	N.S.
C	1	0.52	p<0.05	-0.40	N.S.	-0.01	N.S.	0.40	N.S.
	2	0.10	N.S.	0.53	p<0.05	0.61	p<0.05	0.08	N.S.
D	1	0.12	N.S.	0.25	N.S.	0.12	N.S.	0.44	N.S.
	2	0.03	N.S.	0.47	N.S.	0.56	p<0.05	0.05	N.S.
E	1	-0.10	N.S.	-0.42	N.S.	0.26	N.S.	0.33	N.S.
	2	0.40	N.S.	-0.03	N.S.	0.22	N.S.	0.22	N.S.
F	1	0.25	N.S.	0.16	N.S.	0.43	N.S.	0.12	N.S.
	2	0.52	p<0.05	0.24	N.S.	0.19	N.S.	0.22	N.S.
Graphic	1	0.54	p<0.05	-0.13	N.S.	0.34	N.S.	0.45	N.S.
	2	0.47	N.S.	0.26	N.S.	0.37	N.S.	0.28	N.S.
Overall	1	0.28	N.S.	0.20	N.S.	0.33	N.S.	0.45	N.S.
	2	0.40	N.S.	0.16	N.S.	0.32	N.S.	0.02	N.S.

+ Significance tests are two tailed

TABLE 27

Characteristics of Severe Aphasics in Experiment 3

n = 12

Pat. No.	Age	Months Post Onset	Adm. date	Sex	Side hemi.	Speech Therapy Interval 1 (No. of sessions)	Speech Therapy 2 (No. of sessions)	Speech Therapist	Treatment and no. of sessions. Interval 1	Treatment and no. of sessions. 2
69	66	1	3.3.76	M	R	8	8	1	NS 8	Op 8
81	49	12	24.5.76	M	R	9	10	1	Op 8	NS 8
83	52	1	7.6.76	M	R	11	11	3	Op 8	NS 8
89	49	4	9.8.76	M	R	11	11	3	NS 8	Op 8
91	62	2	23.8.76	M	R	6	11	1	NS 8	Op 8
95	55	11	20.9.76	M	R	9	8	1	Op 8	NS 7
103	49	1	29.11.76	M	R	8	8	1	NS 7	Op 7
113	62	5	7.3.77	F	R	5	10	3	Op 8	NS 8
118	32	1	8.5.77	F	R	14	14	1	Op 8	NS 8
120	63	2	17.5.77	F	R	12	9	1	NS 8	Op 8
126	64	3	5.7.77	M	R	8	5	3	Op 8	NS 8
130	26	7	25.7.77	M	R	11	11	3	NS 8	Op 8
Mean	52.43	4.17				9.33	9.66		7.91	7.83
S.D.	12.69	3.90				2.57	2.26		0.28	0.38

TABLE 28 PAGE 1

Operant Training summary for Severe Aphasics in Experiment 3

n = 12

Task	Score	69	81	83	89	91	95
		Patient number					
Training	Errors/no attempts	3/30	0/12	14/36	1/12	0/6	0/6
	No.sessions	2	1	2	1	1	1
Letter-letter matching	Errors/no attempts	1/48	0/18	0/36	-	-	-
	No.sessions	3	2	2	-	-	-
Letter-pairs	Errors/no attempts	7/36	-	-	-	-	-
	No.Sessions	2	-	-	-	-	-
Pointing to Picture	Errors/no.attempts	37/188	54/264	43/60	-	-	-
	No. sessions	6	8	4	-	-	-
Picture to Picture	Errors/No attempts	-	-	9/80	-	-	-
	No. sessions	-	-	5	-	-	-
Picture to Picture + Name	Errors/no attempts	-	-	16/90	-	2/36	-
	No. sessions	-	-	3	-	3	-
Name - Name	Errors/no attempts	20/84	9/72	3/120	4/84	1/66	0/6
	No. sessions	4	6	5	6	5	
Name-Picture + name	Errors/No attemps	-	-	4/30	-	2/24	-
	No. sessions	-	-	3	-	2	-
Spoken Name-Pictures	Errors/no attempts	5/6	77/150	5/6	24/114	33/234	-
	No sessions	1	6	1	8	8	-
Named Pictures - Names	Errors/No attempts	35/54	57/114	-	31/180	20/114	0/6
	No. sessions	3	5	-	7	6	1
Silent Name-Picture	Errors/No. attempts	-	-	-	7/42	-	5/22
	No. Sessions	-	-	-	2	-	2
Silent Picture - Name	Errors/no attempts	-	-	-	-	-	4/78
	No sessions	-	-	-	-	-	3
Picture - Phrase	Errors/no attempts	-	-	-	-	-	36/198
	No sessions	-	-	-	-	-	6
Phrase - Picture	Errors/no attempts	-	-	-	-	-	-
	No sessions	-	-	-	-	-	-
Relations	Errors/no attempts	-	-	-	-	-	1/30
	No sessions	-	-	-	-	-	1
Repetition	Errors/no attempts	-	27/48	-	28/42	-	34/156
	No sessions	-	2	-	2	-	6
Sentence Completion	Errors/No attempts	-	-	-	-	-	31/84
	No sessions	-	-	-	-	-	4

TABLE 28 PAGE 2

Task	Score	Patient Number 69	81	83	89	91	95
Naming	Errors/No attempts	-	-	-	-	3/12	-
	No sessions	-	-	-	-	2	-
Total	Errors	126	324	95	95	58	114
	No. attempts	418	678	434	474	482	600
	% Errors	30	48	22	20	12	19

- indicates tasks not given because patient did not reach that level or task was too easy initially.

TABLE 28 contd. PAGE 3

Operant Training summary for Severe Aphasics in Experiment 3

n = 12

Task	Score	Patient number 103	113	118	120	126	130
Training	Errors/no•attempts	6/24	2/12	0/6	2/12	0/6	0/6
	No. sessions	2	1	1	1	1	1
Letter-letter matching	Errors/no.attempts	0/12	0/6	-	0/12	-	-
	No. sessions	1	1	-	1	-	-
Letter-pairs	Errors/No.attempts	-	-	-	-	-	-
	No. sessions	-	-	-	-	-	-
Picture to Picture	Errors/No.attempts	3/30	20/60	-	25/72	-	-
	No. sessions	2	4	-	3	-	-
Picture to Picture + Name	Errors/no.attempts	1/18	2/8	0/6	17/20	0/6	-
	No. sessions	2	1	1	6	1	-
Name-Name	Errors/no.attempts	6/66	5/66	0/6	3/78	6/72	-
	No. sessions	5	5	1	5	3	-
Name-Picture + Name	Errors/no.attempts	2/72	1/12	-	1/42	1/18	1/12
	No. sessions	3	1	-	4	2	1
Spoken name - Pictures	Errors/no. attempts	40/246	33/114	1/30	28/66	29/228	0/6
	No. sessions	7	7	1	4	8	1
Named Pictures - Names	Errors/no. attempts	35/174	33/114	1/30	28/66	29/228	0/6
	No. sessions	5	5	3	1	7	-
Silent name - Picture	Errors/no. attempts	-	-	5/12	-	-	8/12
	No. sessions	-	-	1	-	-	2
Silent Picture-Name	Errors/no.attempts	-	-	12/102	-	7/30	9/138
	No. sessions	-	-	3	-	1	2
Picture-Phrase	Errors/no.attempts	-	-	10/108	-	-	34/420
	No.sessions	-	-	4	-	-	7
Phrase - Picture	Errors/no.attempts	-	-	7/48	-	-	-
	No.sessions	-	-	3	-	-	-
Relations	Errors/no.attempts	-	-	4/24	-	-	25/126
	No. sessions	-	-	2	-	3	3
Repetition	Errors/no.attempts	-	-	2/54	-	-	-
	No. sessions	-	-	5	-	-	-
Sentence Completion	Errors/no.attempts	-	-	-	-	-	-
	No. sessions	-	-	-	-	-	-
Naming	Errors/no.attempts	-	-	-	-	-	-
	No. sessions	-	-	-	-	-	-
Total	Errors	103	85	58	82	93	78
	No.attempts	644	390	540	414	594	834
	% Errors	16	22	11	20	15	9

- indicates task not given because patient did not reach that level or task was too easy initially

TABLE 29

Non-Specific Treatment Summary for Severe Aphasics in Experiment 3

n = 12

The number of sessions that included an activity is recorded.

Activity	Patient number 69	81	83	89	91	95	103	113	118	120	126	130
Colour Matching	✓	2	2	1	2	1	2	1	1	-	1	-
Shape Matching	✓	2	2	1	2	1	2	1	1	-	1	-
Letter Matching	✓	1	-	2	1	1	2	2	1	-	1	2
Sorting Colour	-	3	3	3	2	2	3	3	1	-	2	5
Sorting Shape	-	3	3	3	2	2	3	4	1	-	3	5
Sorting Number	-	3	2	2	2	2	-	2	1	-	1	5
Copying Shapes	✓	-	1	-	-	-	-	-	-	-	-	1
Copying complex figures	✓	2	-	1	1	2	-	1	2	3	1	2
Copy Benton VRT	✓	2	3	1	-	-	1	-	2	1	-	-
Memory Benton VRT	✓	1	3	2	3	4	-	3	3	4	2	4
Corsi Blocks	-	2	-	1	1	1	-	1	-	-	1	1
Williams Delayed Recall	-	-	-	-	-	-	-	-	-	-	-	1
Warrington Retention	-	1	-	2	1	1	-	-	-	-	-	-
WAIS Block Design	✓	4	6	5	4	2	6	7	6	7	6	3
Picture Completion	-	1	-	2	-	1	-	2	1	1	-	1
Picture Arrangement	-	-	-	1	2	1	-	-	1	1	-	1
Object Assembly	-	1	-	2	2	1	1	3	3	2	1	1
Mosaic Easy	✓	1	1	-	1	-	-	-	-	-	-	-
Mosaic Hard	-	1	-	-	-	-	-	-	-	-	-	-
Crawford Dexterity	✓	1	1	1	1	1	-	1	1	1	-	2
Cube counting	-	-	-	-	-	1	-	-	1	-	-	1
Gollen pictures	-	-	-	-	-	1	-	-	-	-	-	-

✓ record of sessions missing but activity included
- activity not included for the particular patient.

TABLE 30

Test Scores of Severe Aphasics in Experiment 3

n = 12

Assessment	Patient	69			81		
	Treatment		NS	Op.		Op.	NS
	Assessment	1	2	3	1	2	3
Token test No. correct		1	0	2	0	0	0
Token test Weighted score		28	37	28	34	28	29
Object Naming No.correct		0	0	0	0	0	0
Progressive Matrices Score		1	13	15	13	17	16
Peabody PVT Score		32	43	42	30	43	41
Eisenson Colours		8.6	12.0	11.2	6.0	6.2	8.2
Shapes		7.8	9.5	15.0	7.75	8.5	7.25
Pictures		9.2	11.2	10.0	9.95	12.5	12.25
Self Rating		6	6	4	6	6	5
PICA I		4.0	4.0	3.9	5.0	5.0	5.0
IV		3.9	4.0	4.4	5.0	4.9	5.1
IX		3.8	4.0	4.3	5.2	5.4	4.7
XII		4.0	3.9	4.3	4.9	6.7	6.5
Verbal		3.93	3.98	4.23	5.03	5.50	5.33
II		7.6	6.4	7.3	10.0	11.0	11.7
III		8.5	7.5	8.9	11.5	13.4	12.0
V		5.6	7.7	6.6	5.0	5.0	7.0
VI		8.8	7.7	9.3	12.6	13.4	13.7
VII		5.0	7.2	8.5	5.0	5.9	6.0
VIII		11.8	14.4	13.3	15.0	15.0	15.0
X		11.4	9.5	12.3	9.8	14.0	14.2
XI		13.2	14.4	15.0	15.0	15.0	15.0
Gestural		8.99	9.35	10.15	10.49	11.49	11.83
A		5.0	5.0	5.0	5.0	5.0	5.0
B		5.0	5.0	5.0	5.0	5.0	5.0
C		5.0	5.0	5.0	5.0	5.0	5.0
D		5.0	5.0	5.0	4.9	5.0	5.0
E		5.0	6.4	10.0	7.1	10.8	8.3
F		8.1	12.5	13.8	12.4	13.3	14.4
Graphic		5.52	6.48	7.30	6.57	7.35	7.12
Overall		6.71	7.20	7.88	7.97	8.82	8.81
Ward S		3	10	18	28	31	32
Physiotherapy S		6	3	6	7	23	28
Occupational therapy S		6	8	12	15	16	29
Ward C		9	10	12	16	17	15
Physiotherapy C		7	15	14	12	16	17
Occupational therapy C		10	6	8	12	15	17
Ward C (4+5)		0	0	2	4	5	3
Physiotherapy (4+5)		0	5	4	4	5	5
Occupational therapy (4+5)		3	3	4	6	4	5

TABLE 30
Page 2

Patient	83			89			91		
Treatment	Op		NS	NS		Op		NS	Op
Assessment	1	2	3	1	2	3	1	2	3
	1	0	0	0	0	0	0	1	0
	30	19	28	11	3	0	4	15	16
	0	0	0	0	0	0	0	0	0
	0	6	1	12	31	33	28	35	40
	14	19	27	40	45	33	42	44	44
	6.2	7.8	6.2	7.6	-	5.2	7.4	9.8	10.6
	6.0	6.8	6.0	7.75	-	5.5	8.75	13.0	9.5
	7.5	6.5	6.0	11.25	-	14.5	13.5	15.0	14.5
	-	-	-	6	4	7	6	5	5
	2.0	3.0	5.0	3.2	3.5	5.0	5.0	5.0	5.0
	3.0	3.0	5.0	5.0	4.7	5.0	5.0	5.0	5.1
	2.9	2.1	4.7	3.5	5.2	4.8	6.7	5.9	6.8
	3.3	3.0	4.7	4.7	6.5	8.3	7.3	10.6	10.9
	2.80	2.78	4.85	4.10	4.98	5.78	6.0	6.63	6.95
	5.5	3.4	5.0	7.2	9.4	5.0	10.3	11.5	11.6
	5.7	3.3	9.1	11.4	9.5	5.8	11.8	13.3	12.6
	6.0	6.0	5.0	7.2	8.0	8.2	7.1	10.0	9.8
	5.9	5.4	5.0	8.7	10.5	10.5	10.8	12.2	11.1
	6.0	5.9	5.0	9.2	8.4	10.5	7.6	9.7	10.0
	12.5	13.0	13.6	15.0	15.0	15.0	14.8	15.0	15.0
	4.5	5.2	5.0	9.9	12.7	9.6	13.0	11.7	10.2
	8.5	12.9	14.4	12.7	14.4	15.0	14.2	15.0	15.0
	6.83	6.89	7.76	10.29	10.99	9.95	11.20	12.30	11.91
	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	5.0	5.0	5.0	4.7	5.0	5.0	5.0	5.0	5.1
	5.0	5.0	5.0	5.0	4.7	5.0	5.0	5.1	5.1
	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	5.0	7.8	5.0	11.3	12.1	5.0	5.0	12.1	11.4
	12.1	9.6	5.0	12.7	12.7	13.5	11.0	13.3	13.6
	6.18	6.23	5.0	7.50	7.28	7.60	6.00	7.58	7.53
	5.72	5.76	6.19	7.98	8.42	8.24	8.31	9.47	9.35
	6	8	6	5	3	10	14	25	8
	3	0	3	0	5	5	16	12	20
	1	1	0	2	1	1	5	4	6
	11	12	12	11	10	12	12	16	11
	9	7	6	6	9	7	13	9	13
	9	4	12	6	9	8	9	9	14
	3	4	3	3	3	2	2	4	3
	2	0	1	1	2	2	2	2	3
	3	3	3	0	3	3	3	3	4

TABLE 30
Page 3

Patient	95			103			113		
Treatment		Op	NS		NS	Op		Op	NS
Assessment	1	2	3	1	2	3	1	2	3
	10	12	7	1	1	4	0	0	0
	71	79	66	35	54	50	22	32	27
	0	1	0	0	1	4	0	0	0
	43	40	40	0	2	3	9	10	12
	50	50	49	20	24	37	36	38	41
	14.6	15.0	15.0	11.6	10.6	14.2	11.5	6.0	6.0
	14.5	15.0	15.0	6.0	6.0	10.0	10.0	6.0	9.5
	15.0	15.0	14.0	11.75	12.75	14.5	15.0	10.0	6.0
	5	3	5	5	3	5	6	6	8
	3.0	3.0	3.0	3.0	4.9	5.3	5.0	5.0	5.0
	4.0	5.1	4.9	3.0	5.3	7.0	4.7	3.0	5.0
	4.7	8.2	8.0	3.6	8.1	9.1	3.8	3.0	3.0
	9.3	10.2	10.3	3.0	12.4	14.5	3.0	3.2	3.0
	5.25	6.63	6.55	3.15	7.68	8.98	4.13	3.55	4.00
	13.7	10.8	11.2	4.3	8.3	7.6	5.0	8.1	5.0
	14.1	13.3	12.8	6.6	8.3	9.5	8.7	9.2	9.1
	9.1	9.1	9.3	4.0	6.0	7.4	11.4	9.1	9.9
	13.5	14.6	12.1	7.8	11.0	12.0	11.6	11.8	10.4
	7.4	10.0	11.7	3.0	6.0	10.1	11.2	8.1	9.6
	15.0	15.0	15.0	9.8	14.8	14.8	14.8	15.0	15.0
	15.0	14.6	14.6	8.1	12.6	14.2	12.1	9.4	10.4
	15.0	15.0	15.0	11.5	13.5	15.0	14.2	14.4	15.0
	12.85	12.80	12.71	6.89	10.06	11.32	11.13	10.64	10.55
	4.6	4.0	4.4	5.0	5.0	5.0	5.0	5.0	5.0
	5.0	4.8	5.2	5.0	4.9	5.6	5.0	5.0	5.0
	7.3	7.5	8.4	4.9	5.0	7.8	5.0	5.0	5.0
	10.8	7.5	10.1	5.0	8.0	8.6	5.0	5.0	5.0
	10.2	8.3	10.2	6.5	12.5	12.4	11.1	12.8	11.1
	13.6	14.2	13.5	8.9	12.0	11.5	13.4	12.9	12.7
	8.58	7.72	8.63	5.87	7.90	8.48	7.42	7.62	7.30
	9.74	9.74	9.98	5.72	8.81	9.85	8.33	8.06	8.01
	9	9	7	13	19	25	6	8	9
	0	15	10	3	18	23	0	0	0
	6	5	13	1	3	27	0	0	0
	10	10	10	17	15	15	12	13	14
	15	19	16	16	11	11	8	8	10
	17	13	14	7	6	11	8	9	9
	3	3	2	5	3	4	4	4	5
	3	4	3	5	4	4	2	3	3
	4	2	3	2	2	4	3	3	3

TABLE 30
Page 4

Patient	118			120			126		
Treatment	Op		NS		NS	Op		Op	NS
Assessment	1	2	3	1	2	3	1	2	3
	0	1	1	1	1	1	1	0	0
	8	31	25	21	28	34	28	32	32
	0	0	0	0	0	0	0	4	6
	26	35	42	21	22	26	15	16	19
	39	46	49	31	25	31	34	42	46
	9.2	10.2	13.8	9.4	6.0	9.2	6.0	10.6	9.0
	7.0	10.5	15.0	6.0	9.5	10.0	7.75	6.0	12.25
	13.25	14.5	15.0	12.0	9.5	10.0	15.0	14.5	15.0
	7	8	7	8	7	7	4	5	4
	3.0	3.2	3.0	4.4	4.0	5.1	4.9	5.0	5.3
	3.0	3.1	5.0	4.0	4.2	5.0	5.0	9.4	8.0
	3.0	3.5	5.6	4.5	4.3	6.2	5.9	5.8	7.3
	3.0	3.9	4.6	3.9	5.3	9.9	13.3	14.3	13.7
	3.00	3.43	4.55	4.20	4.45	6.55	7.28	8.63	8.56
	8.5	9.5	11.5	6.6	6.6	6.9	9.2	10.6	10.1
	10.8	10.0	11.0	6.6	8.0	10.9	9.9	11.7	11.4
	11.7	10.6	11.4	5.0	6.0	5.0	7.9	7.9	8.9
	14.0	14.8	14.2	7.0	7.4	9.8	10.9	12.3	13.2
	11.0	12.0	11.0	6.0	8.3	8.2	11.2	9.6	11.0
	15.0	15.0	15.0	14.0	14.3	15.0	14.6	15.0	15.0
	8.8	12.0	14.4	8.8	9.9	12.5	12.9	13.6	13.5
	15.0	15.0	15.0	14.8	14.8	15.0	14.4	14.8	15.0
	11.85	12.36	12.94	8.60	9.41	10.41	11.38	11.94	12.26
	5.0	5.0	5.0	4.7	4.5	5.0	5.0	5.0	5.0
	5.0	5.1	5.0	5.0	4.7	5.0	5.0	5.0	5.0
	5.0	5.0	7.5	5.0	5.0	5.8	5.0	5.0	5.0
	5.0	5.0	8.5	5.0	4.5	5.1	4.6	5.9	5.0
	11.6	11.8	13.6	5.2	7.9	10.3	8.9	10.1	11.4
	12.9	13.2	14.1	12.0	14.3	13.3	11.5	11.2	12.4
	7.42	7.52	8.95	6.15	6.82	7.42	6.67	7.03	7.30
	8.41	8.76	9.74	6.81	7.44	8.56	8.89	9.57	9.79
	2	15	14	21	24	19	28	18	20
	0	20	18	21	27	24	17	18	21
	0	11	6	-	-	-	20	29	28
	13	16	12	12	11	12	15	10	8
	12	13	11	11	13	14	9	8	9
	11	10	12	-	-	-	13	13	12
	3	4	2	4	3	2	4	2	1
	2	3	2	-	-	-	3	2	2
	2	3	3	-	-	-	3	4	4

TABLE 30
Page 5

Patient	130		
Treatment	NS		Op.
Assessment	1	2	3
	0	0	0
	20	29	20
	1	2	0
	28	35	41
	48	48	49
	11.4	10.4	10.6
	9.25	10.5	11.25
	15.0	15.0	12.75
	7	8	7
	4.8	5.0	5.2
	5.0	5.2	5.1
	4.9	5.2	5.2
	5.5	8.4	7.8
	5.05	5.95	5.82
	12.5	10.9	12.3
	11.9	13.1	12.2
	11.7	11.3	11.3
	10.9	14.1	14.6
	11.1	11.9	12.7
	15.0	15.0	15.0
	13.8	13.0	14.4
	15.0	15.0	15.0
	12.74	13.04	13.44
	5.0	5.0	5.2
	8.3	9.3	8.2
	8.7	8.5	8.7
	8.0	7.7	8.0
	14.6	13.9	14.0
	13.9	14.6	14.0
	9.75	9.83	9.68
	9.88	10.39	10.49
	34	19	26
	8	28	29
	16	25	19
	14	12	12
	7	19	13
	9	11	13
	3	4	3
	1	5	3
	2	4	4

TABLE 31

Mean and Standard Deviations of Test Scores at each Assessment for Severe Aphasics in Experiment 3

n = 12

Assessment	Initial Assessment Mean	Initial Assessment S.D.	Second Assessment Mean	Second Assessment S.D.	Final Assessment Mean	Final Assessment S.D.
Token test No.correct	1.25	2.80	1.33	3.39	1.25	2.17
Token test Weighted score	26.00	17.33	32.25	19.21	29.58	16.38
Object Naming	0.08	0.28	0.67	1.23	0.83	1.99
Progressive Matrices	16.33	13.32	21.92	13.08	24.00	15.05
Peabody PVT	34.66	10.44	33.00	10.09	40.75	7.39
Eisenson Colours	9.12	2.70	9.50	2.80	9.93	3.26
Shapes	8.21	2.35	9.20	2.97	10.35	3.13
Pictures	12.32	2.58	12.40	2.82	12.04	3.32
Self Rating	6.00	1.10	5.55	1.75	5.81	1.40
PICA I	3.94	1.05	4.22	0.86	4.65	0.85
IV	4.21	0.84	4.74	1.70	5.38	1.02
IX	4.37	1.16	5.05	1.85	5.80	1.73
XII	5.43	3.13	7.36	3.80	8.20	3.75
Verbal	4.49	1.30	5.34	1.81	6.00	1.59
II	8.36	2.92	8.87	2.43	8.76	2.92
III	9.78	2.58	10.02	3.10	10.44	2.03
V	7.64	2.76	8.05	2.02	8.31	2.17
VI	10.20	2.57	11.26	3.03	11.32	2.64
VII	7.80	2.88	8.58	2.13	9.52	2.26
VIII	13.94	1.68	14.70	0.59	14.72	0.60
X	9.67	3.93	11.51	2.63	12.10	2.81
XI	13.62	1.95	14.51	0.67	14.95	0.17
Gestural	10.27	2.04	10.94	1.79	11.26	1.57
A	4.94	0.13	4.87	0.31	4.96	0.18
B	5.25	0.96	5.31	1.25	5.34	0.91
C	5.49	1.20	5.48	1.19	6.10	1.51
D	5.69	1.83	5.71	1.25	6.27	1.92
E	8.56	3.39	10.47	2.36	10.81	2.41
F	11.87	1.79	12.81	1.40	12.65	2.54
Graphic	6.96	1.23	7.44	0.90	7.69	1.17
Overall	7.87	1.38	8.53	1.27	8.90	1.20
Ward S	14.08	11.04	15.66	3.46	16.16	8.52
C	12.66	2.42	12.66	2.67	12.08	1.97
C (4+5)	3.16	1.26	3.25	1.28	2.66	1.07
Physiotherapy S	6.75	7.42	14.08	10.05	15.50	10.11
C	10.41	3.26	12.25	4.26	11.75	3.38
C (4+5)	12.50	1.56	3.33	1.61	3.00	1.12
Occupational Therapy S	6.54	7.16	9.36	9.97	12.81	11.37
C	10.09	3.08	9.54	3.35	11.81	2.75
C (4+5)	2.81	1.47	3.09	0.70	3.63	0.67

TABLE 32

Comparison of Treatment Groups for Severe Aphasics in Experiment 3.

n = 12

Assessment	Treatment Effect Difference	t	Interval Effect Difference	t	Inter-action+ Difference	t
Token test No. correct	0.83	1.13	-0.17	-0.23	0.67	1.79
Token test Weighted Score	-2.25	-0.52	-8.58	-1.99	1.58	0.59
Object Naming	0.25	0.64	-0.42	-1.07	-0.25	-0.41
Progressive Matrices	-1.5	-0.82	-3.50	-1.91	3.67	1.97
Peabody Score	0.92	0.34	-2.42	-0.91	-2.25	-1.10
Eisenson Colours	0.65	0.50	0.67	0.51	0.35	0.40
Shapes	-1.58	-1.15	0.49	0.36	0.50	0.69
Pictures	-0.16	-0.26	0.57	-0.91	0.61	0.59
Self Rating	0.48	0.57	0.68	0.80	-0.35	-1.08
PICA I	0.03	0.10	0.16	0.66	0.42	0.45
IV	0.00	0.00	0.12	0.17	-0.22	-0.56
XI	-0.40	-0.60	0.07	0.10	0.13	0.25
XII	-0.59	-0.73	-1.09	-1.35	1.78	2.21
Verbal	-0.24	-0.53	-0.19	-0.43	0.46	1.04
II	0.55	-0.51	-0.62	-0.57	-0.03	-0.06
III	-0.58	-0.63	0.13	0.14	-0.13	-0.17
V	-1.36	-3.21**	-0.16	-0.37	0.61	1.51
VI	0.25	0.44	-1.00	-1.77	1.10	2.46*
VII	-0.35	-0.52	0.17	0.25	1.30	2.12
VIII	-0.67	-1.41	-0.75	-1.58	0.50	1.25
X	0.15	0.16	-0.25	-0.27	-0.07	-0.08
XI	0.17	1.00	1.29	0.74	0.03	0.05
Gestural	-0.38	-1.52	-0.36	-1.42	0.41	1.12
A	-0.01	-0.08	0.16	1.56	0.06	1.83
B	-0.11	-0.49	-0.04	-0.19	0.06	1.05
C	0.10	0.34	0.63	2.17	0.02	0.05
D	-0.65	-1.00	0.53	0.82	0.03	0.08
E	0.04	0.03	-1.58	-1.29	1.31	1.87
F	0.98	-2.25*	-1.11	-2.56*	1.41	1.79
Graphic	-0.26	-0.86	-0.23	-0.75	0.48	1.72
Overall	-0.32	-1.43	-0.29	-1.31	0.46	1.49
Ward S	0.42	0.11	-1.08	-0.28	0.58	0.25
C	0.75	0.65	-0.58	-0.50	0.42	0.55
C (4+5)	0.50	0.83	-0.67	-1.11	0.33	0.82
Physiotherapy S	1.58	0.47	-5.92	-1.74	-0.08	-0.03
C	1.00	-0.48	-2.33	-1.12	0.67	0.63
C (4+5)	0.83	-1.08	-1.17	-1.51	0.50	1.17
Occupational Therapy S	1.80	0.50	0.80	0.22	0.67	0.26
C	0.20	-0.13	2.80	1.82	0.80	0.94
C(4+5)	0.43	-0.71	0.23	0.38	0.90	3.42**

* Significant at $p<0.05$

** Significant at $p<0.01$

\+ Interaction, treatment × interval, is a Group effect.

TABLE 33

Evaluation of Change in Abilities over Time for Severe Aphasics in Experiment 3

n = 12

Assessment	t +	df	p (two tailed)
Token Test No. Correct	0.00	10	N.S.
Token Test Weighted Score	1.21	10	N.S.
Object Naming	1.22	10	N.S.
Progressive Matrices	4.12	10	$p < 0.001$
Peabody PVT	2.99	10	$p < 0.01$
Eisenson Colours	1.28	10	N.S.
Shapes	2.80	10	$p < 0.01$
Pictures	-0.01	10	N.S.
Self Rating	-0.62	10	N.S.
PICA I	2.23	10	$p < 0.05$
IV	2.99	10	$p < 0.01$
IX	2.69	10	$p < 0.05$
XIII	3.28	10	$p < 0.01$
Verbal	3.41	10	$p < 0.01$
II	0.74	10	N.S.
III	0.85	10	N.S.
V	1.67	10	N.S.
VI	2.49	10	$p < 0.05$
VII	2.80	10	$p < 0.01$
VIII	1.95	10	$p < 0.05$
X	1.65	10	N.S.
XI	2.29	10	$p < 0.05$
Gestural	2.71	10	$p < 0.05$
A	0.80	10	N.S.
B	1.67	10	N.S.
C	1.95	10	$p < 0.05$
D	1.36	10	N.S.
E	3.23	10	$p < 0.01$
F	0.98	10	N.S.
Graphic	2.59	10	$p < 0.05$
Overall	3.27	10	$p < 0.01$
Ward S	0.87	10	N.S.
C	-0.77	10	N.S.
C (4+5)	-1.25	10	N.S.
Physiotherapy S	3.36	10	$p < 0.01$
C	1.26	10	N.S.
C (4+5)	1.19	10	N.S.
Occupational Therapy S	2.48	9	$p < 0.05$
C	2.04	9	$p < 0.05$
C (4+5)	3.15	9	$p < 0.01$

$$+\ t = \frac{\text{Mean Change in Score}}{\sqrt{\dfrac{\text{Within Group Mean Square}}{\text{No. of subjects}}}}$$ (Armitage 1971)

TABLE 34

Correlation between Change in Ability and Biographical Variables for Severe Aphasics in Experiment 3

Assessment	Correlation between change in ability and Age	p +	Months post onset	p +
Token Test No. Correct	-0.18	N.S.	-0.52	p< 0.05
Token Test Weighted Score	-0.03	N.S.	-0.58	p< 0.05
Object Naming	0.29	N.S.	-0.26	N.S.
Progressive Matrices	-0.33	N.S.	-0.35	N.S.
Peabody PVT	0.03	N.S.	-0.29	N.S.
Eisenson Colours	-0.13	N.S.	-0.25	N.S.
Shapes	-0.18	N.S.	-0.58	p< 0.05
Pictures	-0.19	N.S.	-0.07	N.S.
Self Rating	-0.20	N.S.	0.12	N.S.
PICA I	-0.10	N.S.	-0.39	N.S.
IV	0.00	N.S.	-0.45	N.S.
IX	-0.16	N.S.	-0.26	N.S.
XII	-0.09	N.S.	-0.31	N.S.
Verbal	-0.11	N.S.	-0.40	N.S.
II	-0.20	N.S.	-0.34	N.S.
III	0.20	N.S.	-0.35	N.S.
V	0.16	N.S.	-0.04	N.S.
VI	-0.29	N.S.	-0.17	N.S.
VII	0.04	N.S.	0.00	N.S.
VIII	0.11	N.S.	-0.44	N.S.
X	-0.38	N.S.	-0.10	N.S.
XI	0.12	N.S.	-0.49	N.S.
Gestural	-0.08	N.S.	-0.35	N.S.
A	-0.15	N.S.	-0.28	N.S.
B	0.04	N.S.	-0.13	N.S.
C	-0.33	N.S.	-0.26	N.S.
D	-0.41	N.S.	-0.45	N.S.
E	0.44	N.S.	-0.53	p< 0.05
F	0.18	N.S.	-0.02	N.S.
Graphic	0.13	N.S.	-0.39	N.S.
Overall	-0.06	N.S.	-0.41	N.S.
Ward S	-0.04	N.S.	-0.30	N.S.
C	0.14	N.S.	-0.04	N.S.
C (4+5)	0.10	N.S.	-0.13	N.S.
Physiotherapy S	-0.76	p< 0.01	0.40	N.S.
C	0.02	N.S.	0.42	N.S.
C (4+5)	-0.02	N.S.	0.14	N.S.
Occupational Therapy S	-0.06	N.S.	0.07	N.S.
C	-0.38	N.S.	-0.02	N.S.
C (4+5)	-0.29	N.S.	-0.54	p< 0.05

+ significance tests are two-tailed.

TABLE 35

Characteristics of 'Untreated' Aphasics in Experiment 4

Pat. No.	Age	Sex	Months Post Onset	Handedness % right	Group	Treatment Between assessments 1 and 2: Speech Therapy	Treatment Between assessments 1 and 2: Occupational Therapy	Hospital
32	56	M	1	64	Severe	None	12hrs/week	Manfield, Northampton
93	18	M	3	67	Moderate	1hr/wk	8hrs/week	Manfield, Northampton
143	39	F	6	42	Severe	¾hr x1	20hrs/week	St.Mary's Kettering
144	55	M	4	17	Severe	None	2hrs/week	St.Mary's Kettering
145	56	F	4	92	Severe	None	2hrs/week	St.Mary's Kettering
146	61	M	3	83	Severe	None	8hrs/week	St.Mary's Kettering
147	67	F	3	100	Moderate	None	1hr/week	Manfield, Northampton
148	69	F	2	84	Moderate	None	None	Manfield, Northampton
149	54	F	4	100	Moderate	None	15hrs/week	Community Hospital, Wallingford
150	55	F	6	100	Moderate	None	6hrs/week	Manfield, Northampton
151	54	M	4	100	Moderate	1hr x1	6hrs/week	General Hos[illegible] Kettering
152	50	M	2	83	Severe	None	6hrs/week	Manfield, Northampton
153	47	F	3	0	Severe	None	None	Nuffield Orthopaedic, Oxford.
154	30	F	5	84	Severe	1hr/wk	5hrs/week	General Hos[illegible] Kettering
155	54	M	2	-	Severe	¾hr/wk	12hrs/week	Manfield, Northampton
156	61	F	1	100	Moderate	¾hr x2	12hrs/week	Manfield, Northampton
157	50	F	6	-	Severe	None	8hrs/week	Manfield, Northampton
158	64	F	2	-	Severe	½hr x1	7hrs/week	Manfield, Northampton
159	33	M	2	100	Moderate	½hr/wk	15hrs/week	Manfield, Northampton
160	47	M	3	100	Moderate	1hr/wk	8hrs/week	Manfield, Northampton
Mean	51.0		3.3	77.5				
S.D	12.8		1.6	30.8				

- Missing information due to patients being unable to give intelligible answers to the questions

TABLE 36

Test Scores of 'Untreated' Aphasics in Experiment 4

n = 20

Assessment	Patient Assessment	32		93		143	
		1	2	1	2	1	2
Token test No. Correct		4	7	0	2	0	1
Token test Weighted Score		57	70	43	47	38	25
Object Naming		0	0	15	15	0	3
Progressive Matrices		31	44	32	32	29	22
Fluency		1	0	17	20	-	-
Picture Description		3	6	22	27	-	-
Self Rating		3	3	5	7	6	2
PICA I		4.0	5.0	5.2	5.9	5.6	4.4
IV		4.0	5.0	11.2	11.3	5.1	4.7
IX		4.6	4.8	9.4	13.3	5.1	7.4
XII		4.5	6.6	15.0	15.0	10.2	11.1
Verbal		4.28	5.35	10.20	11.40	6.50	6.90

Assessment	144		145		146		147	
	1	2	1	2	1	2	1	2
Token test No. Correct	0	0	1	2	0	5	13	13
Token test Weighted Score	21	0	3	11	55	58	74	78
Object Naming	1	1	0	4	0	0	23	25
Progressive Matrices	24	29	11	27	24	22	31	38
Fluency	-	-	0	0	0	0	42	43
Picture Description	-	-	15	22	6	4	49	44
Self Rating	4	6	4	6	4	4	5	6
PICA I	4.9	5.0	4.8	5.0	4.2	3.7	8.4	11.3
IV	5.4	6.0	4.9	5.3	4.0	4.0	13.2	13.2
IX	5.3	6.5	5.0	5.4	4.0	3.8	14.1	13.1
XII	11.9	15.0	8.1	8.2	5.7	4.7	14.4	14.2
Verbal	6.90	8.10	5.83	6.15	4.48	4.05	12.53	12.95

TABLE 36 contd.

148		149		150		151	
1	2	1	2	1	2	1	2
7	17	2	1	18	21	14	17
73	90	43	52	89	95	78	86
18	21	4	6	19	20	21	20
16	17	7	9	22	23	25	25
16	16	3	1	21	17	26	26
25	23	5	1	18	27	65	60
7	7	8	8	5	6	5	5
10.8	13.7	5.0	5.0	7.9	13.3	10.0	10.6
13.1	14.7	6.6	8.0	9.5	12.6	12.9	12.2
12.7	14.2	7.9	6.6	12.9	10.7	12.4	13.7
15.0	15.0	10.8	11.7	11.5	14.4	14.3	14.8
12.90	14.40	7.58	7.83	10.45	12.75	12.42	12.82

152		153		154		155	
1	2	1	2	1	2	1	2
0	0	1	0	1	0	1	3
28	36	8	13	39	33	42	44
0	0	0	0	0	0	0	0
30	28	4	8	10	9	10	8
0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0
5	6	4	2	6	4	6	7
3.5	3.0	3.0	3.1	5.0	4.6	3.1	3.2
3.1	4.0	3.0	3.1	4.8	4.4	3.5	3.0
3.5	4.2	3.0	3.0	4.6	6.3	3.4	3.3
7.8	7.1	3.0	4.0	4.1	7.3	3.3	3.5
4.48	4.58	3.00	3.30	4.63	5.65	3.33	3.25

TABLE 36 contd.

156		157	
1	2	1	2
11	10	6	2
66	54	69	42
9	8	0	0
21	25	7	8
5	11	0	0
54	37	0	0
4	4	4	2
6.2	7.1	2.9	2.8
7.8	5.5	3.0	3.0
8.9	8.8	2.4	2.4
10.5	11.9	3.4	3.0
8.35	8.33	2.93	2.80

158		159		160	
1	2	1	2	1	2
2	3	1	2	3	9
36	53	39	45	44	60
0	6	13	14	10	22
11	15	6	11	34	40
1	4	15	15	2	10
23	26	26	25	28	51
5	4	5	6	2	5
4.4	5.3	6.8	12.1	7.1	9.7
4.3	5.8	12.8	12.2	5.6	11.0
4.5	8.2	13.4	14.0	11.3	12.7
11.6	11.7	11.4	14.1	12.6	15.0
6.20	7.75	11.85	13.10	9.15	12.10

TABLE 37

Mean and Standard Deviations of Test Scores and Biographical Variables for Moderate Aphasics in Experiment 4

Assessment	Initial Assessment n	Mean	S.D.	Final Assessment n	Mean	S.D.
Age	9	50.89	16.37			
Months Post Onset	9	3.44	2.07			
Edinburgh Handedness Inventory	9	94.55	11.60	Not assessed		
Token Test No. Correct	9	7.67	6.56	9	10.22	7.40
Token Test Weighted Score	9	61.00	18.82	9	67.44	19.75
Object Naming	9	14.67	6.23	9	16.78	6.50
Progressive Matrices	9	21.56	10.31	9	24.44	10.96
Fluency	9	16.33	12.69	9	17.67	11.77
Picture Description	9	32.44	19.32	9	33.89	17.11
Self Rating	9	5.11	1.69	9	6.00	1.23
PICA I	9	7.41	1.96	9	9.85	3.19
IV	9	10.30	3.02	9	11.19	2.81
IX	9	11.44	2.20	9	11.90	2.65
XII	9	12.83	1.85	9	14.01	1.30
Verbal	9	10.60	1.94	9	11.74	2.23

TABLE 38

Comparison of 'Treated' and 'Untreated' Moderate Aphasics in Experiment 4 on Biographical Variables

Variable	F	df.	p.
Age	1.28	4,28	N.S.
Months Post Onset	1.11	4,28	N.S.
EHI	2.35	4,28	N.S.

TABLE 39

F Values of Analysis of Variance to compare 4 'Treated' Moderate Aphasic Groups from Experiment 1 with 'Untreated' Controls from Experiment 4

Assessment	F	df.	p.
Token Test No. Correct	0.11	1,28	N.S.
Token Test Weighted Score	0.02	1,28	N.S.
Object Naming	0.12	1,28	N.S.
Progressive Matrices	0.08	1,27	N.S.
Fluency	0.19	1,28	N.S.
Picture Description	0.07	1,28	N.S.
Self Rating	0.14	1,28	N.S.
PICA I	0.05	1,28	N.S.
IV	0.00	1,28	N.S.
IX	0.03	1,28	N.S.
XII	0.08	1,28	N.S.
Verbal	0.00	1,28	N.S.

TABLE 40

Evaluation of Change in Abilities for Moderate Aphasics in Experiment 4

Assessment	t +	df.	p (two-tailed)
Token Test No. Correct	2.35	28	$p < 0.05$
Token Test Weighted Score	3.35	28	$p < 0.005$
Object Naming	4.40	28	$p < 0.001$
Progressive Matrices	4.12	27	$p < 0.001$
Fluency	4.08	28	$p < 0.001$
Picture Description	2.66	28	$p < 0.01$
Self Rating	2.62	28	$p < 0.01$
PICA I	4.67	28	$p < 0.001$
IV	2.86	28	$p < 0.005$
IX	2.93	28	$p < 0.005$
XII	1.49	28	N.S.
Verbal	4.54	28	$p < 0.001$

+ $t = \dfrac{\text{Mean Change in Score}}{\sqrt{\dfrac{\text{Within Group Mean Square}}{\text{No. of Subjects}}}}$ (Armitage 1971)

TABLE 41

Mean and Standard Deviation of Test Scores and Biographical Variables for 'Untreated' Severe Aphasics in Experiment 4

Assessment	Initial Assessment n	Mean	S.D.	Final Assessment n	Mean	S.D.
Age	11	51.1	9.73			
Months Post Onset	11	34.5	1.44			
Edinburgh Handedness Inventory	8+	58.25	34.78	not assessed		
Token Test No.Correct	11	1.45	1.91	11	2.09	2.30
Token Test Weighted Score	11	36.00	20.25	11	35.00	21.44
Object Naming	11	0.09	0.30	11	2.09	2.30
Progressive Matrices	11	17.36	10.22	11	20.00	11.64
Fluency	9*	0.22	0.44	9	0.44	1.33
Picture Description	9*	5.33	8.24	9	6.44	10.23
Self Rating	11	4.64	1.02	11	4.27	1.84
PICA I	11	4.13	0.91	11	4.10	0.95
IV	11	4.10	0.88	11	4.39	1.08
IX	11	4.13	0.94	11	5.03	1.89
XII	11	6.74	3.42	11	7.47	3.80
Verbal	11	4.78	1.40	11	5.01	2.29

* Missing data occurred on these assessments due to refusals of 2 patients to attempt these items.

+ Missing data occurred on the EHI due to inability of patients to perform the task or to give intelligible answers.

TABLE 42

Comparison of Biographical Variables for 'Treated' and 'untreated' severe aphasics in Experiment 4

Variable	F	df.	p.
Age	0.20	1,27	N.S.
Months Post Onset	0.78	1,27	N.S.
Handedness	0.07	1,19	N.S.

TABLE 43

F Values of Analysis of Variance to compare 'Treated' Aphasics from Experiment 2 with 'Untreated' Severe Aphasics in Experiment 4

Assessment	F.	df.	Significance
Token Test No.Correct	0.59	1,27	N.S.
Token test Weighted Score	1.24	1,27	N.S.
Object Naming	1.81	1,27	N.S.
Progressive Matrices	0.17	1,27	N.S.
Fluency	1.42	1,25*	N.S.
Picture Description	0.00	1,25*	N.S.
Self Rating	1.54	1,27	N.S.
PICA I	1.09	1,27	N.S.
IV	0.53	1,27	N.S.
IX	0.22	1,27	N.S.
XII	1.63	1,27	N.S.
Verbal	0.25	1,27	N.S.

* Variation in degrees of freedom occurred due to missing data on some tests.

TABLE 44

Evaluation of Change in Abilities for Severe Aphasics in Experiment 4

Assessment	t.+	d.f.	p (two-tailed).
Token Test No. Correct	0.75	27	N.S.
Token Test Weighted Score	1.00	27	N.S.
Object Naming	0.81	27	N.S.
Progressive Matrices	3.01	27	$p<0.005$
Fluency	2.32	25	$p<0.025$
Picture Description	1.12	25	N.S.
Self Rating	0.37	27	N.S.
PICA I	1.12	27	N.S.
IV	1.29	27	N.S.
IX	2.98	27	$p<0.005$
XII	3.81	27	$p<0.001$
Verbal	3.85	27	$p<0.001$

$$+ \quad t = \frac{\text{Mean Change in Score.}}{\sqrt{\dfrac{\text{Within Group Mean Square}}{\text{No. of Subjects.}}}}$$

Armitage (1971).

TABLE 45

The Relation between Biographical Variables and Change in Ability for 'Untreated' aphasics in Experiment 4

Assessment	n	Correlation with age r	p*	Correlation with months post onset r	p*
Token Test No. Correct	20	0.25	N.S.	-0.28	N.S.
Token Test Weighted Score	20	0.19	N.S	-0.48	$p<0.05$
Object Naming	20	0.10	N.S.	-0.01	N.S.
Progressive Matrices	20	0.35	N.S.	-0.32	N.S.
Fluency	18+	0.08	N.S.	-0.40	N.S.
Picture Description	18+	0.23	N.S.	0.24	N.S.
Self Rating	20	0.07	N.S.	-0.55	$p<0.05$
PICA I	20	0.04	N.S.	-0.11	N.S.
IV	20	0.27	N.S.	0.10	N.S.
IX	20	-0.42	$p<0.05$	-0.08	N.S.
XII	20	-0.30	N.S.	0.14	N.S.
Verbal	20	-0.14	N.S.	0.03	N.S.

\+ Missing data occurred because two patients refused to attempt these items

* Significance tests are two-tailed.

TABLE 46

The Relation between Intelligence and Change in Ability for 'Untreated' Aphasics in Experiment 4

Assessment	n	Correlation with Initial Progressive Matrices Score r	p (two-tailed)
Token Test No. correct	20	0.35	N.S.
Token Test Weighted Score	20	0.08	N.S.
Object Naming	20	0.16	N.S.
Fluency *	18+	0.34	N.S.
Picture Description*	18+	0.24	N.S.
Self Rating	20	0.28	N.S.
PICA I	20	0.00	N.S.
IV	20	0.23	N.S.
IX	20	0.08	N.S.
XII	20	-0.01	N.S.
Verbal	20	0.23	N.S.

\+ Missing data occurred because two patients refused to attempt these items.

TABLE 47

The Relation between Patients' Self Rating and Change in Ability for 'Untreated' Aphasics in Experiment 4

Assessment	n	Correlation with Initial Self Rating r	p (two-tailed)
Token Test No. Correct	20	-0.01	N.S.
Token Test Weighted Score	20	0.06	N.S.
Object Naming	20	-0.24	N.S.
Progressive Matrices	20	-0.48	Sig $p<0.05$
Fluency	18+	-0.48	Sig $p<0.05$
Picture Description	18+	-0.41	N.S.
PICA I	20	-0.06	N.S.
IV	20	-0.22	N.S.
IX	20	0.19	N.S.
XII	20	-0.15	N.S.
Verbal	20	-0.21	N.S.

\+ Missing data occurred because two patients refused to attempt these items

TABLE 48

Biographical variables of Patients included in Experiments 5, 6 and 7

n = 38

Patient	Diagnosis	Age	Months Post Onset	Experiments for which included 5	6	7.1	7.2	7.3	7.4	7.5
18	CVA	45	2			✓	✓	✓		✓
26	CVA	52	3	✓	✓					
32	CVA	52	5					✓		✓
38	CVA	57	4					✓		✓
46	CVA	53	1	✓	✓					
48	CVA	43	9	✓	✓					
49	CVA	48	6		✓					
51	CVA	62	1	✓	✓					
52	CVA	48	2	✓	✓					
54	CVA	52	2	✓						
55	CVA	52	7	✓						
56	CVA	40	2	✓	✓					
57	CVA	68	1	✓	✓					
58	CVA	48	8	✓						
59	CVA	66	1	✓						
161	Head injury	31	60	✓	✓					
162	CVA	55	1	✓	✓					
163	CVA	53	1	✓	✓					
164	CVA	63	24	✓	✓					
165	Head injury	57	7	✓	✓					
166	CVA	35	4	✓	✓					
167	Head injury	25	7	✓	✓					
168	CVA	55	1		✓					
169	Angioma	36	6		✓					
170	Head injury	19	1		✓					
171	CVA	40	5.			✓				
172	CVA	40	1			✓				
173	CVA	54	2			✓				
174	CVA	27	19			✓				
175	CVA	44	3			✓	✓			
176	CVA	46	9				✓	✓	✓	
177	CVA	48	28				✓	✓	✓	
178	CVA	54	2				✓	✓	✓	
179	Angioma	13	3					✓	✓	
180	Angioma	28	24							✓
181	Head injury	45	3							✓
182	Head injury	28	72							✓
183	CVA	53	78					✓		

TABLE 49

Scores obtained on 3 shortened forms of The Token Test by patients in Experiment 5

n = 18

Patient no.	Order forms given	No. Correct Form A	Form B	Form C	Weighted Score Form A	Form B	Form C
26	A B C	13	11	11	81	82	80
46	A C B	2	2	0	36	41	39
48	B A C	1	3	1	30	30	29
51	C A B	1	1	0	27	8	2
52	A B C	1	0	1	22	14	29
54	B C A	0	2	0	27	18	24
55	A B C	2	4	4	54	59	42
56	C A B	10	10	12	59	63	74
57	A C B	2	1	1	37	41	38
58	B A C	3	1	3	53	48	59
59	C B A	3	4	2	57	44	56
161	C A B	0	2	0	46	46	41
162	B C A	2	3	1	47	47	49
163	A C B	0	0	0	0	3	17
164	B A C	6	7	7	52	65	62
165	C B A	5	6	9	61	69	63
166	B C A	22	20	20	96	93	93
167	C B A	21	21	22	94	95	96

TABLE 50

F values obtained from analysis of variance of 3 forms of Token Test and strength of associations for Aphasic Patients in Experiment 5

	Analysis of Variance						Strength of Association	
	Between subject			Between Forms			Subjects	Forms
	Fratio	df	p	Fratio	df	p		
No.correct	115.7	17,34	p<0.01	0.86	2,34	NS	0.97	0.001
Weighted Score	15.56	17,34	p<0.01	0.09	2,34	NS	0.82	0.006

TABLE 51

Scores obtained on Object Naming Test by patients in Experiment 6

n = 18

Patient No.	Test Administration Order	No. Correct 1st occasion	No. Correct 2nd occasion
26	1	6	7
46	2	0	0
48	1	0	0
49	1	20	21
51	3	0	0
52	2	0	0
56	2	4	6
57	3	0	0
161	2	6	5
162	3	0	0
163	1	0	0
164	2	17	17
165	3	6	4
166	3	15	10
167	1	12	14
168	1	22	26
169	3	2	1
170	2	23	23
Mean		7.38	7.44
S.D.		8.45	8.94

TABLE 52

Scores on the Speech Questionnaire obtained by Patients in Experiment 7 n = 16

Experiment	7.1						7.2						7.3					
Rater	1		2		3		4		5		6		1		2		3	
Patient	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C
18	26	13	38	16	26	13	28	14	23	13	33	16	16	10	22	17	27	14
32													17	11	15	11	20	12
38													32	9	25	14	33	13
171	28	14	25	17	32	20												
172	37	15	35	13	30	15												
173	34	17.5	31	13	30	15												
174	29	13	26	14	32	12												
175	32	16	32	17	36	16	32	14	30	13	34	17						
176							15	10	23.5	13	23	11						
177							33	19	33	16	29	17						
178							35	17	35	16	36	19						
179							4	11	11.5	16	12.5	11						
180													32	16	33	15	34	13
181													27	7	29	14	26	14
182													35	14	34	15	34	15
183													34	16	27	11	32	13

Experiment	7.4						7.5					
Rater	4		5		6		1		2		3	
Patient	S	C	S	C	S	C	S	C	S	C	S	C
18							24	13	21	15	27	12
32							23	12	10	11	18	13
38							29	15	31	14	34	15
171												
172												
173												
174												
175												
176	17.5	8	27.5	15	24	13						
177	33	18	33	16	32	16						
178	34	18	33	15	36	17						
179	6	10	11.5	12	12.5	12						
180							37	15	35	16	35	14
181							28	14	31	14	31	14
182							38	15	34	15	35	15
183												

TABLE 53

Inter-rater reliability of questions in the communication section of the Speech Questionnaire for raters in Experiment 7.2 and 7.3

	Experiment 7.2		Experiment 7.3	
Number of Raters	3		3	
Number of Patients	6		7	
Communication Question	W	p	W	p
C1	0.69	N.S.	0.53	N.S.
C2	0.49	N.S.	0.00	N.S.
C3	0.89	$p<0.05$	0.55	N.S.
C4	0.73	N.S.	0.70	N.S.
C5	0.83	$p<0.05$	0.69	N.S.
C6	0.88	$p<0.05$	0.05	N.S.
C7	0.50	N.S.	0.33	N.S.

TABLE 54

Test-Retest Reliability for experienced raters in Experiment 7.4

n = 4

	T	z	p
Speech section	0.88	2.06	$p < 0.05$
Communication section	0.63	1.50	N.S.

TABLE 55

Test-retest reliability for trained raters in Experiment 7.5

n = 6

	T	z	p
Speech section	0.91	2.46	$p < 0.01$
Communication section	0.31	1.14	N.S.

TABLE 56

Test-retest reliability of Questions C4 and C5 in the communication section for patients in experiments 7.4 and 7.5.

	Experiment 7.4			Experiment 7.5		
	n = 4			n = 6		
Question	T	z	p	T	z	p
4	0.72	1.85	$p<0.05$	0.08	0.34	N.S.
5	0.78	1.96	$p<0.05$	-0.11	-0.65	N.S.

Fig. 1 Object Naming Test Interval x Block Interaction

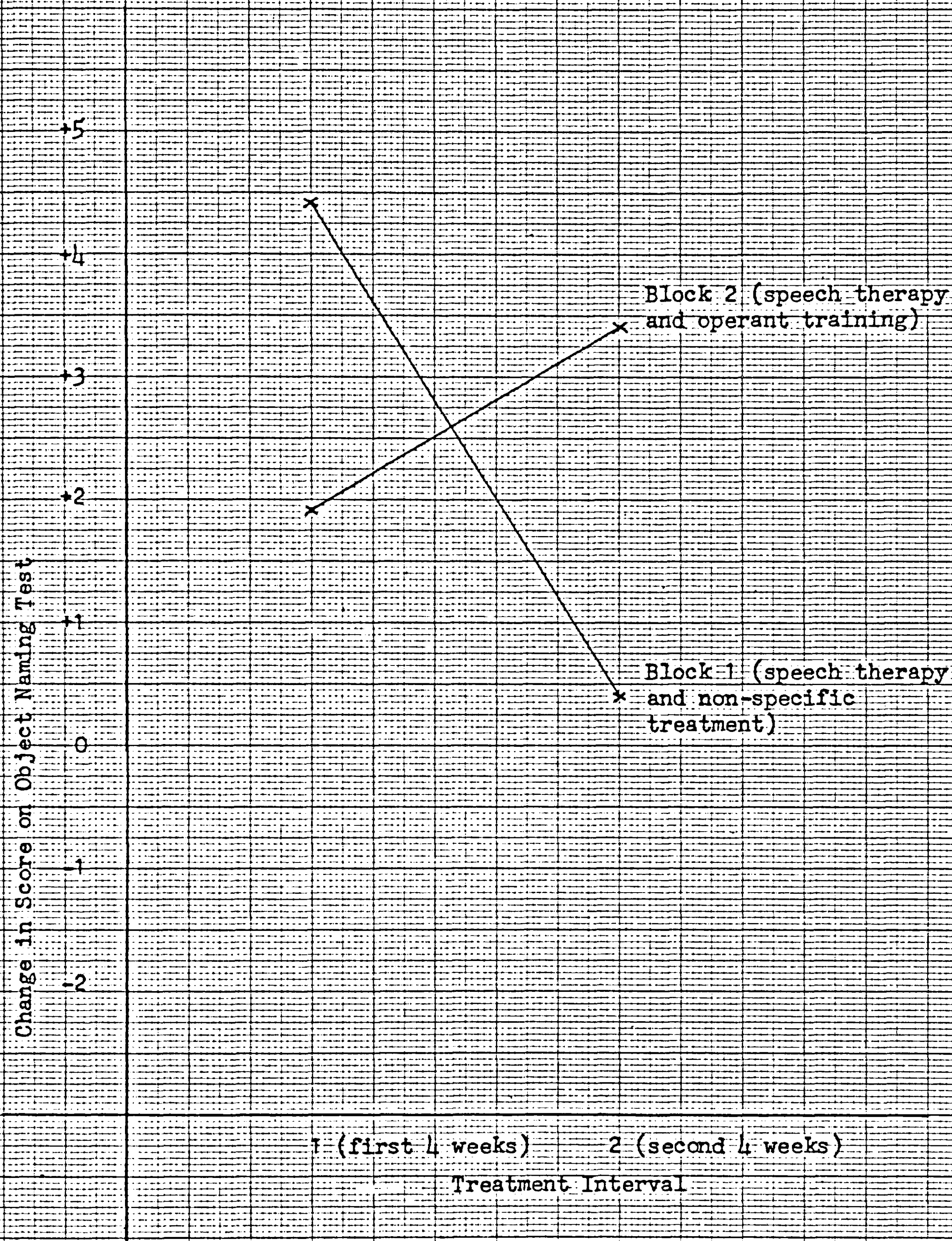


Fig. 2 Picture Description Interval x Block Interaction

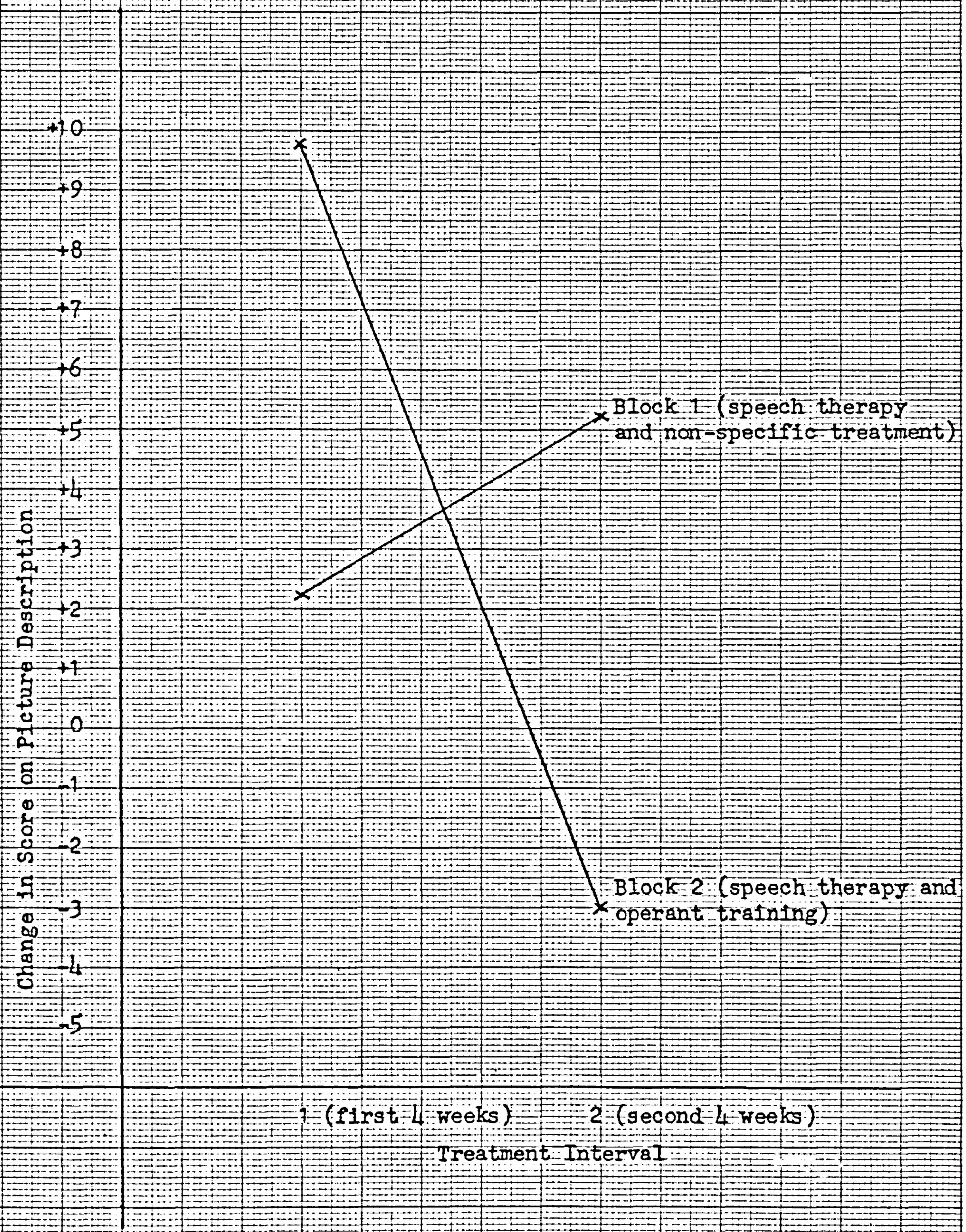


Fig. 3 P.I.C.A. Test D Interval x Block Interaction

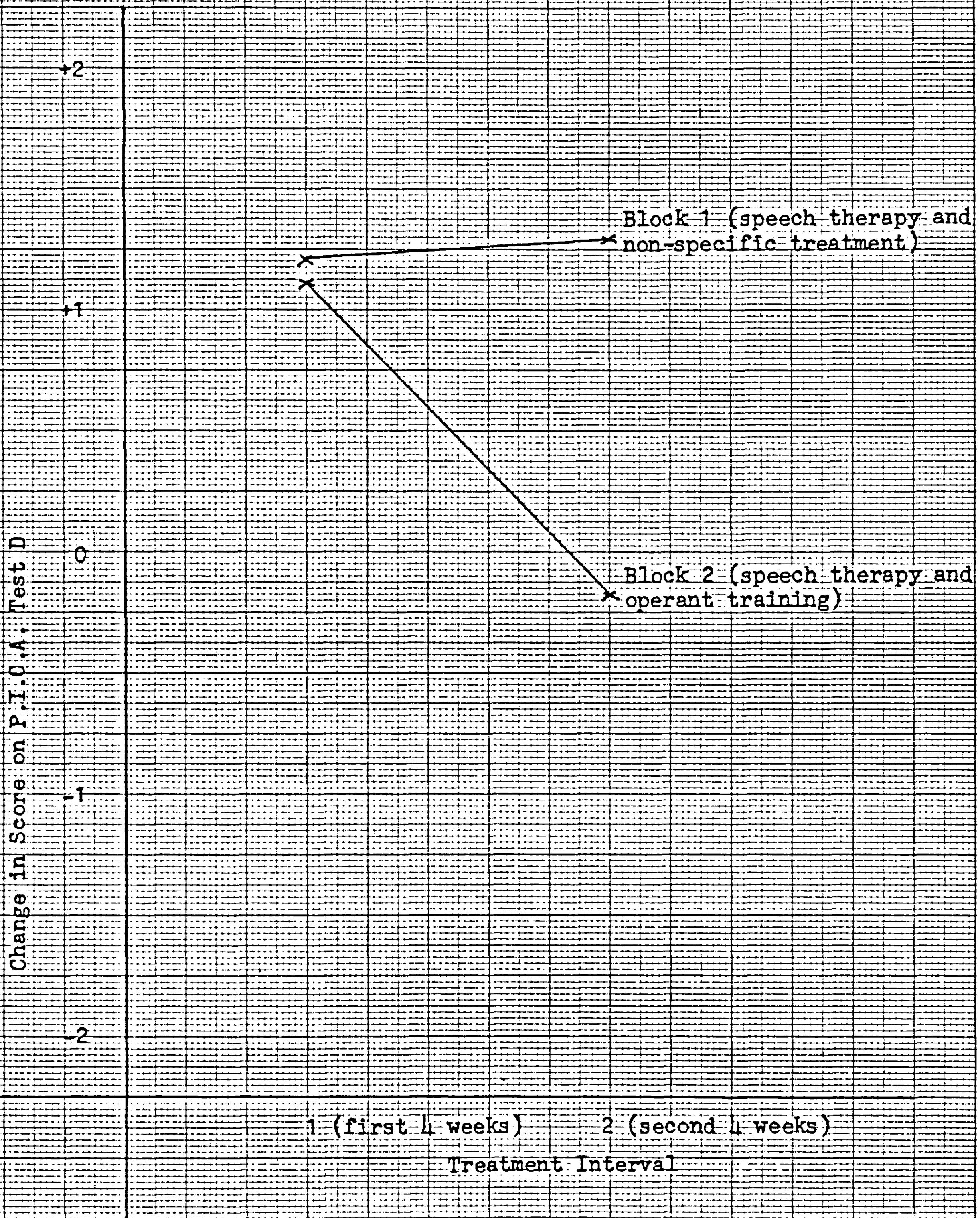
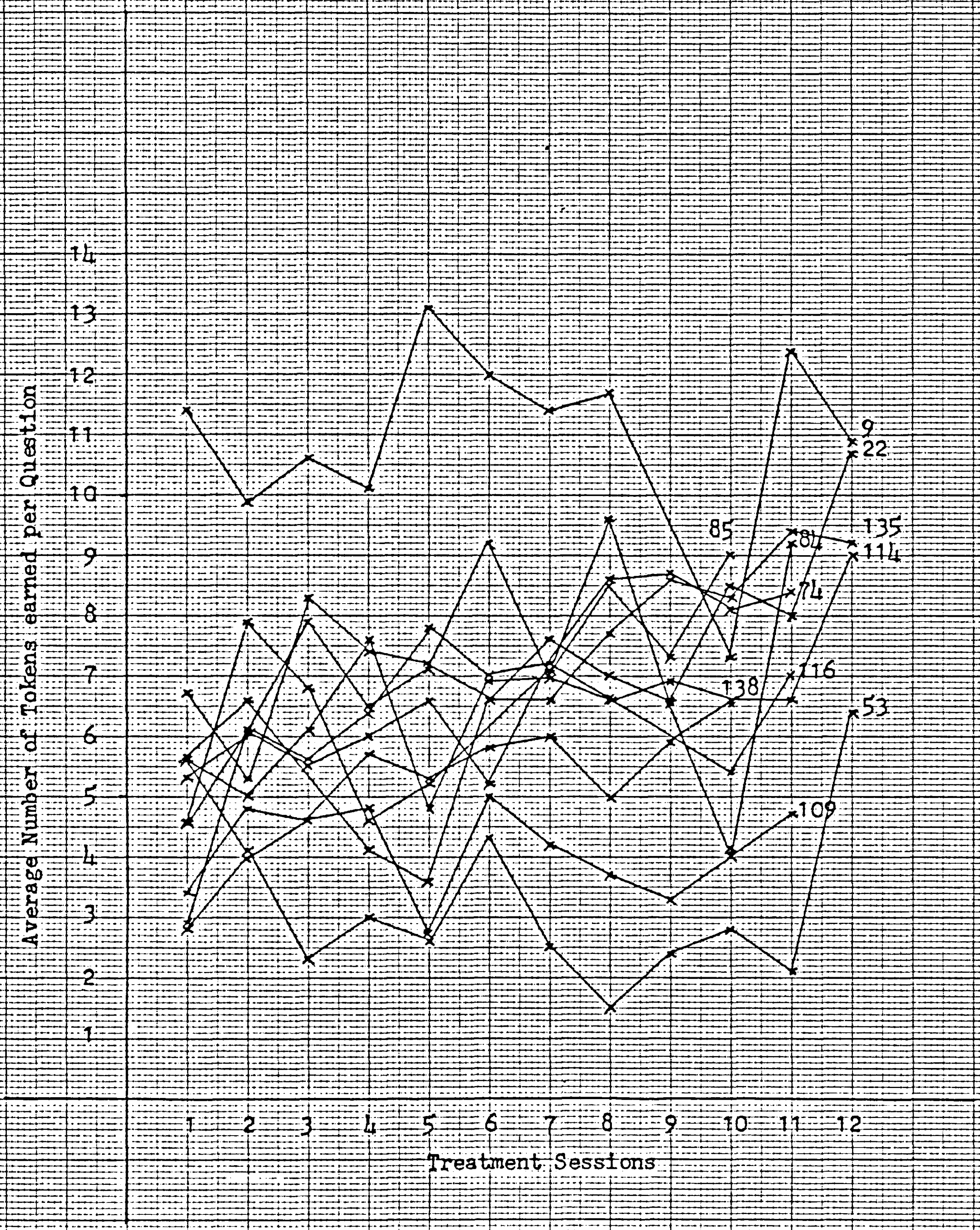


Fig. 4 Operant Treatment Summary

n = 11*



*Patient 32 omitted due to insufficient data available.

Fig. 5 Relation between Age and Change in P.I.C.A. Overall Score

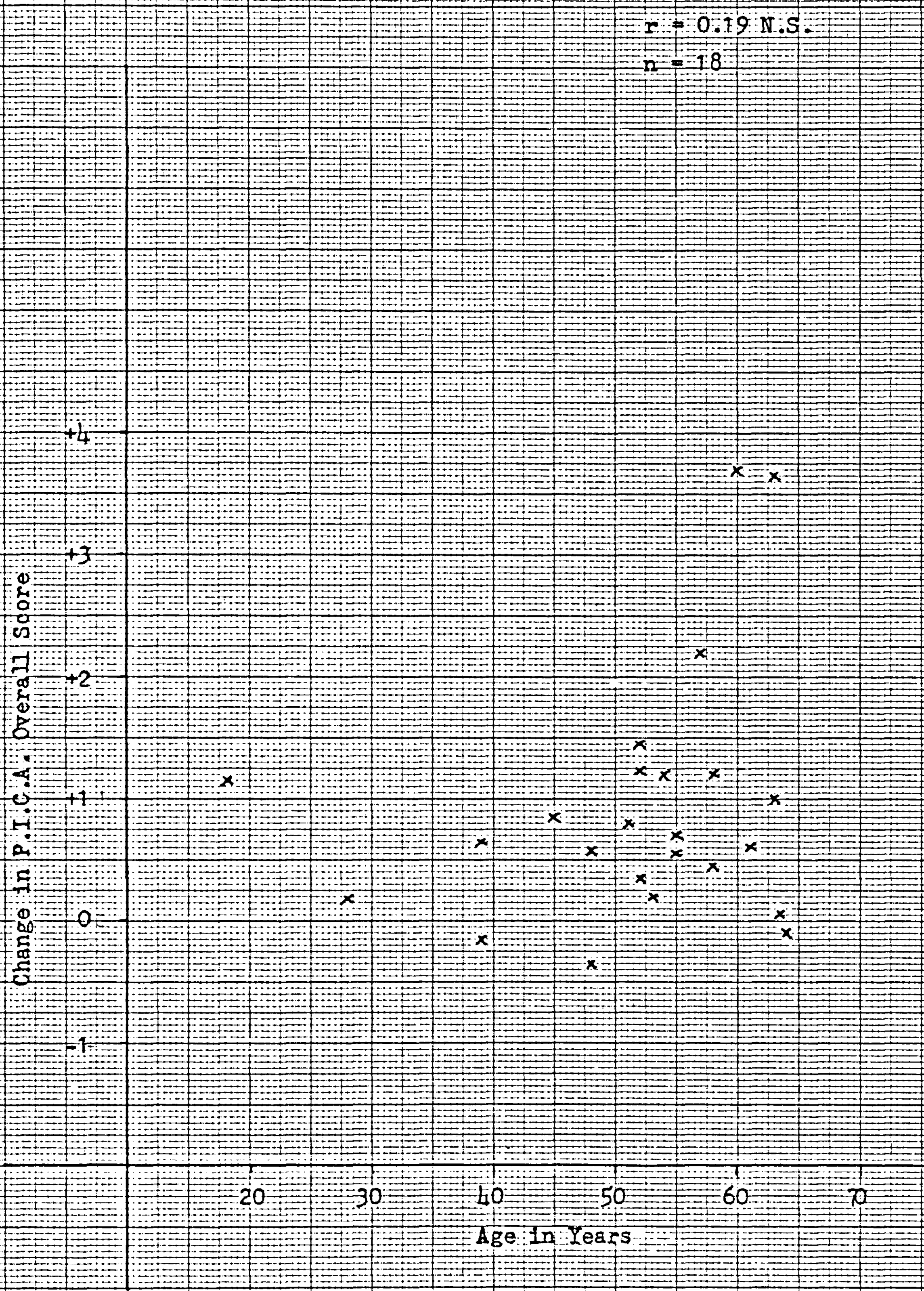


Fig. 6 Relation between months post onset and Change in P.I.C.A. Overall Score

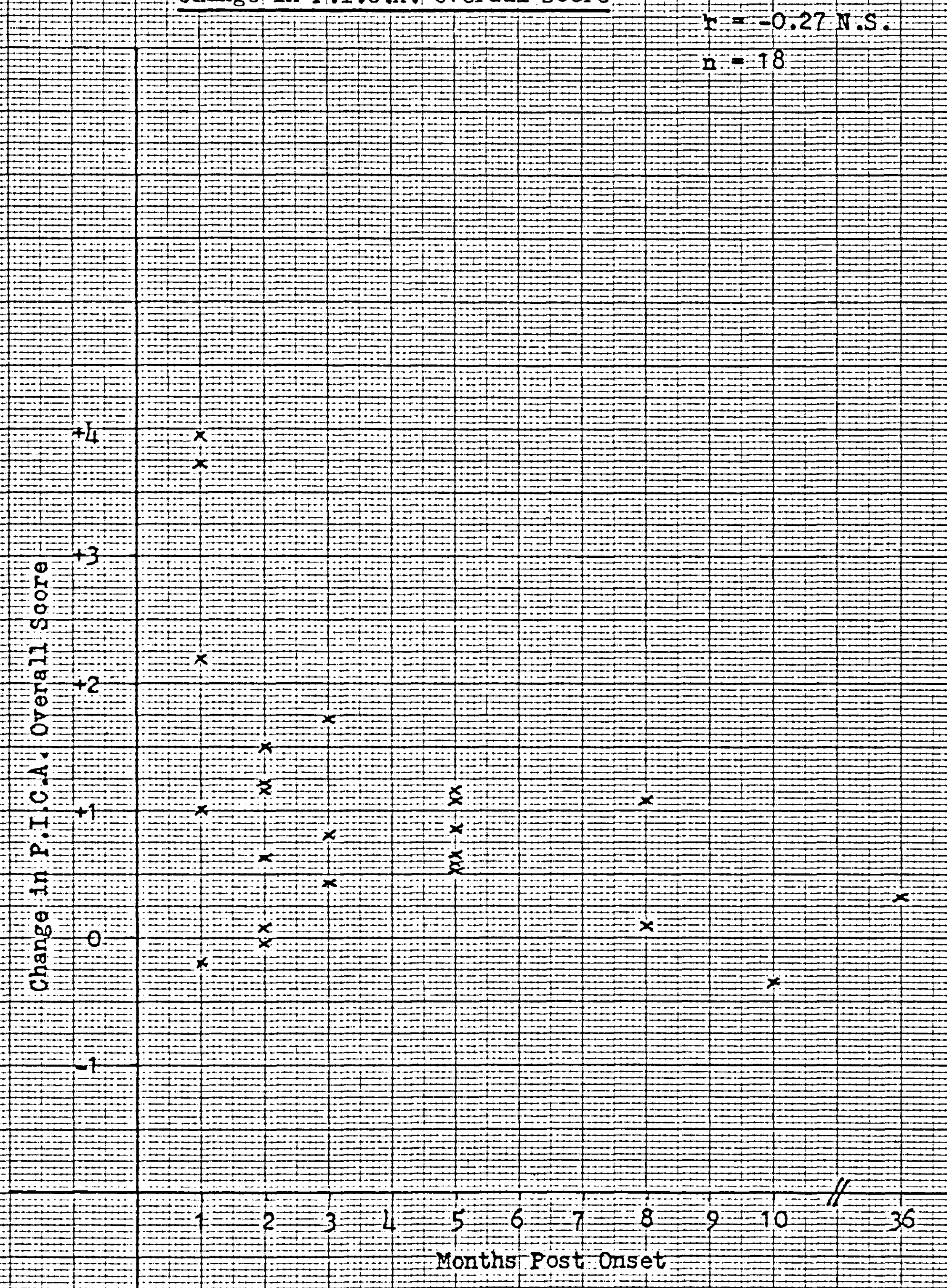


Fig. 7 Object Naming Test Score in Relation to Months Post Onset and Treatment for Moderate Aphasics in Experiment 1

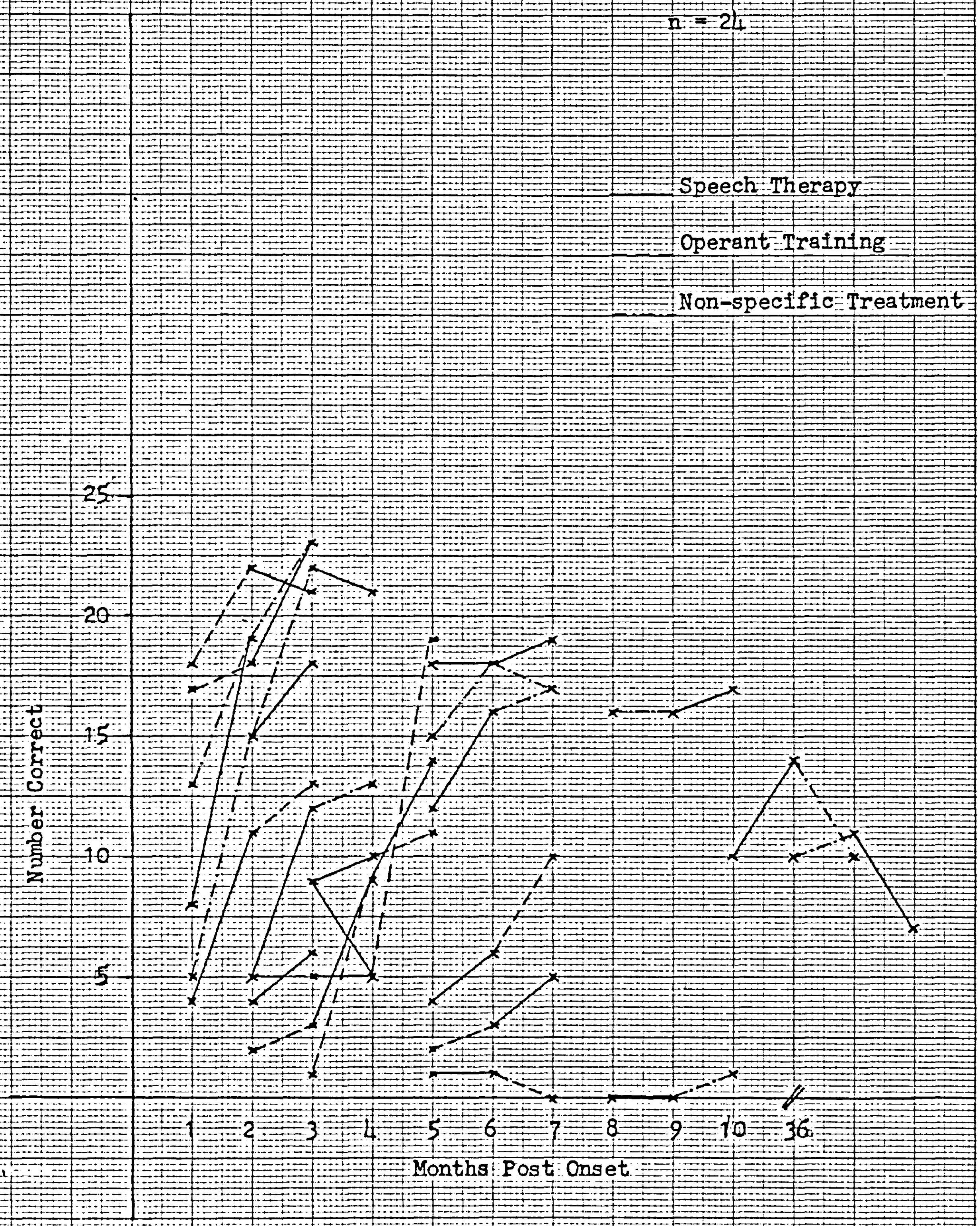


Fig. 8 P.I.C.A. Overall Score in Relation to Months Post Onset and Treatment for Moderate Aphasics in Experiment 1

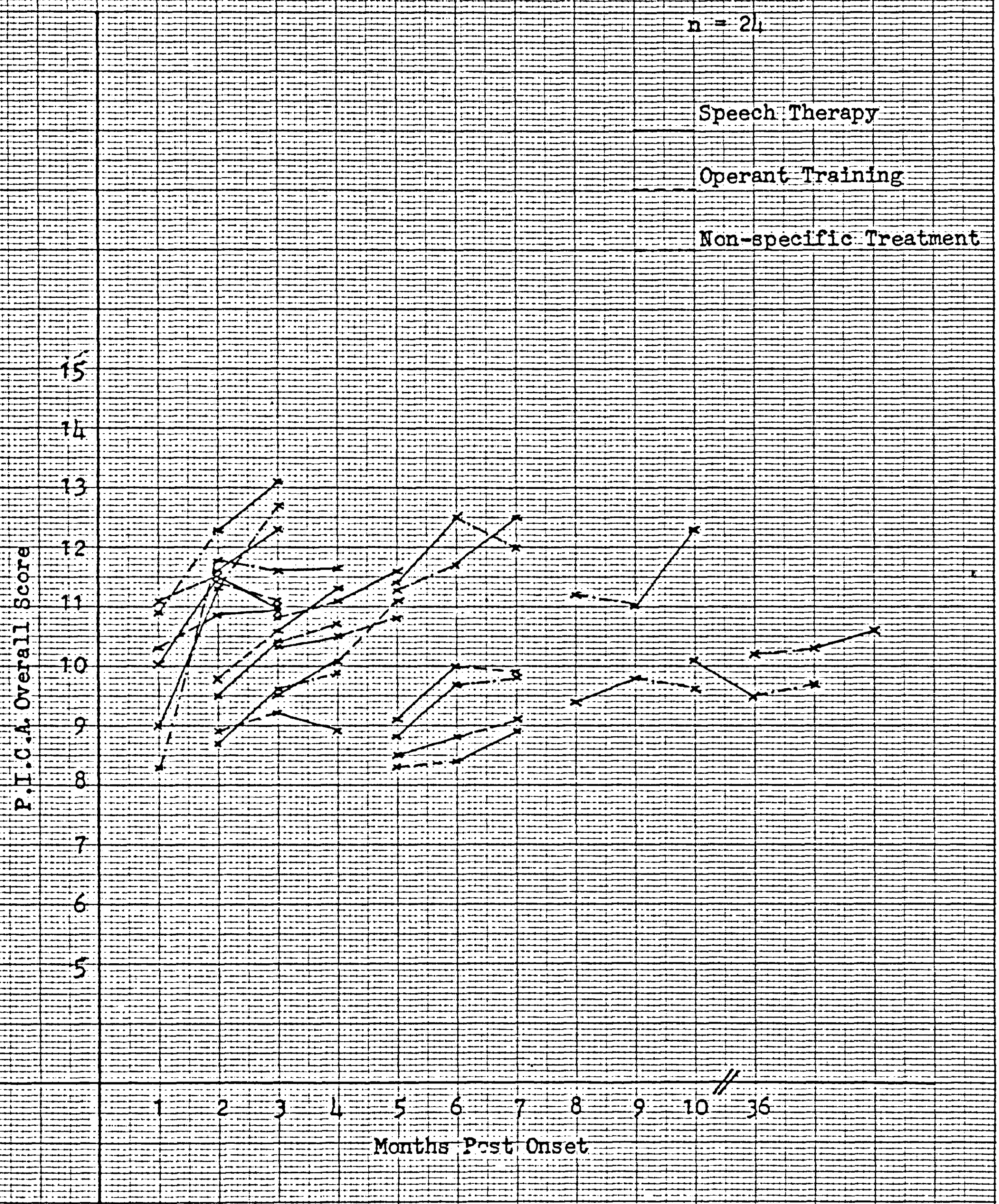


Fig. 9 Relation between Handedness and Change in P.I.C.A. Overall Score

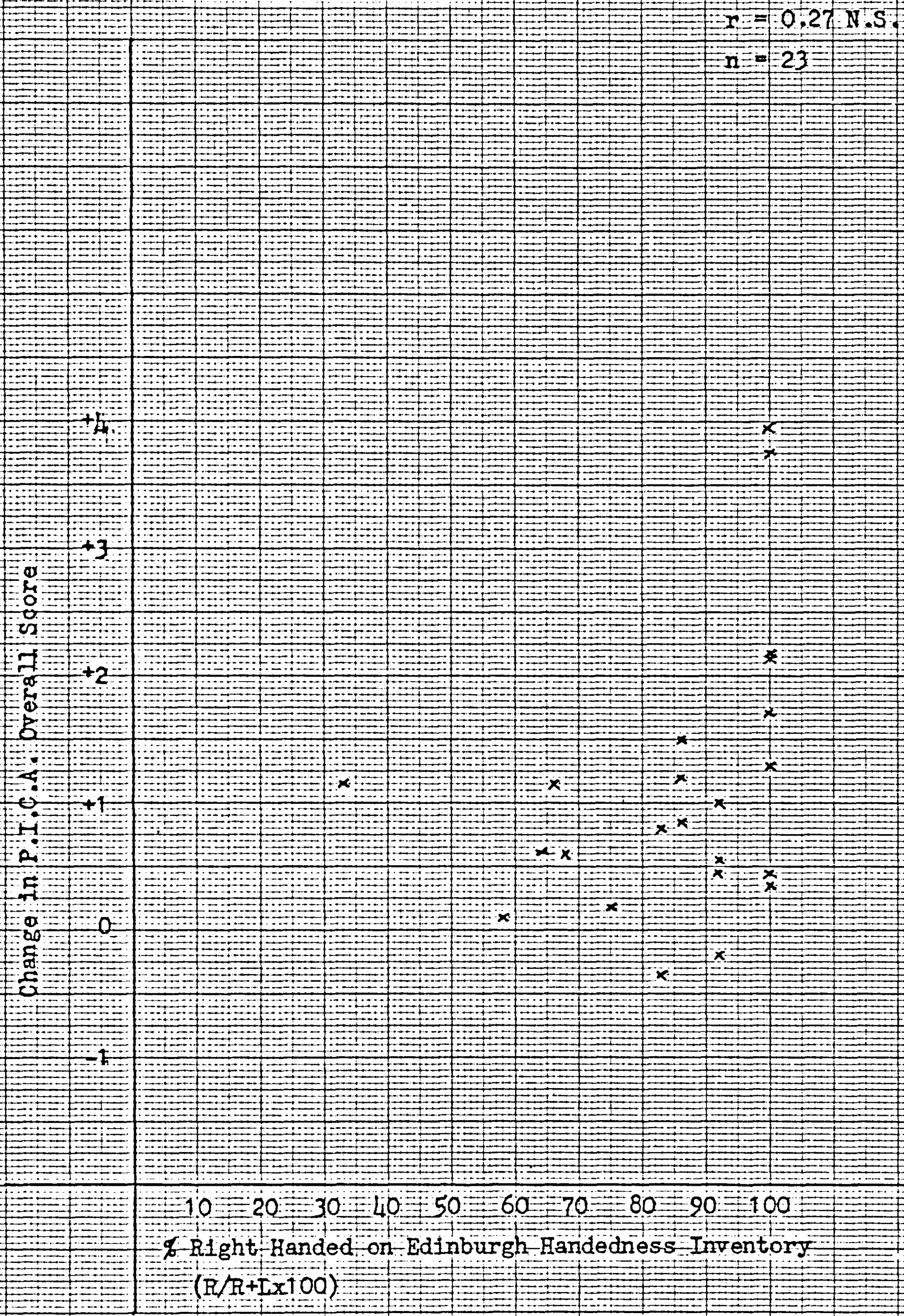


Fig. 10 Relation between Age (x) and Months Post Onset (y) with Handedness (z) constant

r x.y.z. = -0.19 N.S.

n = 24

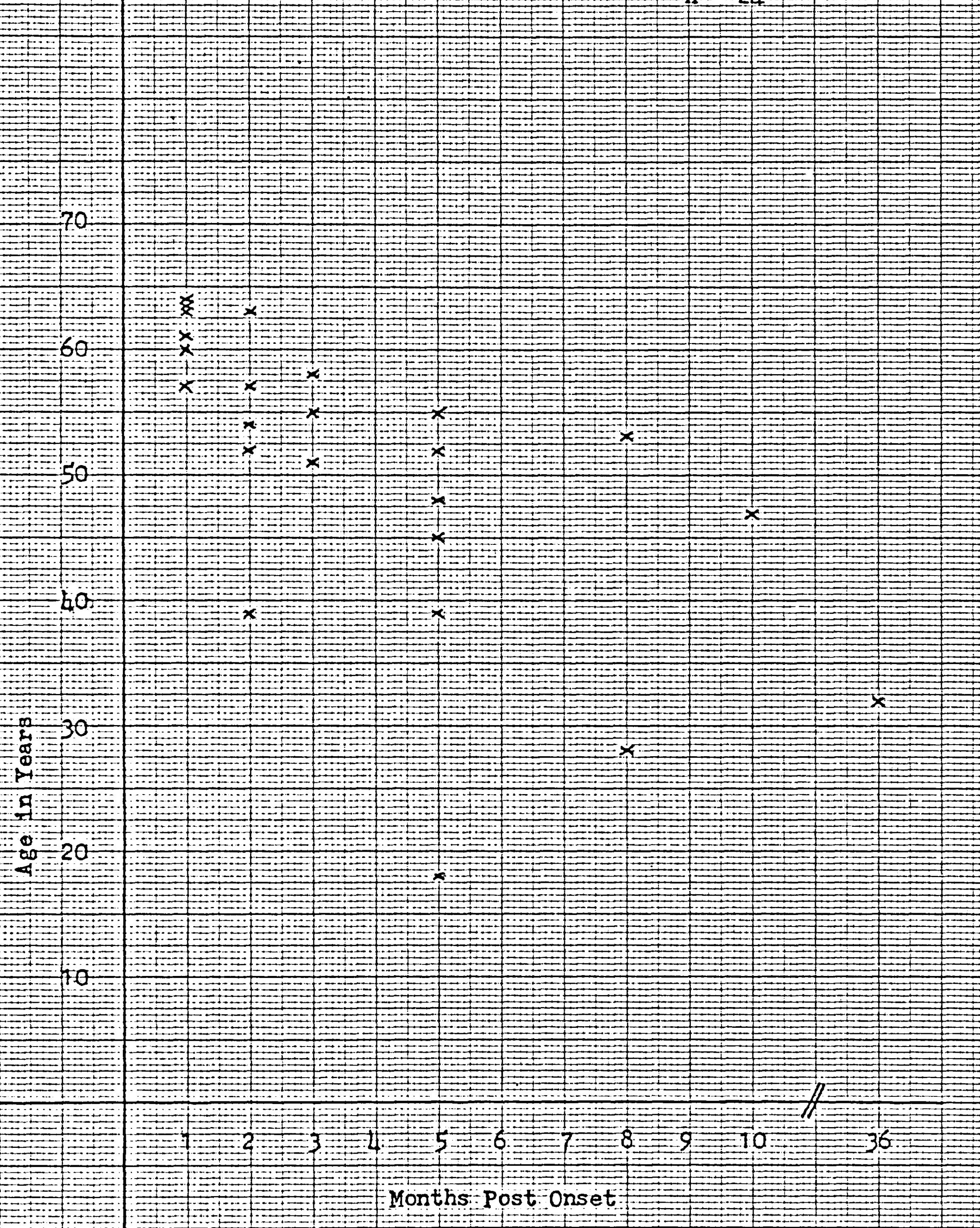


Fig. 11 Relation between Handedness (z) and Age (x) with Months Post Onset (y) constant

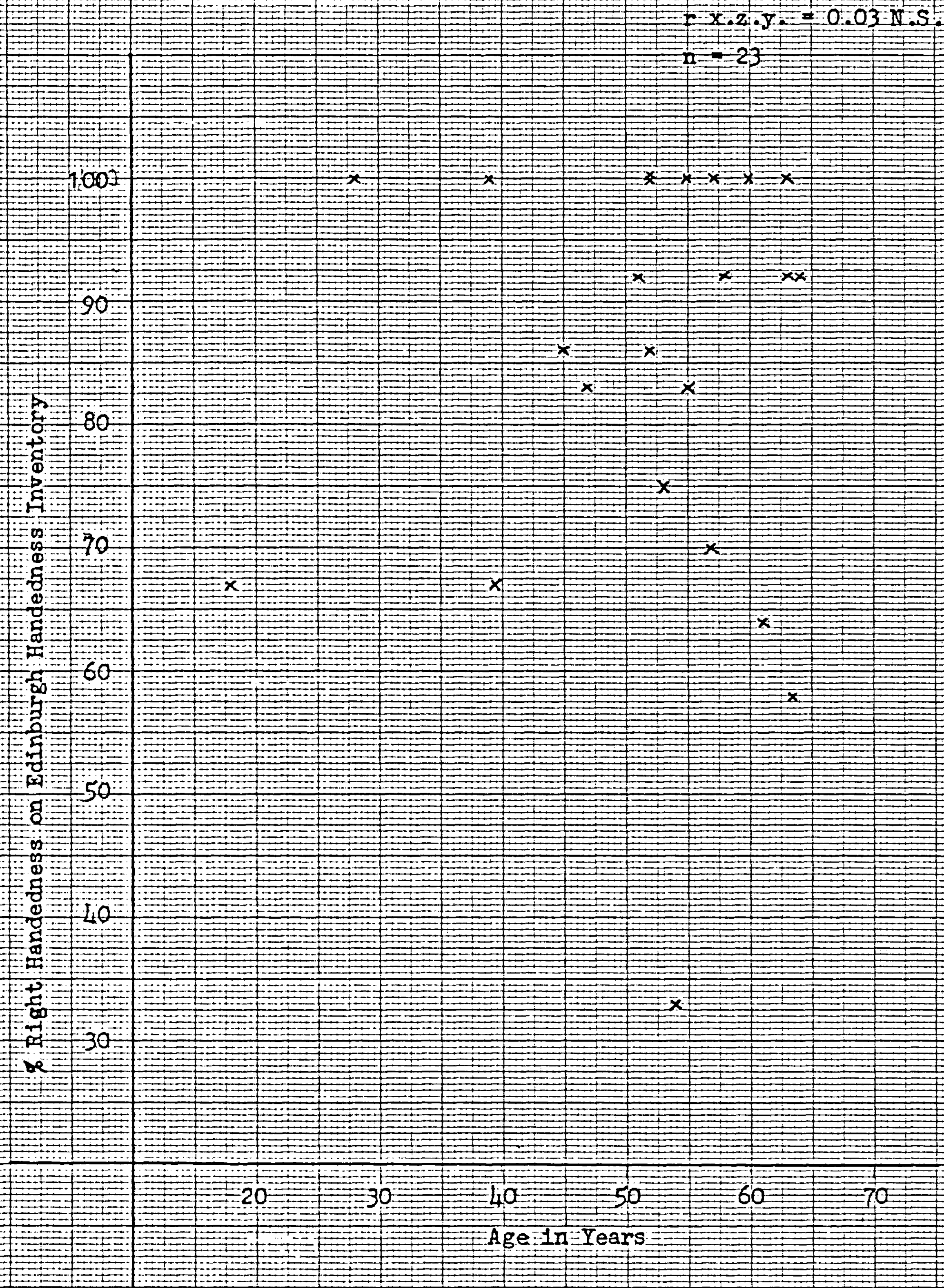


Fig. 12 Relation between Handedness (z) and Months Post Onset (y) with Age (x) constant

r y.z.x. = 0.18 N.S.
n = 23

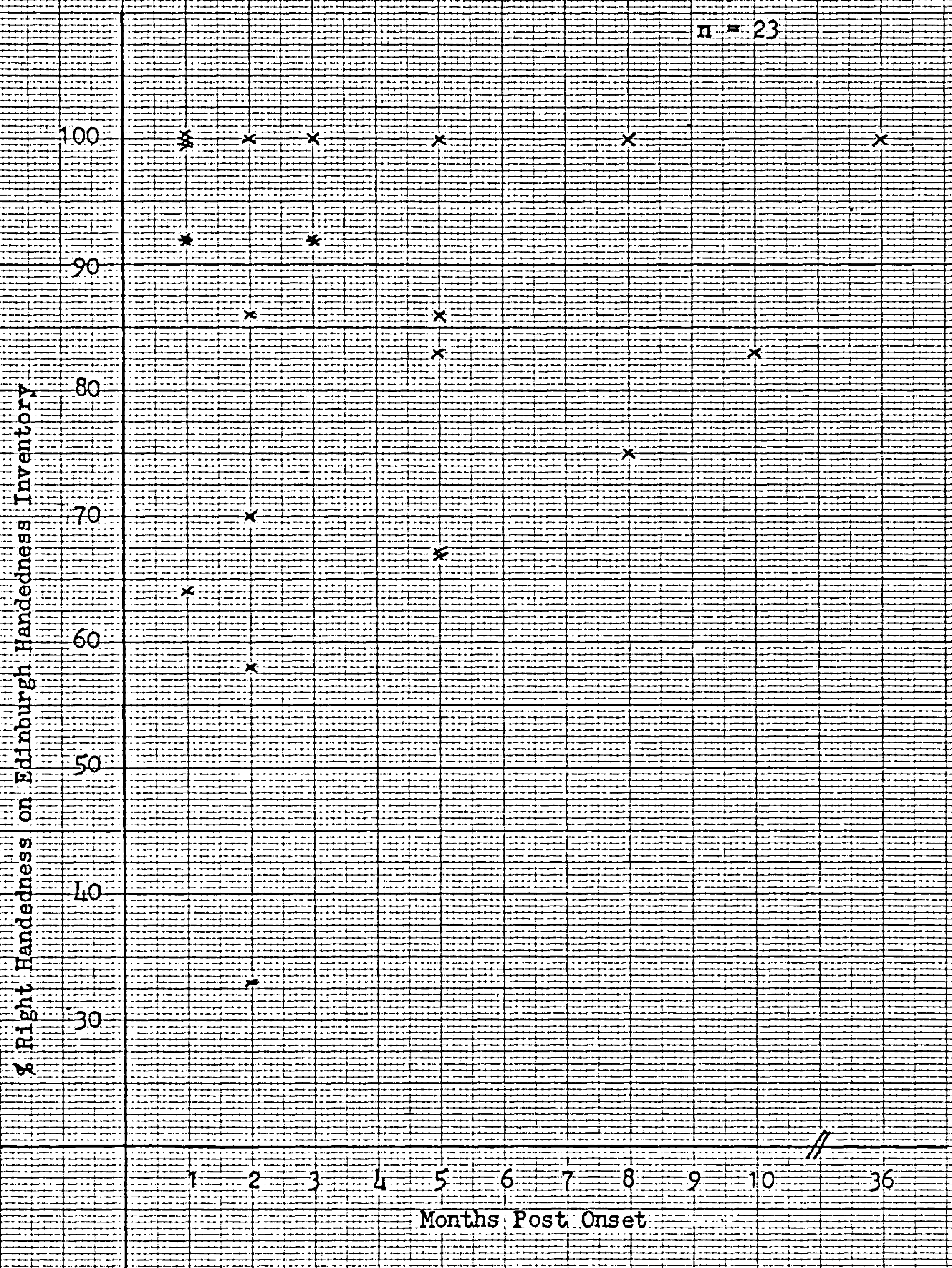


Fig. 13 Comprehension as measured on Token Test in Relation to Months Post Onset and Treatment for Moderate Aphasics in Experiment 1

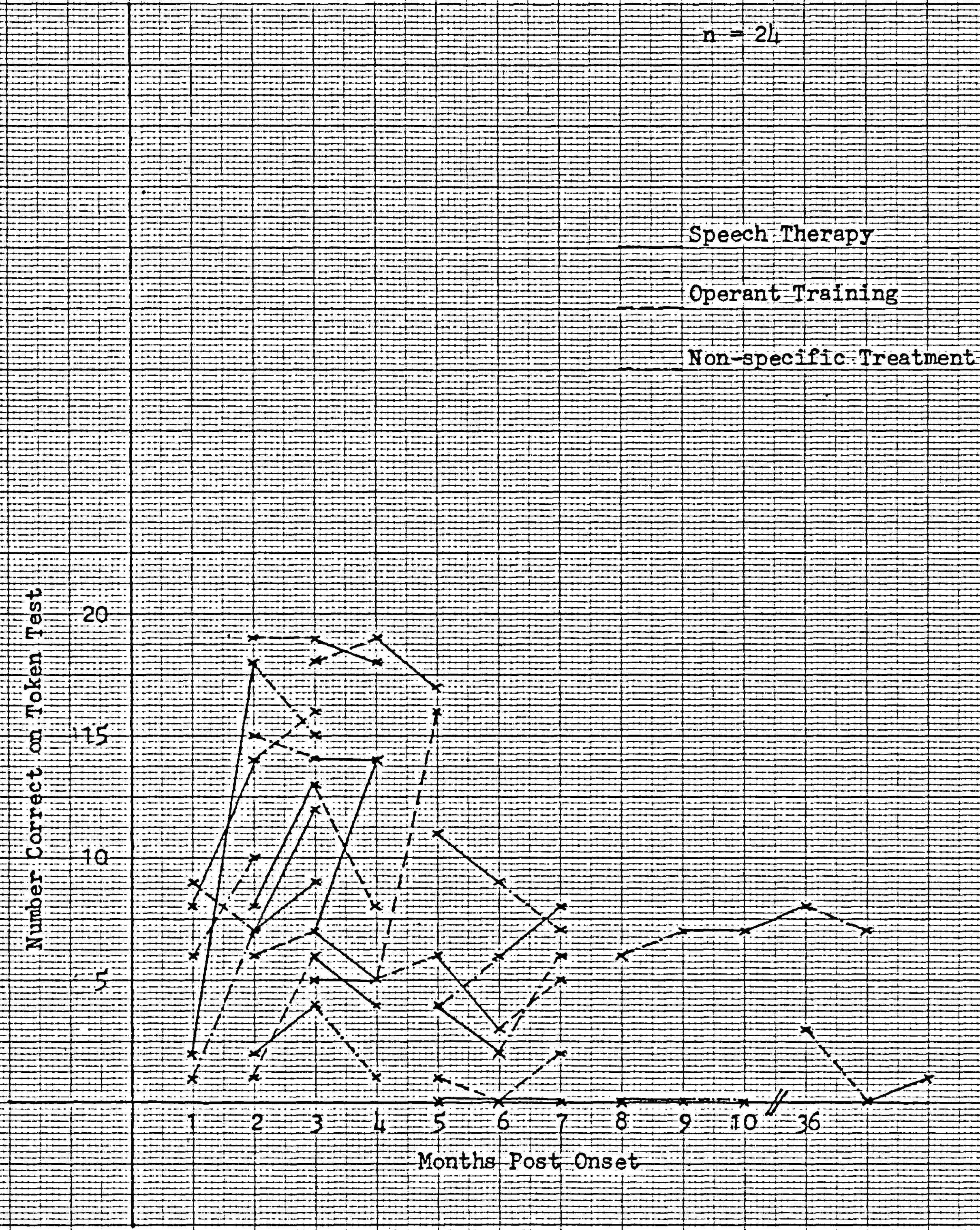


Fig. 14 Fluency in relation to Months Post Onset and Treatment for Moderate Aphasics in Experiment 1

n = 24

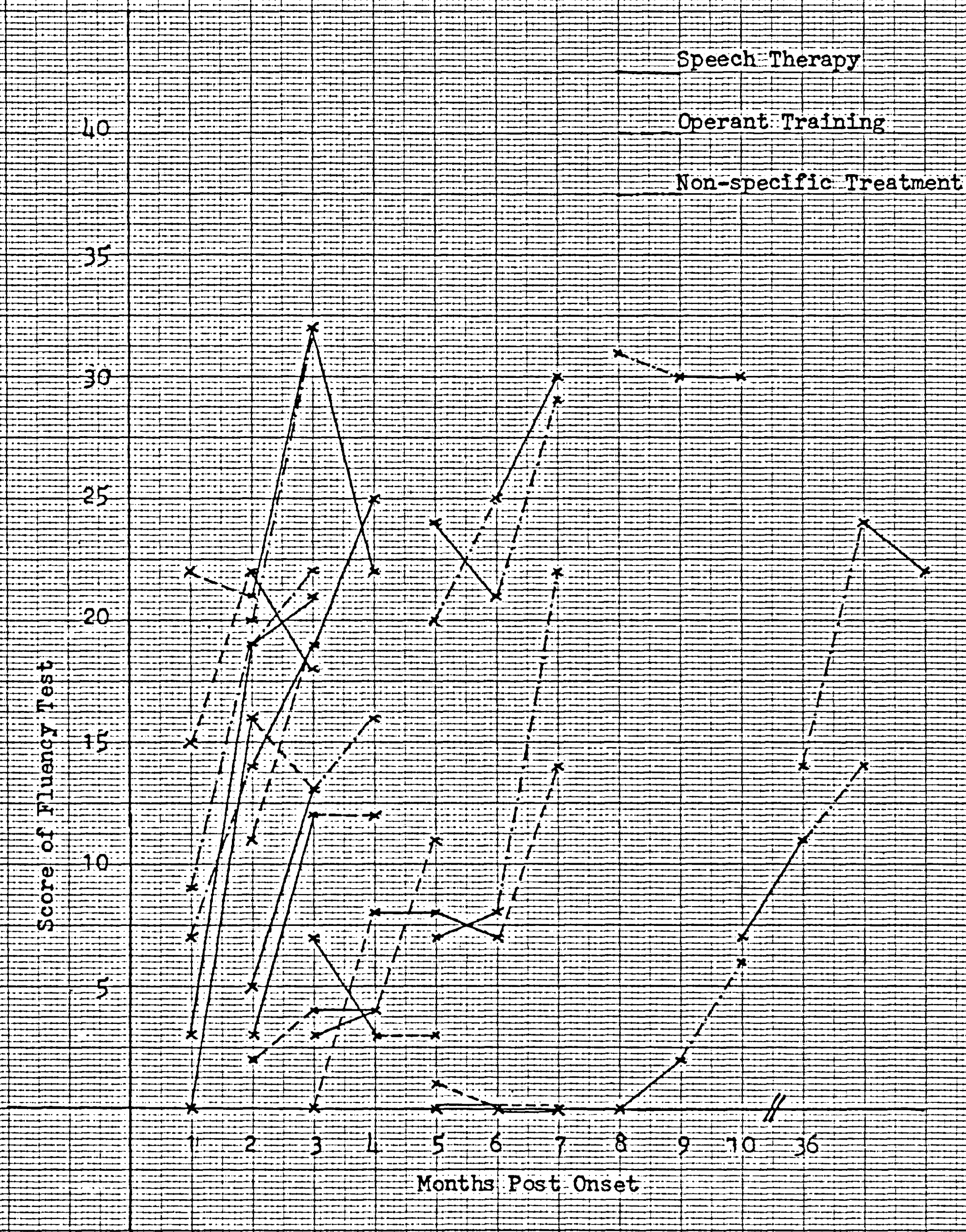


Fig. 15 Picture Description in relation to Months Post Onset and Treatment for Moderate Aphasics in Experiment 1

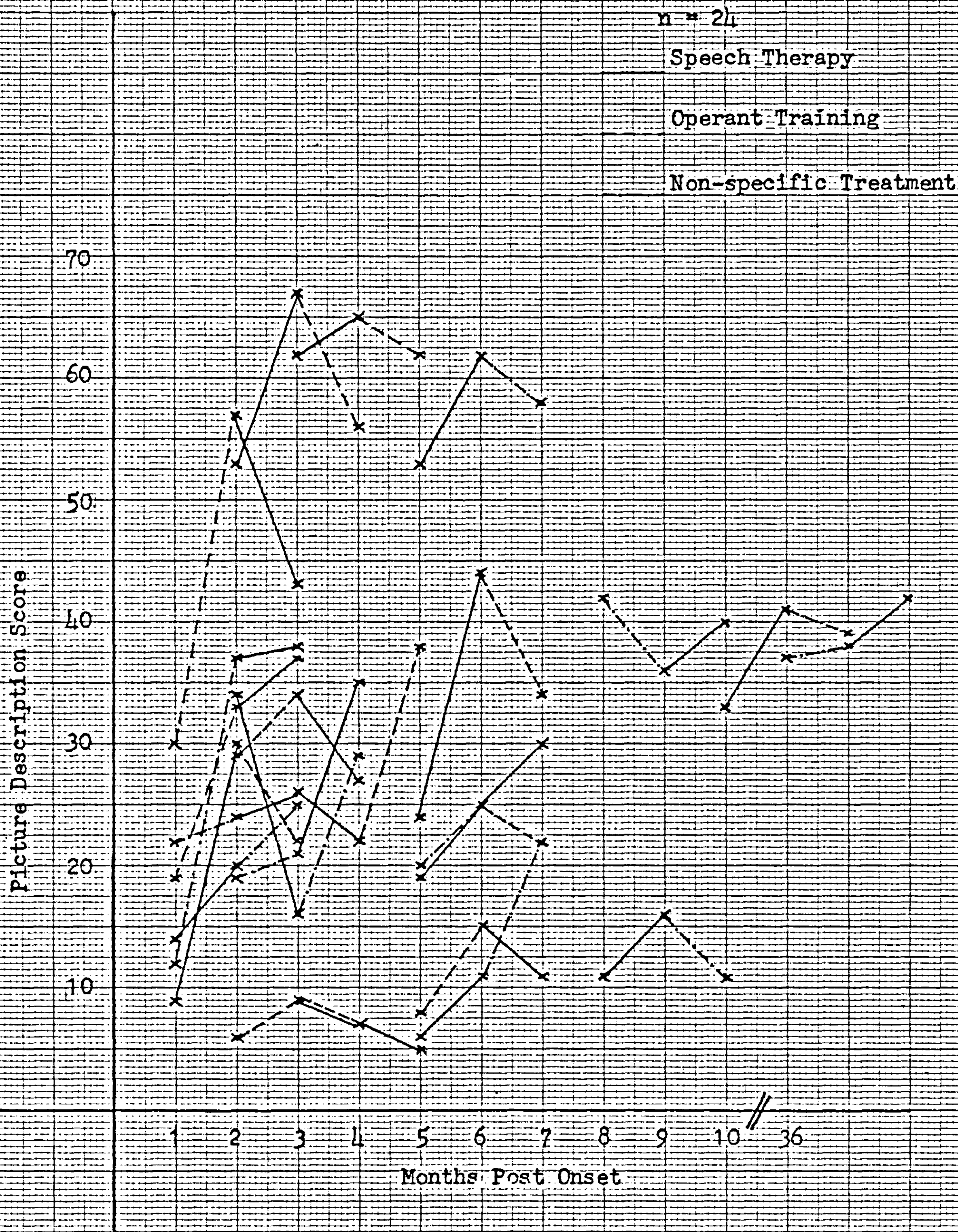


Fig. 16 Progressive Matrices Score in relation to Months Post Onset and Treatment for Moderate Aphasics in Experiment 1

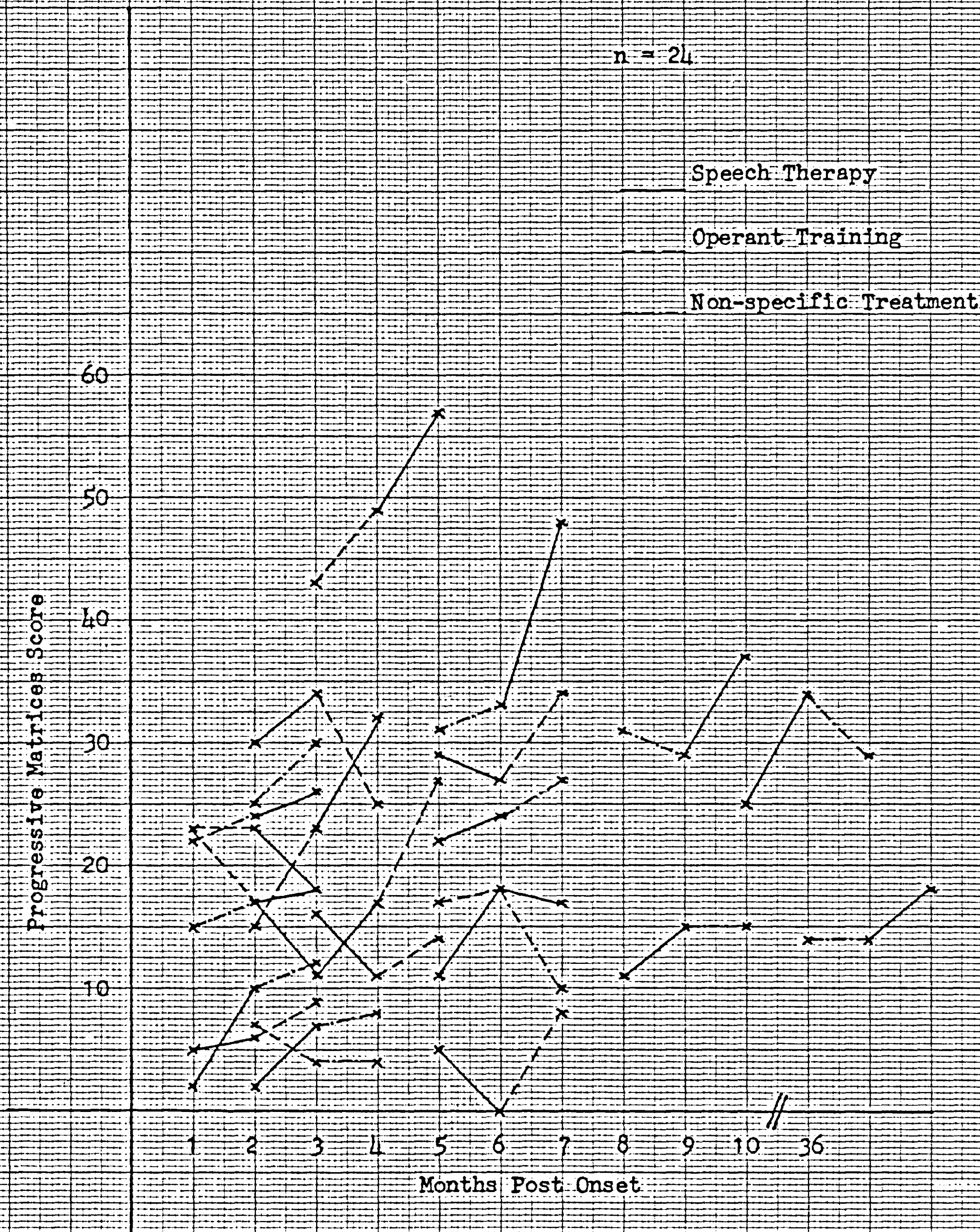


Fig. 17 P.I.C.A. Scores for Patients 32 and 93 under "no treatment" and "treatment" conditions

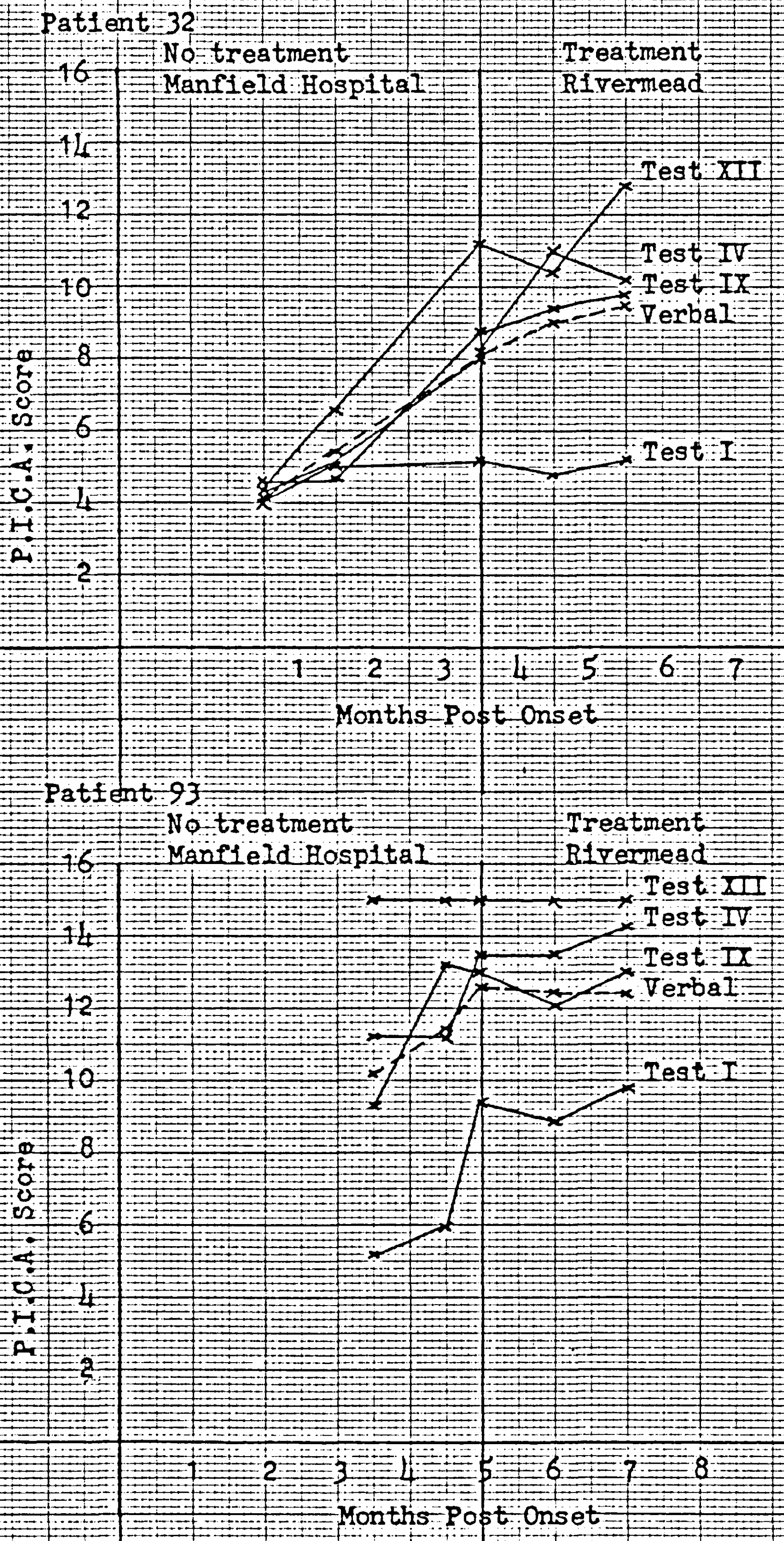


Fig. 18 Token Test Scores for Patients 32 and 93 under "no treatment" and "treatment" conditions

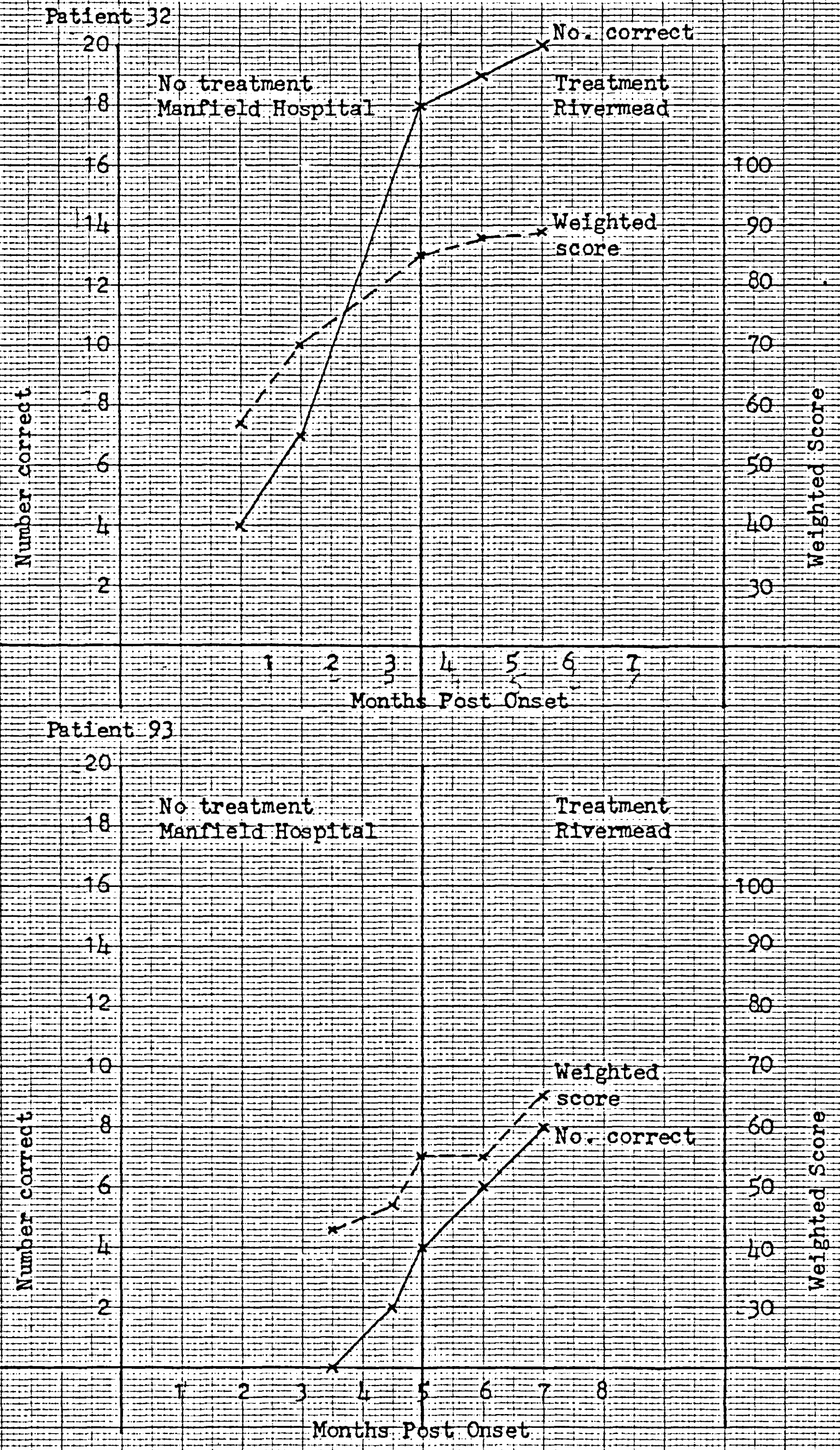


Fig. 19 Scores on Expressive Verbal Tests for Patients 32 and 93 under "no treatment" and "treatment" conditions

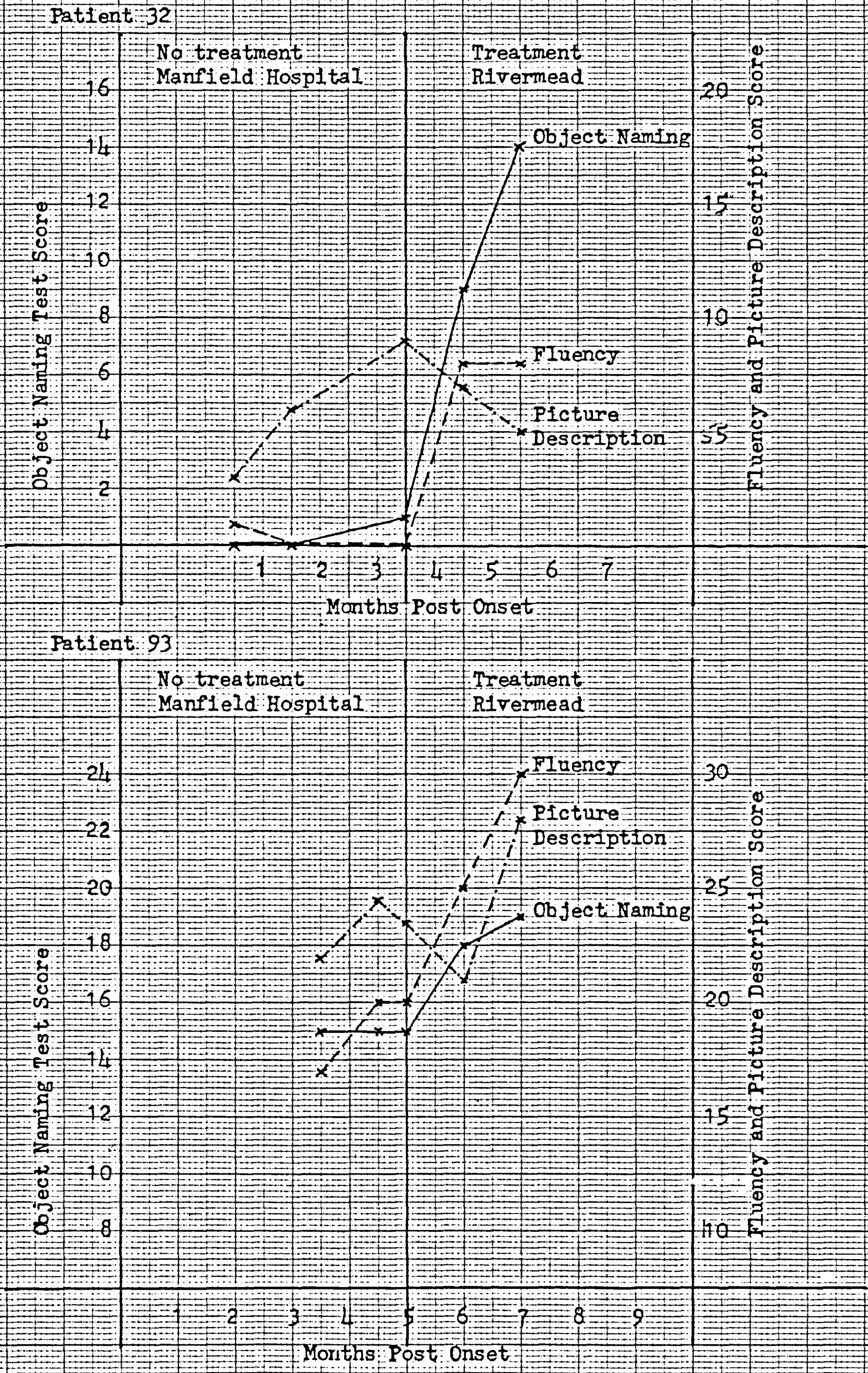
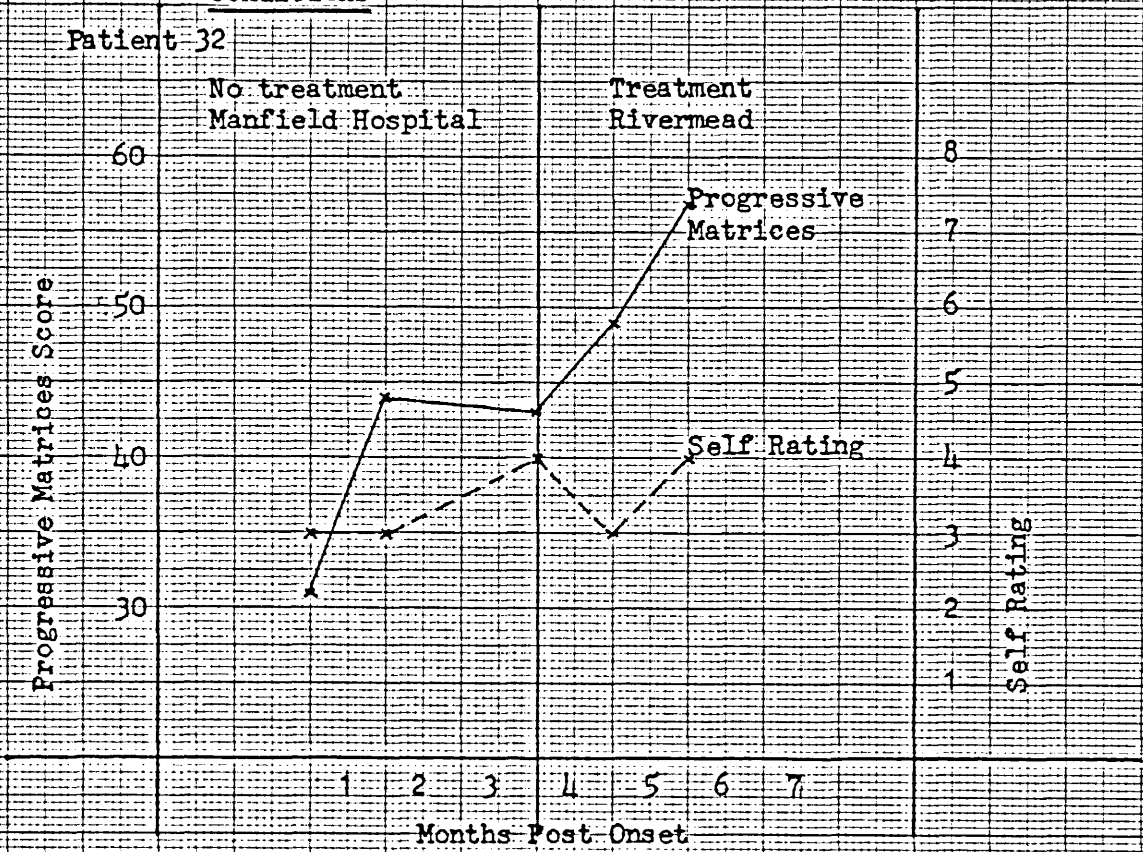


Fig. 20 Scores on Progressive Matrices and Self Rating for Patients 32 and 93 under "no treatment" and "treatment" conditions

Patient 32



Patient 93

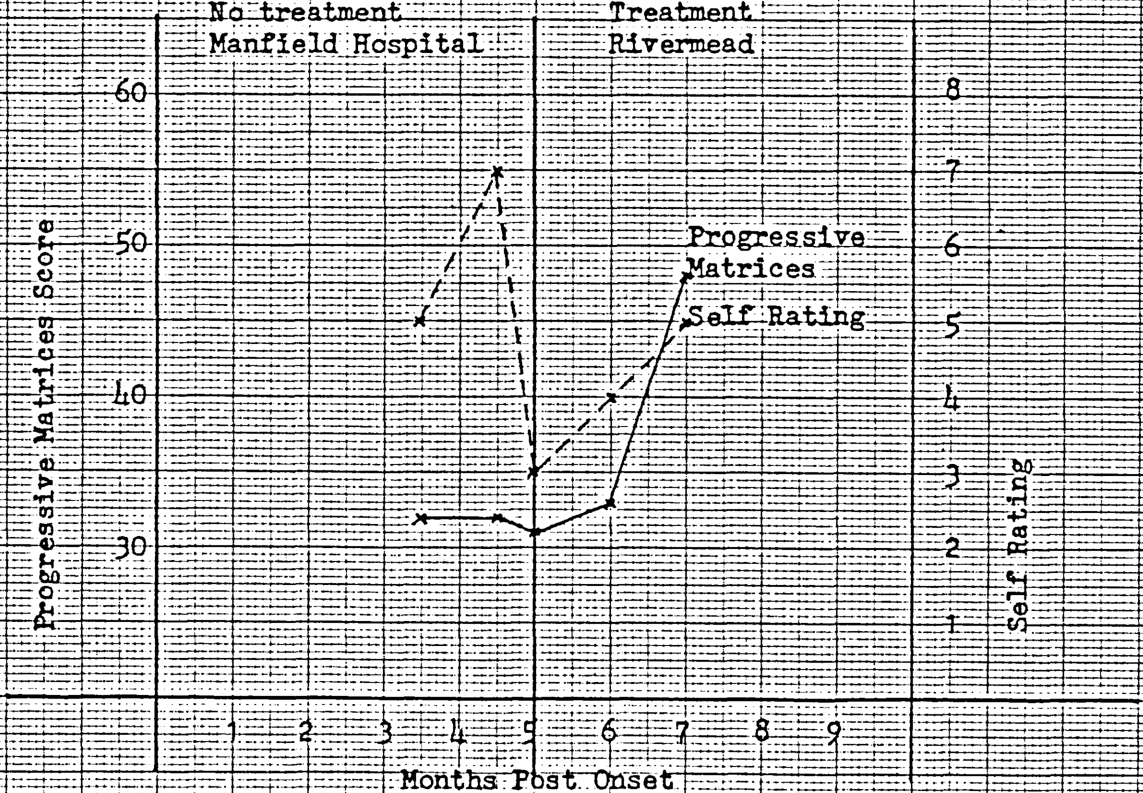


Fig. 21 Relation between Change in P.I.C.A. Verbal Score and Months Post Onset for "untreated" Aphasics in Experiment 4

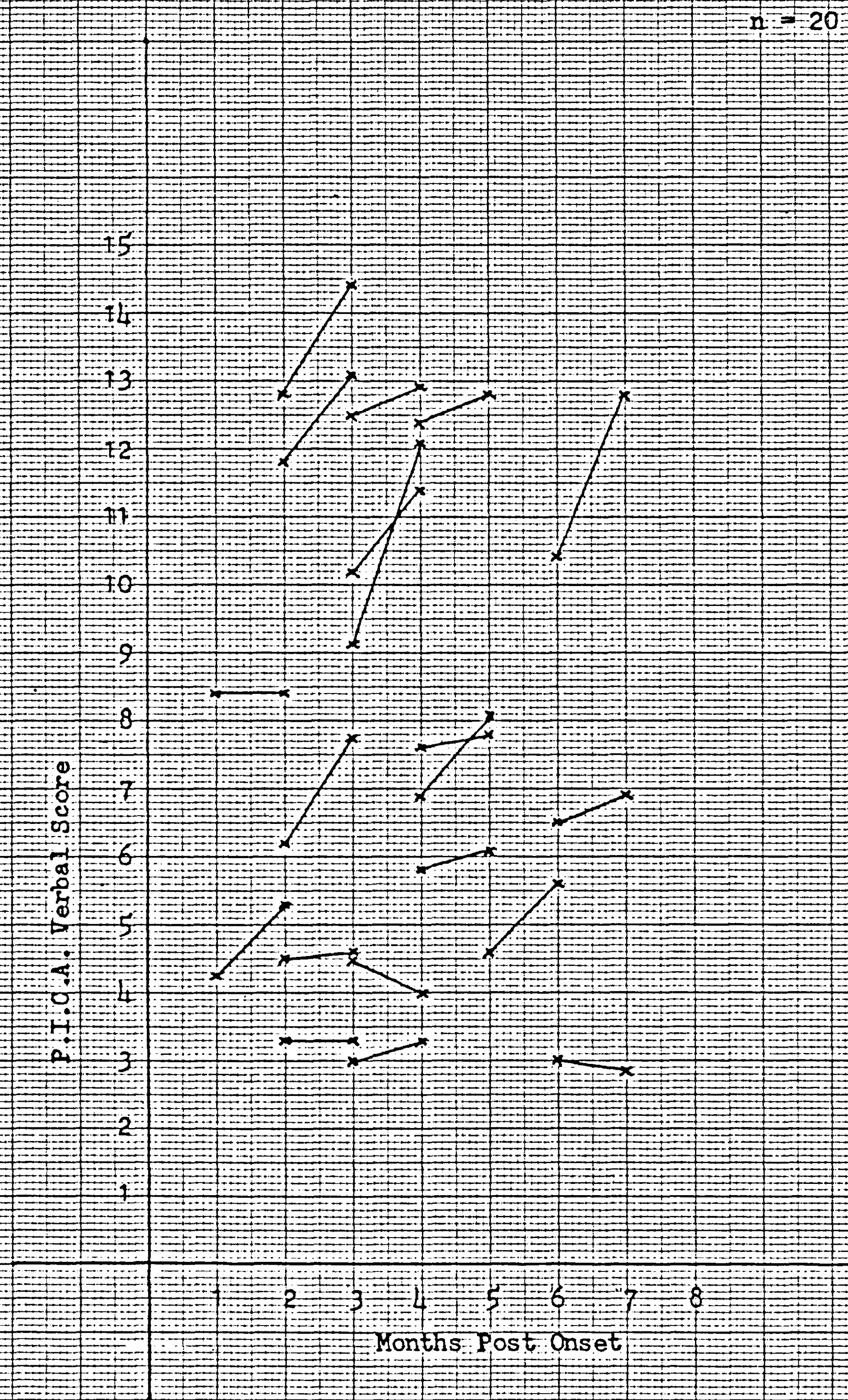


Fig. 22 Relation between Change in Token Test Score and Months Post Onset for "untreated" Aphasics in Experiment 4

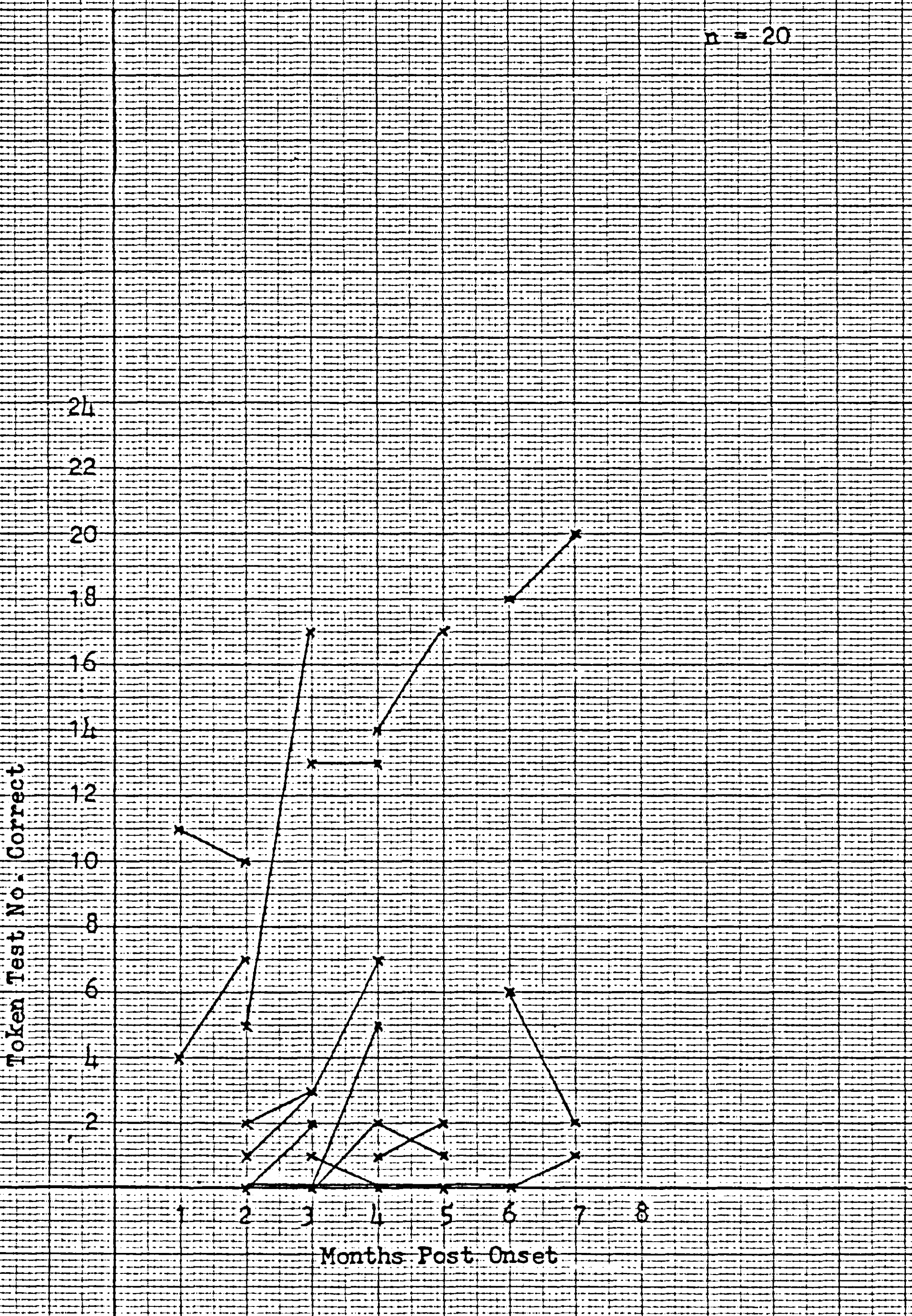


Fig. 23 Relation between Change in Object Naming and Months Post Onset for "untreated" Aphasics in Experiment 4

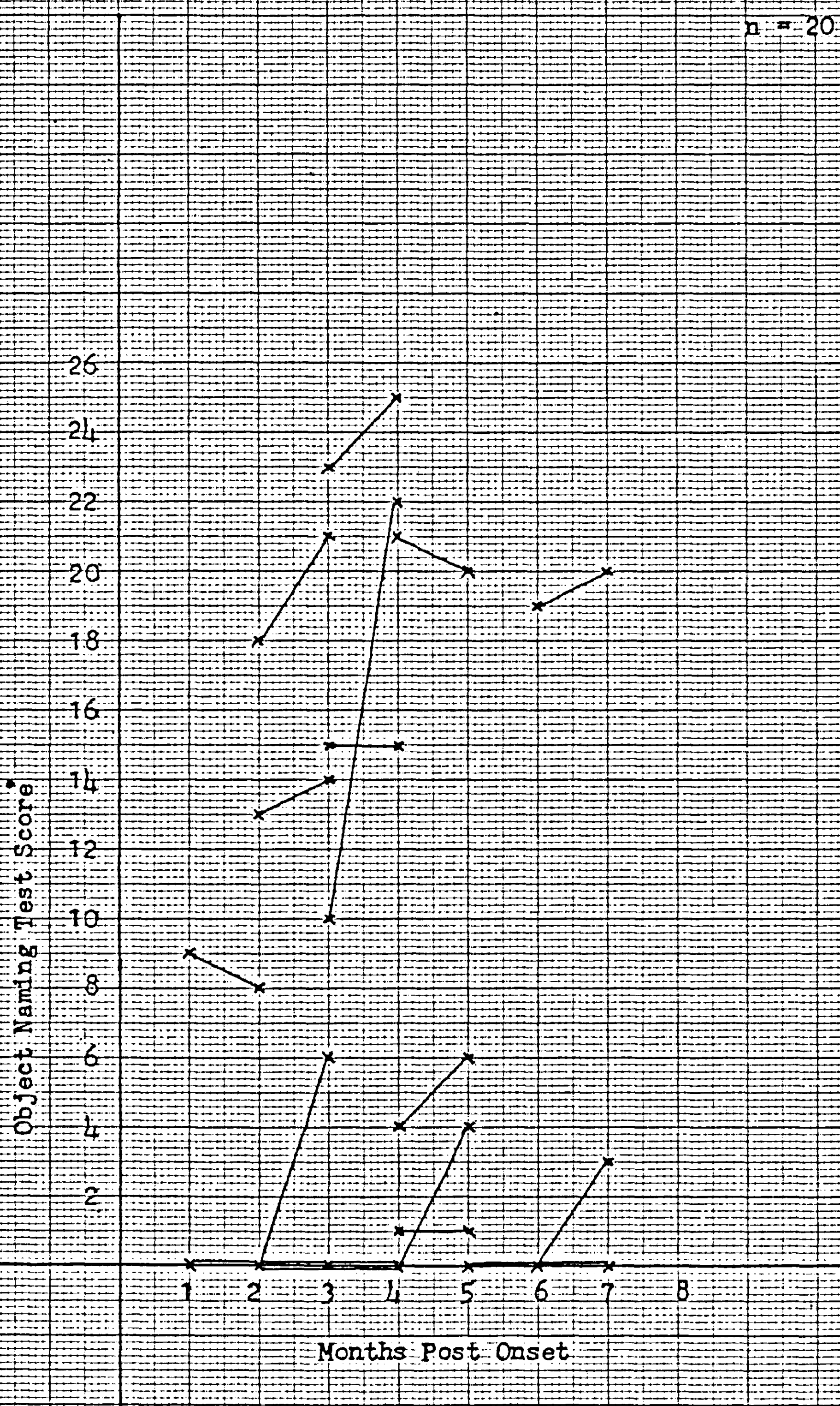


Fig. 24 Relation between Change in Progressive Matrices and Months Post Onset for "untreated" Aphasics in Experiment 4

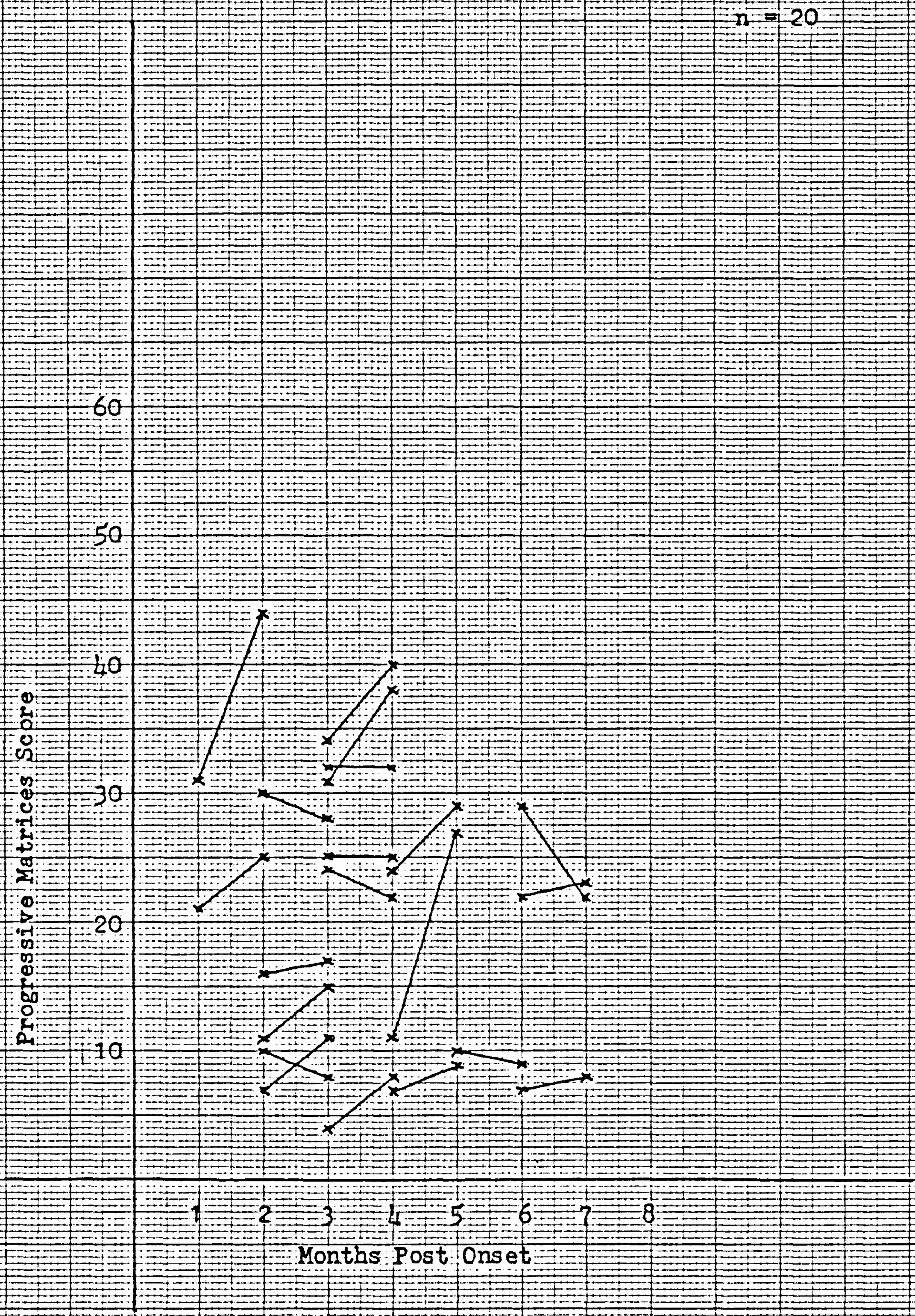
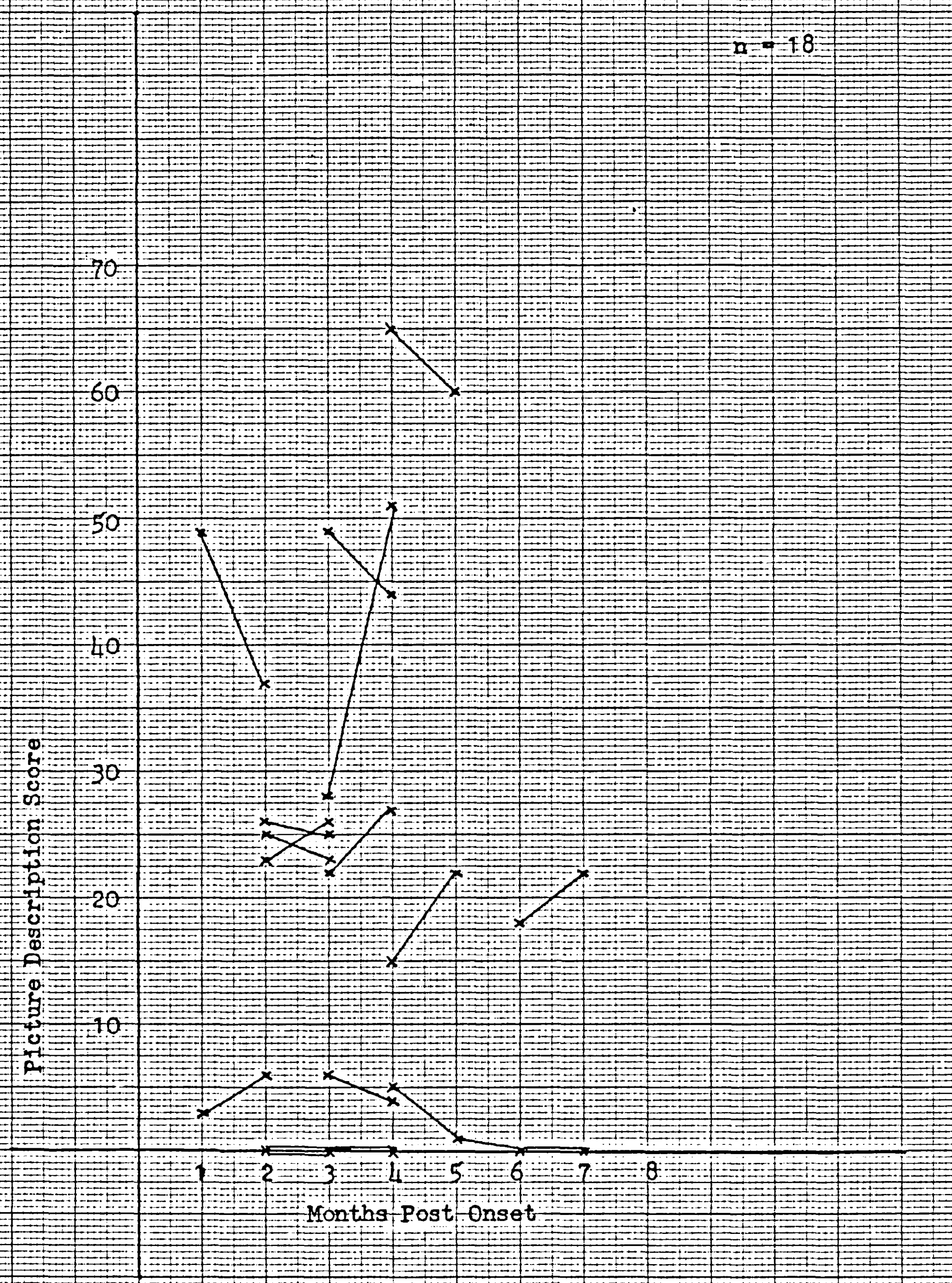


Fig. 25 Relation between Change in Picture Description Score and Months Post Onset for "untreated" Aphasics in Experiment 4



APPENDIX 1

SPEECH QUESTIONNAIRE

Patient: Date:

Completed by: Department:

Please circle the most appropriate description of this patient's behaviour at the moment based on your own experience with them.

Section 1 SPEECH

1. Does he/she use common everyday phrases spontaneously?

   Hello/Good morning....................Yes / No
   Goodbye...............................Yes / No
   Please................................Yes / No
   Thank you.............................Yes / No
   Yes...................................Yes / No
   No....................................Yes / No

2. Are these used appropriately?

   Often Sometimes Rarely No

3. Does he/she respond appropriately to familiar serial responses produced by you?

   Hello.................................Yes / No
   Good morning..........................Yes /No
   Goodbye...............................Yes / No

4. Does he/she use other words spontaneously?

   Single words..........................Yes / No
   Simple phrases........................Yes / No
   Sentences.............................Yes / No

5. Does he/she respond to your questions?

   No
   With single words
   With phrases
   With sentences

6. Does he/she initiate conversation with you?

   Often Sometimes Rarely No

7. Is this conversation appropriate?

   Often Sometimes Rarely No

8. Does he/she converse with other patients?

   Often Sometimes Rarely No

9. Does he/she initiate conversation with other patients?

Often Sometimes Rarely Never

10. Does he/she spontaneously correct errors?

Often Sometimes Rarely Never

11. Are these corrections then accurate?

Often Sometimes Rarely Never

12. Is his/her speech clear?

Often Sometimes Rarely Never

13. Is his/her speech slow or hesitant?

Never Rarely Sometimes Never

Section 11 COMMUNICATION

1. Does he/she supplement communication with gestures?

Often Sometimes Rarely Never

2. Does he/she supplement communication with writing?

Often Sometimes Rarely Never

3. Does he/she avoid conversation?

Never Rarely Sometimes Often

4. Does he/she show anxiety about communicating?

Never Rarely Sometimes Often

5. Does he/she appreciate opportunities to communicate?

Often Sometimes Rarely Never

6. Does he/she understand simple instructions?

Often Sometimes Rarely Never

7. Does he/she understand general conversation?

Often Sometimes Rarely Never