"A COMPARISON OF TWO APPROACHES IN THE TREATMENT OF PERCEPTUAL PROBLEMS AFTER STROKE"

by Judi Edmans

Thesis submitted to the University of Nottingham

for the degree of Doctor of Philosophy, November 1999.

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

There are many people who have assisted in the preparation of this thesis but I would particularly like to thank the following:-

I would like to thank the Stroke Association for the financial support to enable this study to be carried out.

I would also like to thank Mrs J. Webster for her assistance in data collection; the staff of all disciplines on the Stroke Unit for their assistance in data collection; Dr. P. Berman for permitting me to carry out this study on his ward; the patients on the Stroke Unit who agreed to participate in this research; Professor P. Fentem and the staff of the Stroke Research Unit for their support; Dr. I. Ilott for her assistance in writing the thesis; Dr P. van Vliet for her assistance regarding the viva and last but not least Professor N. Lincoln, my supervisor, for her invaluable advice and guidance throughout this study, without which I would never have managed.

Finally, I would like to thank my husband, Mr P. Fowler for his endless support, tolerance and encouragement throughout this work.

ABSTRACT

Perceptual problems are common following stroke and affect the patients' functional ability, suggesting that these problems should be treated.

Eighty patients admitted to the Nottingham Stroke Unit, were assessed for perceptual and functional abilities, using standardised assessments (Rivermead Perceptual Assessment Battery, Barthel ADL Index and Edmans ADL index). Each patient identified as having perceptual problems, was randomly allocated to one of two groups for perceptual treatment. One group followed the transfer of training approach and one group followed the functional approach. The study compared the effectiveness of the two approaches in improving perceptual and functional abilities.

Treatment was given for 2.5 hours per week for six weeks. On completion of the six weeks treatment, each patient was reassessed for perceptual and functional abilities.

There was no significant difference between the treatment groups on patient characteristics or impairments. The results also showed no significant difference between the treatment groups before and after treatment on perceptual ability total scores, individual perceptual subtest scores, or functional ability total scores (Mann Whitney U 642.5-798.0, $p > 0.05$). Wilcoxon Matched Pairs Signed Ranks Tests showed a significant improvement after treatment, on perceptual and functional abilities, (perceptual $z = 6.02$, $p<0.001$, functional $z = 6.72$, $p<0.001$).

These results indicated the improvement in perceptual abilities was equivalent using either of the two approaches. Therefore, a no treatment group of 20 patients was studied. The results showed similar results between the treatment and no treatment groups, suggesting that neither treatment approach improved outcome. However, these results may have been influenced by spontaneous recovery or the effects of the Stroke Unit.

STUDY 1

COMPARISON OF THE TRANSFER OF TRAINING AND FUNCTIONAL APPROACHES IN THE TREATMENT OF PERCEPTUAL PROBLEMS AFTER STROKE

CHAPTER ONE - INTRODUCTION

INTRODUCTION

1.1 Definition of Stroke

In 1980, the World Health Organisation (WHO) defined stroke as:-

"Rapidly developed clinical signs of focal (or global) disturbance of higher cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin" (Aho et al., 1980).

The WHO explained that this definition therefore includes most cases of subarachnoid haemorrhage, intracranial haemorrhage and cerebral infarction but not cases of transient ischaemic attacks. The term "global" disturbance referred only to patients with subarachnoid haemorrhage without focal neurological deficits.

Stroke is a common condition with many survivors remaining disabled. It is estimated that the prevalence is 6/1000 in the general population (Langhorne and Dennis, 1998). Stroke care accounts for approximately 6% of UK hospital costs which emphasises the enormity of the problem (Langhorne and Dennis, 1998) and this does not include the costs to Social Services Departments. As a result, stroke is one of the Health of the Nation (1992) targets for future action. The Health of the Nation's aim is to reduce illness and death from stroke and to reduce the risk factors for stroke (unbalanced diet, smoking, raised blood pressure, alcohol misuse and lack of physical activity) by the year 2000.

1.1.1 Problems caused by stroke

The lesion caused by the haemorrhage or infarct in the cerebral hemisphere, affects the motor and / or sensory fibres of the cortico-spinal tracts, which in turn affects the opposite side of the body, i.e. a lesion in the right cerebral hemisphere results in a left hemiplegia.

The brain is a complex structure which consists of two cerebral hemispheres, each of which is divided into four lobes. Testani-Dufour and Marano Morrison (1997) describe the functions of the four lobes as follows:

- The frontal lobe is supplied by the anterior cerebral and middle cerebral arteries. Damage to this area causes many problems, including memory, abstract thinking, judgement, ethical behaviour, emotions, insight, tact, inhibition, motor problems, non-fluent aphasia and oral dyspraxia.
- The parietal lobe lies posteriorly to the frontal lobe and is supplied by the middle cerebral artery. Damage to this area causes sensory deficits and unilateral neglect.
- The occipital lobe lies posterior to the parietal lobe and is supplied by the posterior cerebral artery. Damage to this area causes visual disorders and contralateral disorders such as hemianopia.
- The temporal lobe lies in front of the occipital lobe but below the parietal lobe and is supplied by the middle and posterior cerebral arteries. Damage to this lobe causes aphasia, comprehension, reading and jargon difficulties.

As a result of this, patients may experience different problems and to varying extents, depending on the site and severity of the lesion. The author considers the most common of these problems to be as shown in table 1.

However, there are differences according to which hemisphere is damaged, which were first noted by Hughlings Jackson in 1876. The left hemisphere is the dominant hemisphere in most right handed people and damage to this hemisphere may result in a right sided hemiparesis, where the dominant hand may be affected. Testani-Dufour and Marano Morrison (1997) stated that damage to the left anterior cerebral or middle cerebral arteries may result in aphasia and / or limb dyspraxia. Similarly, York and Cermak (1995) found that patients following left hemisphere stroke had poor gesture comprehension and poor praxis production. Lezak (1995) also described the function of the left hemisphere as being: verbal functions e.g. reading, writing, understanding and speaking; verbal ideation; verbal memory; numerical ability; control of posture and control of sequencing hand / arm movements.

The right hemisphere is the non-dominant hemisphere for most right handed people and damage to this hemisphere may result in left sided hemiparesis, where the dominant hand is spared. Testani-Dufour and Marano Morrison (1997) stated that damage to the right middle cerebral artery may result in left visual neglect and York and Cermak (1995) also found that patients following right hemisphere stroke had poor visual perception and poor gesture discrimination. Similarly, Lezak (1995) described the functions of the right hemisphere as being: perception of shapes, textures

Table 1

Common Problems Following A Stroke

1. Motor:	- loss of function head, trunk, upper or lower limb - abnormal tone - abnormal reflexes - abnormal mass movement patterns - abnormal selective movement patterns - abnormal balance - associated reactions
2. Sensation:	- tactile hemianaesthesia - proprioceptive hemianaesthesia
3. Continence:	- abnormal control of bladder - abnormal control of bowel
4. Vision:	- hemianopia - quadrantopia
5. Swallowing:	- dysphagia
6. Language:	- comprehension (dysphasia) - expressive speech (dysphasia) - dysarthria
7. Reading & writing:	- acquired dyslexia - dysgraphia
8. Calculation:	- dyscalculia
9. Perception:	- form constancy - body scheme - sequencing - spatial - inattention - agnosia
10. Cognition:	- memory - concentration - reasoning - dyspraxia
11. Emotion:	- anxiety - depression - lability

and patterns; spatial relation; visual imagery; copying and drawing figures and spatial judgement.

Thus, the main differences between the right and left hemispheres are that the left hemisphere predominates for language and praxis and the right hemisphere predominates for visual spatial ability.

1.1.2 Recovery from stroke

At present it is not known how or whether rehabilitation affects the recovery of the brain following stroke. Recent technological advances, i.e. Positron Emission Tomography (PET), Transcranial Magnetic Stimulation (TMS) and Functional Magnetic Resonance Imaging (fMRI), have demonstrated that the brain can repair itself, although different mechanisms may be responsible for this.

Various studies have described these mechanisms for recovery discovered by the use of PET, TMS and fMRI (Lee and Van Donkelaar, 1995; Steinberg and Augustine, 1997; Turton, 1998). Lee and Van Donkelaar (1995) suggested that there were three mechanisms for plastic reorganisation of the brain following stroke, i.e. reorganisation of representations and functions in the sensory and motor cortex. These were:

- unmasking previously inactive pathways
- sprouting fibres from existing functional neurones which form new synapses
- alternative pathways taking over functions, i.e. the uncrossed pathways.

Steinberg and Augustine (1997) carried out a review of studies that had used PET and fMRI to show brain recovery following stroke. They stated that "responses re-emerge in a fixed sequence that resembles the initial acquisition" but that the extent varied for each individual person. Steinberg and Augustine suggested that "the brain was comprised of parallel circuits which may be disinhibited and / or recruited when damage occurs".

Turton (1998) also explained how PET and TMS had been used to demonstrate the increased synaptic activity during hand function tasks, which confirmed reorganisation of the brain. Turton suggested that there was a reorganisation of motor pathways after stroke, to either adjacent or remote areas of the brain or that the undamaged hemisphere took over via the uncrossed fibres of tracts (approximately 80% fibres only cross over in the brain stem). She also advocated repetition to reinforce synaptic changes i.e. synaptic plasticity, use of a variety of tasks and practice of tasks using the affected limb to increase its recovery.

An explanation and some examples of the use of the three technological advances are as follows:

- PET maps the regional cerebral blood flow (rCBF). It is thought that as cerebral blood flow increases, this signifies increased synaptic activity in that area (Turton, 1998). PET cannot identify which neurones are active, so comparison of rCBF is made between rest and during activity. Weiller (1995) described three main studies (Chollet et al., 1991; Weiller et al., 1992; Weiller et al., 1993) that investigated reorganisation of the human motor system after stroke. The first study (Chollet et al., 1991) compared rCBF during movements of the recovered hand with that of the contralateral hand. The second study (Weiller et al., 1992) compared rCBF during movements of the recovered and contralateral hand of 10 patients with those of 10 normal control subjects. The third study (Weiller et al., 1993) compared rCBF during movements of the recovered hand with the mean values of the controls. The results showed a redistribution of rCBF in both hemispheres although different patterns were noticed for different individuals.

- TMS investigates corticospinal tract connections. A large current is passed briefly from a stimulating coil over the head of the patient, to produce a fast changing magnetic field (Turton, 1998). Traversa et al. (1997) used TMS to map the somatotopical organisation of the motor cortex. They investigated the effect of finger movements on both hemispheres in 15 patients following either right or left hemisphere stroke and 15 healthy control subjects. Their findings demonstrated the "plasticity" of the central nervous system. Netz et al. (1997) also used TMS over the unaffected hemisphere with 15 patients with hemiparesis following stroke. The responses were recorded by electrodes attached to the thenar muscles of both hands and compared with normal control subjects. They found that the motor output in the unaffected hemisphere had changed significantly following stroke and that plastic changes in the motor output organisation were identified in the unaffected hemisphere.

- fMRI "assesses transient hyperoxygenation of the venous blood pool or changes in blood flow velocity, both of which may be related to neuronal activity" (Weiller, 1995). Cramer et al. (1997) used fMRI to compare brain activations in normal controls and subjects who had recovered from hemiparetic stroke. FMRI was performed during an index finger tapping activity, to identify brain activation. The results showed that the stroke subjects and controls activated the same motor regions. The stroke subjects activated a larger area than the controls, particularly in the unaffected hemisphere. They concluded that fMRI studies provided evidence for the restoration of neurological function. Cao et al, (1998) also used fMRI, with eight right handed patients recovering from hemiparesis and compered the results with those from a control group. The patients were scanned whilst carrying out a sequential finger oppostion task. They suggested that "pre-existing uncrossed motor neural pathways may be accessed or recruited to compensate for damage to the crossed motor pathways after stroke". A further study by Thurlborn et al. (1999) investigated the correlation between functional recovery from aphasia following stroke and brain activation. They studied six normal adults and two adults with aphasia after stroke. Their results showed normal activation for language was predominantly in the left hemisphere whereas activation from the patients with aphasia was in the right hemisphere.

The main difficulty with these modern techniques is that the patient has to remain still during the investigation with functional activity consequently being limited, which may not reflect stroke recovery. Further research is still needed to correlate perceptual ability with brain activation.

1.1.3 Spontaneous recovery

An aspect of stroke recovery that needs to be considered is that of spontaneous recovery. Gresham (1986) described spontaneous recovery as being "spontaneous return of some degree of neurological function" which is thought to be completed by six months post stroke. Gresham explained that this "recovery" may be marginal or dramatic.

When studies of stroke rehabilitation are carried out within the first six months after stroke, the effects of spontaneous recovery therefore need to be considered.

Kwakkel et al. (1999) claimed that it was impossible to detect whether early improvement following stroke was due to the effect of rehabilitation or spontaneous recovery. They described the mechanisms that could be responsible for spontaneous recovery. These included:

- "recovery of penumbral tissue around the infarcted area (Furlan et al., 1996)
- subcortical reorganisation by means of repair, caused by denervation and supersensitivity, axonal growth and synaptogenesis (Nudo et al., 1996)
- reduction of temporarily deactivated intact brain regions, remote from but automatically connected to the area of primary injury (Feeny and Baron, 1986)
- reinforcement of ipsilateral motor pathways, such as thalamus, caudate, lentiform nuclei and premotor cortex (Weiller et al., 1993)
- behavioural compensations".

Another study which considered the effect of spontaneous recovery, was that of Friedman and Leong (1992b). They assessed the changes in perceptual abilities that occurred over the first three months following stroke. The study included 70 patients, aged 60+ years, who were assessed on the Rivermead Perceptual Assessment Battery within two weeks of their stroke. Eighty six percent were classified as having perceptual problems and these patients were reassessed three months later, on the subtests that they had failed. Improvements were identified on all 16 subtests, although 64% of patients were still classified as having perceptual problems. Friedman and Leong concluded that perceptual abilities greatly improved over the first three months after stroke, but that perceptual problems still remained common. However, Friedman and Leong did not describe what treatment these patients had received between the assessments. The results indicated that spontaneous recovery had some effect on perceptual ability but did not resolve the perceptual problems completely.

1.2 Definition of Perception

According to the Oxford English Dictionary (Fowler and Fowler, 1961) the definition of "perceive" is "become aware of by one of the senses" and perception is therefore "the act or faculty of perceiving, referring of sensations to their external causes".

Laidler (1994) also defined perception as "the ability to interpret sensory messages from the internal and external environment such that the sensation has meaning, i.e. the process is the mental interpretation of a sensory stimulus".

Similarly, Grieve (1993) explained that "from moment to moment all the senses, vision, sound, touch, pain and proprioception, pick up information from the world around us and from inside the body. Perception is the processing in the brain that transforms all this information into our immediate experience of the world". She also stated that "our expectations and our past experiences have an active influence on perception".

For the majority of people vision is the primary sensory system, although tactile, proprioceptive and auditory systems predominate for blind or partially sighted people. It is the treatment of visual perceptual problems only that is the focus of this study.

1.3 Classification of Perceptual Problems

There are many types of perceptual problems that can occur following a stroke. The classification of these problems that is most well recognised by the medical profession, is by Benton (1984), who classified perceptual problems into three main categories - visuoperceptive, visuospatial and visuoconstructive.

1.3.1 Visuoperceptive problems

Visuoperceptive problems include:-

I. Visual object agnosia - an impairment in the recognition of objects, although visual acuity is intact.

II. Defective visual analysis and synthesis - difficulty in making fine visual discrimination, separating the foreground from the background, recognising on the basis of incomplete information or synthesising elements into meaningful unity, e.g. viewing an action picture.

III. Impairment in facial recognition - difficulty in identifying familiar persons (prosopagnosia or facial agnosia).

IV. Impairment in colour recognition - difficulty in naming colours correctly without an impairment in object naming (colour agnosia).

1.3.2 Visuospatial problems

Visuospatial problems include:-

I. Defective localisation of points in space - difficulty in differentiating positions of items in the visual fields.

II. Defective judgement of direction and distance - including depth perception.

III. Defective topographical orientation - difficulty in understanding the relationships of places to one another. This causes problems in finding the way from one place to another.

IV. Unilateral visual neglect - difficulty in responding to stimuli in one or other lateral visual field. This differs from homonymous hemianopia, a visual field defect, where the patient learns to compensate by postural adjustments.

1.3.3 Visuoconstructive problems

Visuoconstructive problems are known as constructional praxis and refer to any type of performance in which parts are put together to form a single object. This includes:-

I. Defective assembling performance - difficulty assembling blocks to form a design.

II. Defective graphomotor performance - difficulty drawing four lines to form a rectangle.

However, the standardised perceptual assessments that were available to Occupational Therapists at the start of this study, did not strictly follow this classification. The classification of perceptual problems, most widely used by Occupational Therapists, is by Zoltan, Siev and Freishtat (Siev and Freishtat, 1976; Zoltan, Siev and Freishtat, 1986), who classified perceptual problems into four main categories:- body image and body scheme, spatial relations, apraxia and agnosias. They chose these categories for clarity in describing the different perceptual problems that patients may suffer following a stroke. Zoltan, Siev and Freishtat subdivided each of these main categories as follows:-

1.3.4 Body Image and Body Scheme Problems

Body Image problem:- is the lack of visual and mental image of one's body. This relates to the feelings and thoughts of the body, rather than the physical structure.

Body Scheme problem:- is the difficulty in perceiving the position of the body and the relationship of body parts. This is needed in order to know what, where and how to move oneself.

Somatognosia:- is the lack of awareness of the body structure and relationships, causing the patient to confuse the sides of the body and body parts.

Unilateral Neglect:- is the neglect of the affected side of the body or the environment.

Anosognosia:- is the lack of recognition of the presence or severity of the paralysis, or compete denial of the illness.

Right / Left Discrimination problem:- is difficulty in understanding the concept of right and left.

Finger Agnosia:- is the difficulty in knowing which finger is touched, when there is no sensory loss, causing dexterity problems.

1.3.5 Spatial Relations Problems

Spatial Relations problem:- is the difficulty in perceiving the position of two or more objects in relation to oneself or each other, e.g. difficulty putting food onto a spoon and then into the mouth or difficulty putting a teapot lid on a teapot.

Figure Ground Problem:- is the difficulty in distinguishing the foreground from the background, e.g. difficulty finding a brush in a cluttered drawer or a white shirt on a white sheet.

Form Constancy problem:- is the difficulty in attending to subtle variations in form, e.g. difficulty differentiating between a water jug and flower vase.

Position in Space problem:- is the difficulty in understanding the concept of in/out, front/behind, up/down etc., e.g. difficulty finding a cup behind a kettle.

Topographical Disorientation:- is the difficulty in understanding and remembering relationships of places to one another, e.g. difficulty in finding one's way.

Depth and Distance problem:- is the difficulty in judging depth and distance, e.g. difficulty navigating stairs and barriers such as walls or doorways, or difficulty knowing when a glass is full when filling it with water.

1.3.6 Apraxias

Apraxia:- is the difficulty in performing skilled, purposeful movements without the loss of motor power, sensation, co-ordination, dementia or unco-operativeness.

Motor Apraxia:- is the loss of memory patterns for movement, causing difficulty in performing purposeful tasks on command, although understanding of the concept and purpose of the task is intact. It is a deficit of execution, e.g. a patient may be able to carry out simple motor tasks automatically, but cannot complete a complicated sequence.

Ideomotor Apraxia:- is the difficulty in imitating gestures or performing purposeful motor tasks on command, although the patient fully understand the concept. The memory patterns for movement are intact and there is no difficulty carrying out habitual tasks, e.g. if a patient is asked to write with a pencil, he / she could describe the act and recognise it but not write on command, yet could do so spontaneously.

Ideational Apraxia:- is the difficulty carrying out an activity automatically or on command, due to difficulty understanding the concept of the act or the sequencing, e.g. if a patient is given a cigarette and match and told to light the cigarette, he / she may put the match in his /her mouth, or put the unlit match to the cigarette and be unable to describe the function of the match.

Constructional apraxia:- is the inability to copy, draw or construct in two or three dimensions e.g. a patient may be unable to perform purposeful acts while using objects in the environment.

Dressing apraxia:- is the inability to dress oneself because of a disorder of body scheme and / or spatial relations.

1.3.7 Agnosias

Agnosia:- is the lack of recognition of familiar objects perceived by the senses, i.e. visual, tactile, proprioceptive, auditory or body scheme.

Visual Object Agnosia:- is the difficulty in recognising objects although visual acuity and visual fields are intact, e.g. a patient may fail to recognise relatives or possessions.

Simultanognosia:- is the difficulty in absorbing more than one aspect of a whole picture, e.g. a patient may be able to pick out a single letter but be unable to read a complete word.

Prosopagnosia:- is the difficulty in recognising differences in faces.

Colour Agnosia:- is the difficulty in recognising colours.

Metamorphosia:- is the difficulty in realising the actual size of an object.

Tactile Agnosia (Astereognosis):- is the difficulty in recognising objects by touch, although tactile, thermal and proprioceptive functions are intact.

It is not clear where Zoltan et al. derived this classification from and some subdivisions may appear to be under the incorrect category e.g. somatognosia, anosognosia and finger agnosia, are all under the category of body image and body scheme, although some may say they should be under the category of agnosia. Similarly, it may be argued that Zoltan et al.'s description of constructional apraxia and dressing apraxia, are not apraxias at all but problems of spatial relations and body image / scheme. However, providing all the perceptual areas included in the subdivisions are assessed, the classification of these subdivisions into the four categories is of less importance. The classification of Zoltan, Siev and Freishtat (1986) was chosen for use in this study as it was most closely related to the classification of perceptual problems as identified using the Rivermead Perceptual Assessment Battery (RPAB) (Whiting et al., 1985). It should be remembered though that several of the above problems are interrelated and may therefore occur together. Patients are likely therefore to have a combination of perceptual problems rather than just one individual perceptual problem alone, which is why the treatment of perceptual problems is such a challenging and complex problem.

Another consideration is that unilateral neglect may also be described as being an attentional disorder or a disorder of mental representation. Heilman and Valenstein (1979) and Kinsbourne (1977) describe the role of each hemisphere in orienting attention to the opposite side of space i.e. the right hemisphere orients attention to the left side of space and vice versa. They suggest that damage to one hemisphere causes an imbalance in orienting, resulting in attention being directed to the other side of space i.e. damage to the right hemisphere causes attention to be directed to the right, resulting in left sided neglect. Bisiach et al. (1978) suggested that patients with unilateral neglect may be unable to form mental images or representations of the affected side of space. They asked patients with left unilateral neglect following stroke, to describe a well known street from one end and then to describe it from the other end. They found that patients omitted the left side of the street on both occasions. Riddoch and Humphreys (1994) also support the suggestion of unilateral neglect being an attention disorder. They argue that patients with unilateral neglect are unable to attend appropriately to stimuli on the contralesional side of space, which caused the patients difficulty in object and word recognition. They also claim that contralesional stimuli may be processed more poorly than ipsilateral stimuli and that these patients have poor internal representations. If unilateral neglect is in fact an attention disorder rather than a perceptual disorder, this may have implications on the strategies used in treatment and needs to be taken into consideration.

More recent classifications of perceptual / cognitive problems have been described by McCarthy and Warrington (1990), Lezak (1995) and Ellis and Young (1996). McCarthy and Warrington (1990) classified cognitive problems into problems of object recognition; face recognition; spatial perception; voluntary action (dyspraxia); language abilities; memory and problem solving. Each of these classifications was then divided into subdivisions. They claimed that object recognition, face recognition and spatial perception were disorders originating from damage to the right hemisphere whereas voluntary action disorders originated from damage to the left hemisphere, suggesting therefore that dyspraxia and other types of perceptual problems originate from different areas of the brain.

Lezak (1995), also suggested that perceptual problems did not include dyspraxia. She classified cognitive problems into four aspects, as in computer functions i.e. input (receptive functions, i.e. sensation, perception, attention, concentration); storage (memory and learning, i.e. verbal and visual memory, short and long term memory);

processing (thinking i.e. reasoning, judgement, problem solving); and output (expressive functions, i.e. dysphasia, dyspraxia, constructional disorders).

A more recent classification was by Ellis and Young (1996) which was similar to that of McCarthy and Warrington (1990). Ellis and Young (1996) classified cognitive problems as disorders of object recognition, visual and spatial abilities, face processing, language abilities and memory, again with subdivisions in each category.

All these authors agreed on the inclusion of three main problem areas, i.e. agnosias, spatial problems and unilateral neglect (inattention). According to Lezak (1995), these are all input problems and McCarthy and Warrington (1990) suggested that these originated from damage to the right hemisphere. Dyspraxia was included in some classifications but is thought to arise from damage to the left hemisphere (McCarthy and Warrington, 1990) and was classified as an output function by Lezak (1995).

To add to this debate about the classification of perceptual problems, Bowen et al. (1999) carried out a systematic review of the frequency of unilateral spatial neglect. This study highlighted the many different terms used, which refer to unilateral spatial neglect. Heilmann et al. (1993) defined unilateral neglect as "a failure to report, respond or orient to stimuli in the contralesional hemispace that cannot be attributed to sensory or motor impairments". However, many terms are still used to describe this impairment, e.g. unilateral neglect, unilateral inattention, hemi neglect, hemi inattention, a disorder of attention, a disorder of intention to act, visual inattention, perceptual neglect, motor neglect.

Overall, different authors use a different classifications of perceptual / cognitive problems and different terminology resulting in an inconsistent approach to the classification of perceptual problems. For this reason, the classification most widely followed by Occupational Therapists, i.e. that of Zoltan et al. (1986) was used for this study.

1.4 Frequency of perceptual problems

Perceptual problems have been shown to be common following both right and left hemiplegic stroke (Andrews et al., 1980; Bernspang et al., 1982b; Van Ravensberg et al., 1984; Edmans and Lincoln, 1987). However, the proportion of patients with perceptual problems appears to vary according to which patients are assessed and which assessments are used. For instance:

- Andrews et al. (1980) assessed 135 patients, including right and left hemiplegic stroke patients, both men and women, of all ages, on simple drawing tests to identify the presence of perceptual abnormalities. They found that approximately half their patients had difficulties on these tasks. They also found no significant difference between patients with left or right hemiplegia or between males and females.

- Bernspang et al. (1982b) assessed 57 patients, including right and left hemiplegic stroke patients, both men and women, with a mean age of 72 years, using a modified version of the LOTCA (Itzkovich et al., 1993). They found perceptual problems were evident in 75% of left hemiplegic stroke patients and 37% of right hemiplegic stroke patients.

- Van Ravensberg et al. (1984) assessed visual perception in 46 patients, including right and left hemiplegic stroke patients, male and female, with ages ranging from 17 to 77 years, using a rod test of vertical perception, perception of distance equality, a motor free visual perception test and a three dimensional constructional test. They found 54% had disturbed visual perception and there was a significant difference in performance between left and right hemiplegic patients with the left hemiplegic patients performing worse.

- Edmans and Lincoln (1987) assessed 150 patients, including right and left hemiplegic stroke patients, male and female patients, with ages ranging from 39 to 89 years, using the RPAB (Whiting et al., 1985). They found perceptual problems in 81% of left hemiplegic, 71% of right hemiplegic, 97% dysphasic right hemiplegic, 47% non-dysphasic right hemiplegic, 84% female and 67% male stroke patients.

All these four studies included sufficient number of both right and left hemiplegic stroke patients, males and females patients, of all ages. In these studies patients were assessed within one month of their stroke, with the exception of the Van Ravensberg et al. study where the patients were within two years of their stroke. Patients in the

Bernspang et al. and the Edmans and Lincoln studies were consecutively admitted to hospitals and in the Andrews et al. study were listed consecutively in a register from general practitioners and hospitals. In all three of these studies, all the patients were included, not just those selected as being thought to be suitable for rehabilitation. In contrast, the Van Ravensberg et al. study included patients admitted to a rehabilitation centre, where the neurologist and rehabilitation team decided whether patients were suitable for rehabilitation. Very severe and / or mild stroke patients may therefore have been omitted from this study and this could have accounted for the lower percentage of their patients showing evidence of perceptual problems. The Bernspang and Edmans studies were similar in that they both included consecutive admissions and assessed patients at similar times post stroke However, they identified similar percentages of left hemiplegic stroke patients having perceptual problems but found different percentages of right hemiplegic stroke patients having perceptual problems. This may be due to the Bernspang et al. study having difficulty in assessing some patients due to aphasia, which was not the case in the Edmans and Lincoln study. The Andrews et al. study also found a lower percentage of patients with perceptual problems. This may have been due to difficulty in quantifying the patients' picture drawings which involved subjective interpretation. Andrews et al. also explain that if there was doubt as to whether a drawing was normal or abnormal, it was classified as normal. Some patients with minor perceptual problems may therefore not have been classified as such.

All four of these studies classified their patients according to side of hemiplegia rather than site of the brain that was damaged. Due to the complex nature of the brain, as described in section 1.1.1, the site of damage in the brain is more important than the side of hemiplegia, in determining the types of impairments, disabilities and handicap that patients may suffer.

1.4.1 Frequency of unilateral neglect

Some studies have investigated the incidence of unilateral neglect only, for instance, Weinstein and Friedland (1977) found that left spatial neglect frequently followed right cerebral lesions. Lawson (1962), Gainotti (1968), and Campbell and Oxbury (1976), found neglect to be severe immediately after a left hemiplegic stroke but that it usually improved over time. Levine et al. (1986), found the rate and extent of improvement depended on the integrity of the remaining areas in both cerebral hemispheres. Neglect of the right side of visual space is less commonly reported, Oxbury, Campbell and Oxbury (1974) found that seven of the 17 left hemiplegic stroke patients (41%) were classified as having left visual spatial neglect. In contrast none of the 15 right hemiplegic stroke patients showed evidence of neglect. They suggested that left visual spatial neglect may be an important factor responsible for the impairments of spatial analysis and visual perception arising from left hemiplegia. In another study Willanger et al. (1981) found a slightly lower proportion of neglect in left hemiplegic patients.

However, this may in part be a results of the assessment methods used. Oxbury et al., (1974) assessed neglect by asking patients to copy line drawings freehand with diagnosis of neglect being based on failure to complete either the left or the right hand side of any one of these four drawings. Patients also had to describe items in a picture and in an array in front of them, read, write and bisect lines. Patients who showed neglect on the drawings also showed neglect on these other tests. Willanger et al., (1981) on the other hand, clinically examined the patients' visual fields and carried out an examination of vision and the patients' awareness of this function.

In other study, Gainotti et al., (1986) found that when the task required patients to explore the half of space contralateral to the damaged hemisphere, there was no significant difference between left and right hemiplegic patients, with both groups tending to explore the hemisphere ipsilateral to the damaged hemisphere. When the test used emphasised the capacity to focus attention on both sides, significant differences emerged between left and right hemiplegic patients. The incidence of neglect remained the same in left hemiplegic patients but was significantly lower in right hemiplegic patients. More recently, Halligan et al., (1989) found the incidence of neglect varied according to the test used although neglect was still more common in left hemiplegic patients than right hemiplegic patients.

Most of these studies have found the incidence of neglect in left hemiplegic patients to be about 30-40% and few studies found any significant evidence of neglect in right hemiplegic patients. However, all perceptual problems not just unilateral neglect need to be considered when planning the rehabilitation of stroke patients.

1.4.2 Frequency later post stroke

Many impairments identified immediately following a stroke may be transient and therefore permanent disabilities will not be evident until later. Many crucial problems may not emerge until the patient attempts to return to his/her former lifestyle. It is not clear therefore when intervention should take place.

Spontaneous recovery of aphasia has been found to occur at the fastest rate during the first few months after onset (Skilbeck et al., 1983; Miller, 1985). It then levels off but recovery continues for up to two or three years. This has also been found to be true for recovery of motor ability (Kinsella and Ford, 1980; Skilbeck et al., 1983) and functional ability (Skilbeck et al., 1983). However, there is little information documented about the pattern of spontaneous recovery of perceptual problems and it is uncertain whether spontaneous recovery affects perceptual ability in the same way.

Campbell and Oxbury (1976) assessed 14 left hemiplegic stroke patients who had been assessed at three to four weeks, from a previous study (Oxbury et al., 1974), six months after onset of the stroke. The patients were aged less than 65 years and were reassessed on drawings as previously mentioned and on tests of spatial analysis and visual perception. The results showed that the incidence of neglect at six months had dropped compared with the initial assessment, but that the patients remained impaired on tests of spatial analysis and visual perception.

Denes et al., (1982) assessed 48 patients, including 24 with left hemiplegia and 24 with right hemiplegia, with a mean age of 62 years and 61 years respectively on admission and at six months after onset. They and found unilateral neglect present in eight left hemiplegic patients and five right hemiplegic patients on the initial assessment.

However, six months later seven left hemiplegic patients still showed evidence of neglect as did two right hemiplegic patients.

In two studies by Kinsella and Ford (1980; 1985), 31 patients, aged less than 75 years were followed up to study the recovery pattern of unilateral neglect. They found no change in the severity of neglect between assessments at four weeks and three months after stroke but there was some improvement in the frequency of right/left disorientation. However, when the patients were reassessed 18 months after stroke, the neglect was less severe and in some cases had completely resolved.

In a more recent study, Sunderland et al., (1987) assessed 197 patients, 113 with right hemiplegia and 84 with left hemiplegia, on two measures of unilateral neglect, the Greek Cross and Ravens Coloured Progressive Matrices. They found a significant recovery between three weeks and six months and between six months and one year after stroke.

A further study was carried out by Edmans et al. (1991) who assessed 90 patients at one month and two years after onset of stroke on the RPAB. They found perceptual problems were still common two years after the stroke, with 74% of patients still having perceptual problems, concluding that there was no significant difference in the frequency or severity of perceptual problems between the two assessments.

The main limitation of these studies is that they mainly investigated the recovery of unilateral neglect only. Denes et al., Kinsella and Ford, and Sunderland et al. assessed unilateral neglect alone whereas Campbell and Oxbury, and Edmans et al., assessed a wider range of perceptual problems. Another limitation is that some studies had very small sample sizes, Denes et al. included only 48 patients, Kinsella and Ford investigated 31 patients and Campbell and Oxbury only reassessed 14 patients. Sunderland and Edmans et al., on the other hand included 197 and 90 patients respectively. Kinsella and Ford, and Campbell and Oxbury were more selective in criteria for their studies by only including younger patients (less than 75 years and 65 years respectively) and Campbell and Oxbury only reassessed left hemiplegic patients.

Despite these limitations and the fact that different assessments were used in each study, these studies all agree that some spontaneous recovery of neglect is apparent over time (Campbell and Oxbury, 1976 Denes et al, 1982 Kinsella and Ford, 1980; Kinsella and Ford, 1985 Sunderland et al., 1987). However, it is important in the rehabilitation of stroke patients, to discover the extent to which all perceptual problems recover spontaneously. Two studies however showed no evidence of spontaneous recovery for patients presenting with a wider range of perceptual problems (Campbell and Oxbury, 1976 and Edmans et al., 1991).

These studies (Campbell and Oxbury, 1976; Denes et al, 1982; Kinsella and Ford, 1980; Kinsella and Ford, 1985; Sunderland et al., 1987; Edmans et al., 1991) have investigated the long term effects of perceptual problems after stroke and found no significant difference in the frequency or severity of perceptual problems over time, except for unilateral neglect. These studies imply that spontaneous recovery for perceptual ability is not attained except possibly for unilateral neglect.

As treatment for perceptual problems is time consuming (see section 1.9) and consequently costly for the National Health Service, it is important for Occupational Therapists to know which patients will get better spontaneously, so they can treat the others. If a large proportion of patients recover spontaneously, the high number of patients with perceptual problems in the initial stages, is not so important as if only a few recover spontaneously. If perceptual problems recover, it is not known whether functional ability also improves. Alternatively, functional ability may improve even though perceptual test ability remains impaired. It is for these reasons that the research in this study is important.

1.5 Assessment of perceptual ability

The aim of assessing perceptual ability was to identify which patients had any perceptual problems, including which types of perceptual problems and their severity, in order to decide which patients required perceptual treatment. Perceptual assessment was also needed to establish a baseline of perceptual ability for comparison in evaluating the effectiveness of that treatment.

A standardised perceptual assessment was required to ensure that the assessment was valid (i.e. it measured what was intended), reliable (i.e. it measured in a reproducible fashion either between raters or over time), had an established procedure for administration and scoring and had normative data available for comparison.

Many standardised perceptual assessments cannot be administered and interpreted by Occupational Therapists (OTs), e.g. Wechsler Adult Intelligence Scale (Wechsler, 1955). As there are few Clinical Psychologists available to assess the large number of stroke patients, OTs need standardised perceptual assessments that they can administer and interpret themselves. Information gained from such assessments is then meaningful to other OTs and evaluation of patients' progress throughout their treatment can be monitored, especially considering each patient may be treated by more than one OT and in more than one setting.

The only standardised assessments of visual perception designed for use by Occupational Therapists (OT), are the Chessington OT Neurological Assessment Battery (COTNAB) (Tyerman et al., 1986), Loewenstein OT Cognitive Assessment (LOTCA) (Itzkovich et al., 1993) and the Rivermead Perceptual Assessment Battery (RPAB) (Whiting et al., 1985).

1.5.1 Chessington OT Neurological Assessment

The COTNAB is a standardised assessment for the identification of functional impairment of neurological patients, aged 16 - 65 years, who have suffered a head injury or stroke. It tests four main functional areas:- visual perception, constructional ability, sensory-motor ability and the ability to follow instructions. This assessment was not chosen for use in this study as it has not been standardised for patients over 65

PAGE
MISSING
IN
ORIGINAL

Zoltan, Siev and Freishstat (Siev and Freishtat, 1976; Zoltan et al., 1986) mentioned previously.

Evidence of the validity, inter-rater reliability and test-retest reliability are given in the RPAB manual. Validity of the RPAB was established by testing 41 stroke patients and 16 head injured patients, aged 17 - 69 years, on the RPAB and on a battery of psychological tests of perception and intellectual abilities. All patients were assessed during their second week of admission and had a clinical assessment of eyesight, visual fields, hearing, sensation, proprioception and motor co-ordination. Spearman rank correlation coefficients were calculated between the RPAB subtests and the psychological tests of perception and intellectual abilities. The results indicated that most RPAB subtests correlated well with the psychological tests of visual perception but not with the test of memory. Some RPAB subtests were related to psychological tests measuring verbal abilities and the RPAB manual suggests these tests may be omitted when testing dysphasic patients.

Inter-rater reliability of the RPAB was tested using six patients, aged 21 - 70 years, who had a wide range of perceptual disabilities. They were tested on the RPAB and videotaped. These videotapes were then scored by three OTs. Kendall coefficients of concordance for the agreement between raters were calculated and significant agreement was found on all subtests.

The test-retest reliability of the RPAB was tested using 19 left hemiplegic stroke patients, aged 47 - 68 years, who were more than one year post onset. They were assessed on the RPAB and again after four weeks by the same person. Spearman rank correlation coefficients were calculated which indicated that 14 out of 16 subtests were reliable over time and one test remained at the not significant level but had its instructions made clearer. Spearman rank correlation coefficients could not be calculated for one test (Object Matching) due to lack of variation in the scores obtained.

A factor analysis of results from the original RPAB validation sample showed that all subtests loaded highly on one factor (Lincoln and Edmans, 1989). These loadings were used to weight the test to provide an overall score of perceptual ability. The formula for this overall score is as follows:-

RPAB TOTAL = (Picture Matching x 0.4) + (Colour Matching x 0.4) + (Object Matching x 0.7) + (Size Recognition x 0.8) + (Series x 0.2) + (Animal Halves x 0.8) + (Missing Article x 0.6) + (Figure Ground x 0.6) + (Sequencing Pictures x 0.4) + (Self Identification x 0.3) + (Cancellation x 0.6) + (Body Image x 0.7) + (Right Left Copying Shapes x 0.6) + (Right Left Copying Words x 0.8) + (3D Copying x 0.8) + (Cube Copying x 0.8).

A limitation of the RPAB is that it takes approximately one hour to administer all 16 subtests, which is too long for some patients in hospital to tolerate and may be tiring for elderly patients. Three shortened versions, of eight subtests in each, were therefore investigated by Lincoln and Edmans (Lincoln and Edmans, 1989). Version A included the RPAB subtests that most closely represented common features of the RPAB for both normal subjects and stroke i.e. Picture Matching, Object Matching, Size Recognition, Animal Halves, Right Left Copying Shapes, Right left Copying Words, 3D Copying and Cube Copying. Version B included the RPAB subtests that most closely related to the RPAB total score i.e. Figure Ground, Sequencing Pictures, Body Image, Right Left Copying Shapes, Right left Copying Words, 3D Copying, Cube Copying and Cancellation. Version C included the RPAB subtests that were chosen clinically i.e. Picture Matching, Colour Matching, Sequencing Pictures, Body Image, Right Left Copying Shapes, 3D Copying, Cube Copying and Cancellation. Comparison of the three shortened versions of the RPAB indicated no clear advantage of any one version. Lincoln and Edmans therefore suggested that any of these three short versions were acceptable for clinical use. Whiting et al. (1985) identified a high inter-rater reliability on most subtests of the RPAB. However, Nunnally (1967) suggested that a minimum reliability of 0.90 should be considered as acceptable and a reliability of 0.95 should be desirable. The only subtests with a reliability lower than this in the RPAB inter-rater reliability studies, were Picture Matching, Animal Halves and Series. As none of these subtests are included in the shortened version B of the RPAB, this adds more weight to the use of this version instead of the full RPAB.

In a recent study, Matthey et al (1993) considered the clinical usefulness of the RPAB. They assessed 51 patients following stroke or head injury, with time between onset and RPAB assessment being between six days and seven months, except for one head injured patient who was assessed twenty two years post onset. The patients were aged 20 to 84 years, 21 patients had right hemiplegia, 14 had left hemiplegia, 14 had head injuries, one had hypoxic brain damage and one had herpes simplex encephalitis. They calculated whether each RPAB subtest had sufficient level of discriminative power to be useful in a clinical setting and found that four subtests did not, supporting the test-retest results in the RPAB manual (Whiting and Lincoln, 1985). These were picture matching, object matching, size recognition and series, where they found that all except for patients with gross deficits, scored full marks. The short version B of the RPAB (Lincoln and Edmans, 1989) does not include any of these four subtests, Version C includes Picture Matching and Version A include Picture Matching, Object Matching and Size Recognition. Matthey et al. (1993) also found that only five RPAB subtests were clinically useful in terms of discriminative power, specific variance between stroke patients and normal subjects and relationship between ADL and RPAB subtest performance. These five subtests were Sequencing Pictures, Right Left Copying Shapes, Right Left Copying Words, 3D Copying and Cube Copying. Again, short RPAB version B includes all five of these and versions A and C include four of these clinically useful subtests. These factors therefore support the Lincoln and Edmans study where version B was judged to be the most acceptable version by clinicians and version C was found to produce the greatest savings in time. As the Matthey et al. study had included a reasonable sized sample of patients, with wide age range and wide range of times between onset and RPAB assessment, it is likely that these results would generalise to similar populations. However, although short RPAB version B appears to be the most useful version in all respects, this information was not available at the start of the perceptual treatment study and this version was therefore not used.

Another study that investigated the use of the RPAB was by Friedman and Leong (1992a). Their study compared the RPAB to line bisection (Motomura et al, 1986), line cancellation (Albert, 1973) and drawing tests from the Mini Mental State Examination (Folstein et al, 1975). Eighty six elderly in-patients following stroke were assessed within 14 days of their stroke on the above assessments by various clinicians, pre-stroke Barthel ADL index score by their families and six-month post discharge Barthel ADL index score. The patients had a mean age of 74.3 years with a standard deviation of 6.5 years, 43 were male and 43 were female, 44 had a dominant hemisphere stroke, 37 had a non-dominant hemisphere stroke and five had brain stem / cerebellar strokes. Friedman and Leong concluded that the RPAB was more sensitive than line bisection, line cancellation or drawing tests, in detecting perceptual problems and predicting functional outcome in elderly stroke patients and that there were equal frequencies of perceptual problems between dominant and non-dominant hemisphere strokes. This study included a large sample of elderly patients, with equal numbers of male and female patients and similar ratio of dominant and non-dominant hemisphere strokes but it is not clear how many clinicians carried out the assessments. Inter-rater variations may have accounted for some of the differences found, although if each assessment was carried out with all patients by only one clinician, this should not have been true.

Cramond et al (1989) also examined the uses and limitations of the RPAB. They investigated the effects of using the dominant or non-dominant hand on performance of four RPAB subtests, Right Left Copying Shapes, Right Left Copying Words, 3D Copying and Cancellation. Thirty five, right handed, first year university students, 13 male and 22 female, aged 17 - 31 with a mean age of 19.3 years, were assessed to determine whether there was a difference in performance according to the dominance of the hand used. Each subject completed the four subtests twice, once with each hand. They had an average time of 18 days between assessments, ranging from 10 - 28 days. Half the group used their right hand first and half used their left hand first. Statistically significant differences were found between right and left hand performance and time taken to complete the subtest on Right Left Copying Shapes and Right Left Copying Words, and for time alone for Cancellation. Twenty four of the 36 students however, failed Right Left Copying Words with their non-dominant hand. No significant differences were found on 3D copying and no significant difference was found according to the sex of the student. Although these results are of great importance when analysing the RPAB with stroke patients, it must be remembered that these results were from a different population and may not generalise to those of stroke patients. The subjects in this study were a relatively small sample of young, first year university students who were predominantly female. However, the expectation would be that the effects of using the dominant or non-dominant hand would be similar following stroke in patients of all ages. The RPAB was not found to be influenced by age according to the RPAB test manual (Whiting et al., 1985) but the time taken to complete the RPAB subtests by stroke patients may be longer than that of students. It is important therefore when interpreting RPAB results, to consider the influence of whether the patient used their dominant or non-dominant hand. A minor limitation of this study though was that only right-handed students were included and no left handed students. It is presumed that the same results would have occurred with left handed students.

A further study involving the RPAB was carried out by Jesshope et al. (1991) who investigated the concurrent validity of the RPAB with 101 stroke patients admitted for rehabilitation. Their ages ranged from 32 to 92 years, 56 had right hemiplegia, 45 had left hemiplegia, 35 were female and 66 were male and they were assessed up to two weeks after admission on the RPAB. Prior to this assessment, therapists gave their opinion on the presence of perceptual deficits. Jesshope et al. found there was little agreement between the therapists' opinion on perceptual deficits and performance on the RPAB. They suggested that therapists may miss deficits which the RPAB identifies, emphasising the need to use the RPAB to assess for perceptual deficits. They also suggested that the RPAB may give a more global rather than specific perspective on perceptual ability, supporting similar comments made by Lincoln et al. (1989) and Edmans and Lincoln (1990). Jesshope et al, finally suggested that reasons for failing on RPAB subtests included patients not understanding what was required of them and limb dyspraxia, highlighting the need to assess other impairments rather than just perceptual ability alone.

The RPAB was chosen for use in this study as it was a standardised assessment and has normative data for patients up to aged 90 years and included the appropriate categories of deficit. The RPAB's strengths are that it was designed for use by Occupational Therapists, it was also designed to be used with all stroke patients, including dysphasic patients and many of the instructions are given largely by demonstration. This therefore reduces the demand for patients to understand the verbal instructions, thus making it suitable for more patients. The studies previously mentioned (Matthey et al., 1993; Friedman and Leong, 1992a; Cramond et al., 1989;

Jesshope et al., 1991) also support the use of the RPAB as the RPAB discriminates between normal subjects and stroke patients and is more sensitive than line bisection, line cancellation and drawing tests. The RPAB's limitations were also taken into consideration, in that it is a time consuming assessment which may be tiring for elderly patients to complete in one session, only some RPAB subtests may be clinically useful, there may be differences according to whether the dominant or non-dominant hand is used and failure on the RPAB may be due to impairments other than perception.

The three short versions were not chosen for use in the treatment of perceptual problems study as it was not known whether the effect of treating perceptual problems would be demonstrated more using some RPAB subtests than others and the results of the Matthey et al. study were not known at the time of starting this study. The greatest sensitivity to change was required for the current study and as a result it was decided to use the full RPAB. The use of the full RPAB therefore gave more scope for evaluation of perceptual treatment which was the purpose of the study.

1.6 Relationship between perceptual and functional abilities

1.6.1 Early post stroke

Perceptual problems have been found to affect the patients' response to rehabilitation and their ability to perform activities of daily living (ADL) (Lorenze and Cancro, 1962; Tsai et al., 1982; Bernspang et al., 1982a; Andrews et al., 1980; Whiting et al., 1985;

Edmans and Lincoln, 1990; Jesshope et al., 1991; Donnelly et al., 1998), suggesting that if possible they should be treated, and the most effective treatment needs to be known by all those concerned.

Lorenze and Cancro (1962) studied 41 stroke patients of whom 25 had left hemiplegia and 16 had right hemiplegia. Patients were excluded from the study if they had bilateral involvement, severe intellectual deficits or aphasia. The patients had a mean age of 63 years and were assessed during the first three weeks in hospital. Perceptual ability was assessed using the Wechsler Adult Intelligence Scale (WAIS) (Wechsler, 1955) Block Design and Object Assembly tests. They were also assessed on ability to dress the upper half of their body, grooming and self feeding. They reported that patients with a severe disturbance in visual perception had a higher proportion of failures in activities of daily living than other hemiplegic patients, and that severe disturbances of visual perception were frequently associated with left hemiplegia.

This finding was supported by Tsai et al. (1982) who studied 16 right hemiplegic and 14 left hemiplegic stroke patients, with mean ages of 59 years and 57 years respectively. Again aphasic patients were excluded from the study. Patients were assessed two weeks after stroke on the Figure Ground and Design Copying subtests of the Southern California Sensory Integration Test and WAIS Block Design test. They were also assessed on dressing performance on a four point rating scale. Visuospatial deficits were found to contribute to the failure of dressing performance especially in left hemiplegic stroke patients.

Bernspang et al. (1982a) investigated 122 stroke patients, consecutively admitted to a Swedish Stroke Unit, but excluding aphasic or confused patients. They had a mean age of 72 years and were assessed within two weeks of stroke. Perceptual ability was assessed using a modification of a test battery developed in Israel. Self care ability was assessed on personal hygiene, dressing and eating. They reported that the level of perceptual function in the early phases after stroke, was closely related to motor function and proficiency in self care activities of daily living.

A major limitation of these three studies is that they all excluded aphasic patients. It has already been shown by Edmans and Lincoln (1987) that a large proportion of dysphasic stroke patients have perceptual problems. The three studies described above therefore failed to include a large number of relevant patients, which may have influenced their results about the impact of perceptual problems on ADL. This may also account for the reasons why Lorenze and Cancro, and Tsai et al., found that left hemiplegic stroke patients performed worse on ADL tasks than right hemiplegic patients. It is also difficult to compare studies when different ADL assessments have been used, particularly since many studies have not used standardised procedures.

The prognostic significance of perceptual disorders for rehabilitation was also studied by Andrews et al. (1980). They studied 135 stroke patients of all ages, at two weeks after stroke. The patients were asked to copy a line drawing of a house and to draw a man and a clock from memory, to identify perceptual disorders. An abnormality of picture drawing was classed as when one or more drawings showed a disturbance in structure, not accounted for by lack of dexterity in the non-dominant hand. Activities of daily living were also assessed using an assessment from a local hospital which included six ADL tasks with seven grades for each. They found that stroke patients who performed poorly on picture drawing tasks had a higher incidence of poor mobility, poor functional recovery, confusion, incontinence and pressure sores and a higher mortality than those who performance was unimpaired. A limitation of this study is the difficulties of subjective interpretation of these picture drawings as already mentioned earlier in this section and the ADL assessment also does not appear to be a standardised assessment. However, the results still support the previous studies mentioned in that perceptual ability correlates with functional ability.

The RPAB manual (Whiting et al., 1985) also states that patients who are independent on less than seven items of the ADL self care scale at any time, are more likely to show evidence of impaired perceptual function than those who are independent on more items. However, it is not clear which patients were included in this study. It can be assumed that it was the patients who were included for the test-retest reliability and the validity testing. If so, these patients included 54 patients, including right and left hemiplegic stroke patients, both men and women, who were aged between 17 and 69 years. These patients were assessed at different times post stroke, validity patients were assessed during their second week of admission (i.e. early post stroke) and test-retest patients were assessed more than one year post stroke (i.e. late post stroke). They give no explanation of why the cut-off of seven items on the ADL assessment was made or what the relevance of this point on the ADL scale was. On investigating the Rivermead ADL Scale this appears to be the point at which patients need to be able to transfer or walk unaided. It may be therefore that the RPAB correlates with motor function rather than ADL ability. Similarly, it could also be that patients with larger lesions are more likely to have perceptual problems and more likely to have worse functional ability due to motor problems.

Edmans and Lincoln (1990) also investigated the relationship of perceptual and functional abilities. They assessed 150 stroke patients, as previously mentioned in this section, on the RPAB and Rivermead ADL Scale (Whiting and Lincoln, 1980). They found that patients without perceptual problems were more often independent in ADL tasks than patients with perceptual problems. They also found that left hemiplegic stroke patients were significantly more independent than right hemiplegic stroke patients on simple ADL tasks but less independent on complex ADL tasks, although this latter finding showed no significant difference according to side of stroke. Finally, a highly significant correlation was found between the severity of perceptual problems and independence in ADL. Edmans and Lincoln suggested that the RPAB may be a measure of overall stroke severity.

This suggestion was also supported by Jesshope et al. (1991) who examined the relationship of the RPAB performance in ADL with 101 stroke patients admitted for rehabilitation. Their ages ranged from 32 to 92 years, 56 had right hemiplegia, 45 had left hemiplegia, 35 were female and 66 were male and they were assessed up to two weeks after admission on the RPAB. The Australian ADL index (Spencer et al., 1986) was also administered on admission to and discharge from rehabilitation. ADL performance improved for all patients during rehabilitation but patients with perceptual deficits performed worse than those without deficits at both admission and discharge.

However, there was no significant difference in the amount of improvement between those with or without perceptual problems. RPAB and ADL scores were not consistently related when categories of the RPAB were compared with specific items on the ADL index.

A more recent study was conducted by Donnelly et al. (1998) studied 35 stroke patients, aged between 38 and 88 years, including both right and left hemiplegic stroke patients, males and females, with a mean time post stroke of 48 days. They were assessed on the RPAB and three functional tasks - making a sandwich and packing a lunch box, putting on a cardigan and setting a table. The three functional tasks were broken down into various stages, with 8, 5 and 7 stages respectively. Donnelly et al. found a significant correlation between the RPAB total score and these three selected functional tasks but could not isolate individual subtests of RPAB to correlate with the ADL tasks, supporting that the RPAB may be a global assessment of perceptual ability.

These latter three studies (Edmans and Lincoln, 1990; Jesshope et al., 1991; Donnelly et al., 1998) have all shown that there is a relationship between perceptual ability and ADL but did not identify which perceptual problems influence which aspects of ADL. They all used the RPAB but used different ADL assessments (Rivermead ADL, Australian ADL and three specific functional tasks respectively). This lack of relationship between individual perceptual problems and individual ADL tasks, may be due to the RPAB subtests not being sensitive enough to detect individual perceptual problems, suggesting that the RPAB may be an assessment of global perceptual ability rather than of individual perceptual problems, as previously mentioned. Alternatively, it may be that the individual ADL tasks involved the use of more that one perceptual ability. Finally, the relationship between perceptual ability and ADL may be a relationship of the severity of the stroke (i.e. the number and severity of perceptual problems) and ADL, with the RPAB assessing severity rather than individual perceptual problems.

Another limitation of these studies (Lorenze and Cancro, 1962; Tsai et al., 1982; Bernspang et al., 1982; Andrews et al., 1980; Whiting et al., 1985; Edmans and Lincoln, 1990; Jesshope et al., 1991; Donnelly et al., 1998) is that none of them included which other impairments were suffered by patients. These other impairments may have had an influence on the patients performance on perceptual assessment and ADL assessment. These could have included impairments such as dysphasia, dyspraxia, memory, reasoning or depression problems (see section 1.10).

The studies mentioned so far in this section were carried out in the acute stages of recovery. When planning services for treating stroke patients, it is necessary also to know the practical effects of perceptual problems in the later stages of recovery.

1.6.2 Later post stroke

Various studies have investigated this at different times post onset, for example, Denes et al. (1982) followed patients up at six months, Andrews et al. (1982) at one year, Kinsella and Ford (1980; 1985) at three months and 18 months, Edmans et al. (1991)

at two years, Kotila et al. (1986) at four years and Bernspang et al. (1987) at four to six years post onset of stroke.

Denes et al. (1982), as described in section 1.4, completed a study on stroke patients on admission and at six months after onset. They assessed 48 stroke patients, including 24 with left hemiplegia and 24 with right hemiplegia, with mean ages of 62 years and 61 years respectively. They assessed patients for motor function, ADL, unilateral neglect, language and neuropsychological ability. They concluded that the left hemiplegic stroke patients showed a lesser degree of improvement in independence, coupled with a poor recovery of motor function than the corresponding right hemiplegic stroke patients. They also found that unilateral spatial neglect seemed crucial in hampering performance.

Andrews et al. (1982) followed up 53 of their original 135 patients previously mentioned (Andrews et al., 1980), one year after onset and reassessed them on picture drawings and ADL. They found that all aspects of functional ability were worse in those patients who had drawn abnormal pictures and concluded that cortical dysfunction such as cognitive or perceptual disorders were a major barrier to recovery.

Kinsella and Ford (1980; 1985), as previously mentioned in section 1.4, followed up 31 stroke patients, aged less than 75 years. They assessed the patients on a cognitive battery of tests, unilateral spatial neglect, motor function and ADL. Their results showed no significant difference between left and right hemiplegic patients, in terms of rate of functional recovery, at three months after stroke. Kinsella and Ford (1980)) also investigated the relationship between left hemiplegic stroke patients and the activities of daily living score, showing that left hemiplegic stroke patients with inattention, formed a nucleus of poor achievers compared to left hemiplegic stroke patients without inattention or right hemiplegic stroke patients. The patients were reassessed at 18 months after onset and patients with unilateral spatial neglect were still found to have poorer levels of functional ability.

Edmans et al. (1991), again as previously discussed in section 1.4, followed up 90 of the patients from their previous study (Edmans and Lincoln, 1990) two years after their stroke and reassessed them for perceptual and ADL abilities. Their results showed there was still a significant correlation between perceptual ability and ADL.

Two later studies by Kotila et al. (1986) and Bernspang et al. (1987), assessed patients four years after stroke. Kotila et al. (1986) reassessed 52 patients, including both left and right hemiplegic stroke patients, aged less than 65 years for visuospatial inattention, ADL and severity of stroke. They found that patients with visuospatial inattention had poorer recovery in activities of daily living, than the patients without visuospatial inattention.

Bernspang et al. (1987) similarly followed up 75 patients from a previous study (Bernspang et al., 1982a), 4-6 years after stroke. These patients were reassessed for perceptual ability, motor function and self-care ADL. Bernspang et al. (1987) found that perceptual dysfunctions were still causing self care disabilities even at this late stage post stroke and found that motor function independently affected self-care ADL abilities. They suggested that patients may learn to compensate for their motor deficits but not for their perceptual deficits..

All these studies (Denes et al., 1982; Andrews et al., 1982; Kinsella and Ford, 1980; Kinsella and Ford, 1985; Edmans et al., 1991; Kotila et al., 1986; Bernspang et al., 1987) highlight the impact of perceptual problems later after stroke. They all found that patients with perceptual problems still had less independence in ADL than patients without perceptual problems, even up to four years post stroke. This emphasises the impact and handicap of perceptual problems for patients and their carers.

One limitation of these studies is that some had only small sample sizes. Denes et al., included 48 patients, Andrews et al., included 53 patients, Kinsella and Ford included 31 patients and Kotila et al., included 52 patients. In comparison Edmans et al, included 90 patients and Bernspang et al. included 75 patients. However, as all the studies reported similar results, the small sample sizes should not have influenced their results. Two studies only included patients under 65 years or 75 years (Kotila et al. and Kinsella and Ford respectively). Age has not been found to influence perceptual ability so again this should not have influenced their results. Similarly, it is not clear whether all the assessments used, both perceptual and ADL, were standardised or not. Again though, the results from all these studies later after stroke produced the same results in that perceptual problems were still causing problems in ADL.

Some studies did not include all types of perceptual problems. Denes et al., Kinsella and Ford, and Kotila et al. only included unilateral neglect. It may be that unilateral neglect is the major perceptual problem affecting ADL and that other perceptual problems have less affect on ADL. At present though, there is no evidence to support this, as the relationship between other individual perceptual problems and ADL has not been investigated.

A flaw of all these studies (Denes et al., 1982; Andrews et al., 1982; Kinsella and Ford, 1980; Kinsella and Ford, 1985; Edmans et al., 1991; Kotila et al., 1986; Bernspang et al., 1987) is that they do not state what rehabilitation the patients received between initial and final perceptual assessments and whether they received any specific perceptual treatment. As mentioned previously, these studies also did not include which other impairments were suffered by patients, that may have had an influence on the patients performance on perceptual assessment and ADL assessment.

However, it seems clear that perceptual problems are common after stroke and significantly affect performance in ADL at all stages of recovery for patients, suggesting that if possible they should be treated.

1.7 Assessment of functional ability

Perceptual problems have been shown to correlate with the ability to perform in activities of daily living (ADL), as discussed in section 1.5. Although the main aim of this study was to identify whether the transfer of training approach or functional approach (explained in more detail in section 1.8) to perceptual treatment was most effective in treating perceptual problems, there may also be a difference in the level of ADL improvement, according to the perceptual treatment approach used. ADL ability needed to be assessed in this study therefore, to identify whether the transfer of training approach to perceptual treatment had a greater or lesser influence on improvement in ADL ability than the functional approach.

There are many activities of daily living assessments available (Mahoney and Barthel, 1965; Collin et al., 1988; Ebrahim et al., 1985a; Granger et al., 1986; Smith, 1979; Granger et al., 1979; Katz et al., 1963; Schoening et al., 1965; Whiting and Lincoln, 1980; Lincoln and Edmans, 1990; Benjamin, 1976; Spencer et al, 1986; Sheikh et al., 1979; Holbrook and Skilbeck, 1983; Wade et al, 1985; Nouri and Lincoln, 1987) for use with stroke patients. Some assessments though do not include a wide range of activities to assess fully whether a person is able to live independently at home. For example; the Barthel ADL index (Mahoney and Barthel, 1965; Collin et al., 1988), Nottingham 10 point ADL scale (Ebrahim et al., 1985a) and the Functional Independence Measure (FIM) (Granger et al., 1986) include mainly self-care activities; the Edinburgh Stroke study ADL scale (Smith, 1979) and Pulses profile (Granger et al., 1979) include little detail about each activity; the Katz ADL index (Katz et al., 1963) only includes six activities and the Kenny self-care assessment scale (Schoening et al., 1965) is aimed at nursing care requirements.

Some assessments do not reflect the degree of dependence, because the scoring is only "dependent, partially dependent or independent", for each activity assessed. Partially dependent therefore covers a wide range of levels of dependence and does not give any details of what the level of dependence is. As a result, these assessments are not sensitive enough to detect minor effects of treatment or changes over time. Examples of this are; the Rivermead ADL assessment (Whiting and Lincoln, 1980; Lincoln and Edmans, 1990), Nottingham 10 point ADL scale (Ebrahim et al., 1985a), Northwick Park ADL index (Benjamin, 1976), Australian ADL index (Spencer et al, 1986), Sheikh et al, modified ADL index (Sheikh et al., 1979) and Katz ADL index (Katz et al., 1963).

The scoring can be misleading. For example, the Barthel ADL index (Mahoney and Barthel, 1965; Collin et al., 1988), although well recognised, well used and endorsed by the Royal College of Physicians, has misleading scoring. Each activity is graded, but with different maximum scores, i.e. 0-1, 0-2, 0-3. This is intended to reflect the relative importance of each activity, in terms of the level of care needed. However, in practice, most people, especially the medical profession, only consider the total Barthel score without considering changes in the individual sections of the assessment.

Finally, some assessments are designed specifically for out-patients, for example, Frenchay Activities Index (Holbrook and Skilbeck, 1983; Wade et al, 1985) and Extended ADL scale (Nouri and Lincoln, 1987).

1.7.1 Edmans ADL index

As a result of these limitations, it was decided to develop the Edmans ADL index (Edmans and Webster, 1997). The aim of developing this new ADL index was to produce an index that could be used to assess functional ability in stroke patients which included:-

- the activities necessary to enable a person to live independently at home
- the degree of dependence, i.e. to include more detail than just dependent / independent for each item of the assessment
- the capacity to be used to monitor progress, i.e. to be sensitive to change over time and to detect changes in ability
- the suitability to use with stroke patients as either in-patients or out-patients
- evidence of validity and reliability

The Edmans ADL index was therefore designed to include the activities necessary to enable a person to live independently at home i.e. washing, bathing, grooming, dressing, swallowing, drinking, eating, sitting, standing, transfers, walking, stairs, on/off floor, getting in / out bed, moving in bed, making a hot drink, snack or meal, cleaning, laundry and ironing. The activities were chosen for inclusion in the index by listing the activities that the Nottingham Stroke Unit Occupational Therapists and patients felt were required for independence and by reviewing the current assessments available. The activities were graded such that staff could monitor a patients' progress over time. The gradings chosen were those used by the Occupational Therapists to describe the progress of patients on the Nottingham Stroke Unit.

It should also be remembered that many other problems may affect the patients' performance in ADL. These are not usually reflected in the scoring on an ADL assessment. This could include the following problems:- comprehension, expressive language, perception, sensation, dyspraxia, reasoning, memory, depression, anxiety, urinary incontinence or faecal incontinence. Therefore, a list of these associated problems, which may affect the patients' performance in everyday activities, was also included.

Once the design of the Edmans ADL index was complete, the index was tested to ensure that it was valid and reliable. Full details of the validity and reliability testing, plus strengths and limitations of this index are shown in appendix 1.

Overall, the results of the validity and reliability testing showed that the Edmans ADL index has content and construct validity, is sensitive to change over time, is reliable for use with stroke patients in hospital and has inter-rater and test-retest reliability.

The Edmans ADL index was chosen for use in this perceptual treatment study as it was a newly developed, standardised assessment which included a wider range of activities, i.e. self care and household activities and has slightly more range of the levels of dependence for each activity, than the Barthel ADL index. This makes this ADL assessment more suitable for observing minor improvements in patients' ADL ability. This was particularly important as the patients in this study were in-patients in hospital and therefore reasonably earlier after their stroke.

1.7.2. Barthel ADL index

The Barthel ADL index (Mahoney and Barthel, 1965; Collin et al., 1988) was also chosen for use in the study comparing the effect of two perceptual treatment approaches, as it is a standardised assessment, is the most well recognised and commonly used ADL assessment. This ADL index was first introduced in 1955 by Dorothea Barthel to monitor progress in self-care and mobility skills during inpatient rehabilitation. It is a simple weighted scale which has evidence of validity and reliability. The Barthel ADL index has concurrent and predictive validity i.e. a patients score on the Barthel ADL index relates to other measures such as motor loss and mortality (Wade and Langton-Hewer, 1987). A factor analysis showed that it was measuring a single domain and in stroke patients there was a predictable progression through the items as recovery took place (Wade and Langton-Hewer, 1987). The Barthel ADL index was also found to be sensitive enough to detect improvement after stroke (Wade and Langton-Hewer, 1987). Collin et al. (1988) investigated the reliability of the Barthel ADL index using four methods of assessment - an observer asked the patients for a self report on their ADL abilities, an observer asked a nurse for her opinion of the patients abilities, a trained nurse and an OT both assessed the patients for ADL abilities. Their results using Kendall's coefficient of concordance showed a highly significant agreement between all four methods. They also noted that a change of more than two points on the Barthel total score was probably a genuine change and that a change of more than four points on the Barthel total score was certainly a genuine change.

However, its limitations were taken into consideration. Firstly, it only includes self care activities of daily living (feeding, transferring bed to chair, personal toilet, getting on and off toilet, bathing self, walking on level surface, ascending and descending stairs, dressing, controlling bowels and controlling bladder). Secondly, each activity is graded, but with different maximum scores. There is no household section in this assessment as it was designed to be an assessment of self-care which may make it less sensitive to change of a patients overall ADL ability. Finally as there are various modifications of the Barthel ADL index, it was decided to use the version by Collin et al. (1988) as the scoring had been made simpler i.e. 0 - 20 instead of the original 0 - 100 and exact guidelines for the Barthel ADL index were published.

1.8 Approaches to perceptual treatment

Four main approaches to the treatment of perceptual problems were suggested by Zoltan et al. in 1986. These are the sensory integrative, the transfer of training, functional and neurodevelopmental approaches. Abreu and Toglia (1987) also describe a cognitive rehabilitation model which corresponds to that of Zoltan et al. Recently though, Zoltan (1996) has revised this classification of perceptual treatment approaches into remedial and adaptive approaches, which can be described as bottom up and top down approaches respectively (Trombly, 1993). Neistadt (1990) also classifies perceptual treatment approaches as being remedial or adaptive.

Neistadt (1990) lists the common assumptions of remedial and adaptive treatment approaches as follows:

1.8.1 <u>Remedial approach</u>

- The adult brain can repair and reorganise itself after injury
- This repair and reorganisation is influenced by environmental stimuli.
- Perceptual and sensorimotor exercises can promote brain recovery and reorganisation
- Perceptual and sensorimotor exercises provide training in the perceptual skills needed for those exercises.
- Remedial training in perceptual skills will be generalised across all activities requiring those perceptual skills
- Functional activities require perceptual skills.
- Perceptual remediation will improve functional performance.

1.8.2 <u>Adaptive approach</u>

- The adult brain has limited potential to repair and reorganise itself after injury
- Intact behaviours can be used to compensate for injured ones
- Adaptive retraining can facilitate the substitution of intact behaviours for impaired ones
- Adaptive activities of daily living provide training in functional behaviours

- Training in specific, essential activities of daily living tasks is necessary because adults with brain injury have difficulty generalising learning
- Functional activities require perceptual skills
- Perceptual adaptation will improve functional performance

Neistadt (1990) also assumes that remedial and adaptive approaches have differences regarding generalisation. Generalisation can be described as the ability to apply what has been learned in therapy to a variety of new situations and environments (Sufrin, 1984). Transfer of learning is included within the concept of generalisation and both transfer of learning and generalisation refer to the use of skills in contexts other than those of their initial use (Toglia, 1991). Neistadt (1990) explained that the remedial approach assumes that generalisation of learning is a process which occurs automatically and that the adaptive approach uses techniques which minimise the requirements for generalisation. Remedial approaches therefore seek to promote the recovery and reorganisation of impaired functions and assume that the patients will be able to generalise their restored abilities to activities of daily living. These include *transfer of training, sensory integrative, Affolter and neurodevelopmental approaches*. Adaptive approaches promote adaptation of and to the environment and capitalise on the patients abilities and provide training of functional behaviours but not perceptual skills. These include *functional, occupational performance and dynamic interactional approaches.*

Remedial approaches:

1.8.3 Transfer of training approach

Zoltan et al. (1986) described the basic assumption of the *transfer of training approach* as being that practice on a particular perceptual task will affect the patients' performance on similar perceptual tasks. For example, a patient with difficulty dressing due to spatial relations problems, may practice a spatial task such as cube copying, in the expectation that the patient improves functionally in areas involving spatial relations, such as dressing. Although techniques vary considerably between occupational therapy departments, treatment is usually based on the expectation that practice on perceptual tasks will improve abilities underlying the execution of that task. Toglia (1991) suggests that therapists can facilitate patients to become aware of the ways in which they process information and by teaching information processing strategies.

Zoltan (1996) referred to the transfer of training approach as being a remedial or restorative approach focusing on the impairments underlying the disability. Here Zoltan assumes that the brain will repair itself by re-establishing synaptic connections or growing new ones. It is also assumed that with a remedial approach occupational performance is built up of subcomponents which can be restored. The goal of this approach is to increase and improve the patients ability to process and use incoming information in order to improve everyday life functions.

The main disadvantage with the transfer of training approach is that the patients may object to abstract perceptual training, finding it childish, degrading and / or irrelevant to their problems. Also, it could be seen as time consuming, as patients still have to do activities of daily living as well and it is not certain whether improvement in transfer of training activities will produce an improvement in functional abilities. Since treatment activities of this type were becoming increasingly popular in occupational therapy departments in Great Britain, even though there was little evidence of their effectiveness, evaluation of their usefulness was needed. Studies have shown conflicting evidence about the effectiveness of this approach, details of these evaluations are discussed in sections 1.9.1 and 1.9.2.

1.8.4 Sensory integrative approach

The ***sensory integrative approach*** was originally developed by Ayres (1980) for use by Occupational Therapists when treating children with perceptual, cognitive or behavioural problems. The model for treatment is based on neurophysiological and developmental principles and Ayres defined it as the organisation of sensation for use by the individual. Sensory integration converts a persons initial sensation into meaningful perceptions and occurs during an adaptive response. Zoltan et al. (1986) explain that during sensory integrative therapy the therapist provides and controls sensory input, especially the input from the vestibular system, muscles, joints and skin. This controlled sensory stimulation is then followed by an adaptive response by the patient, which will integrate those sensations provided and controlled by the therapist.

However, providing sensory integrative therapy and especially vestibular stimulation to a brain damaged adult may cause nausea, fatigue, dizziness, changes in blood pressure, seizures and abnormal associated reactions. These potential problems therefore need to be monitored 24 hours per day when using this approach. As a result this approach is rarely used with adult stroke patients and there is little documented evidence of its use with adult brain damaged patients. It was therefore not thought to be an appropriate approach for this study of perceptual treatment approaches.

1.8.5 Affolter approach

The *Affolter approach* is another bottom up approach which focuses on "facilitating perceptual - cognitive representation through problem solving experience, which is assumed to be at the root of a variety of skills" (Davis and Radomski, 1989). Affolter believes that the tactile - kinesthetic system is crucial to this problem solving experience (Affolter, 1987). Zoltan (1996) explains that the patient must experience learning situations and interact with the environment, in order to learn, thus making this a process-orientated approach which focuses on the input.

The tactile - kinesthetic system provides the patient with information related to actions and objects which leads to perceptual inferences, which are necessary for effective problem solving, which in turn leads to learning and independence. The therapist guides the patient's hand and body non-verbally in functional activities, thus facilitating patient exploration. Only the patients hand should come into contact with the object and when the therapist feels the patient is taking over the movement, the assistance in reduced (Davis and Radomski, 1989). This approach is not commonly used in occupational therapy departments in this country. However, as there is no evidence for its effectiveness, further evaluation of this approach is needed.

1.8.6 Neurodevelopmental approach

Zoltan et al. (1986) describe the ***neurodevelopmental approach*** as being the awareness of movement and function which develops with perception during childhood. They state that as a child develops it becomes aware of the two sides of the body and their differences as well as a sense of direction. A child then gradually develops a stable image of his / her own body which can then be used to act as a consistent point of origin for future perceptual responses. Neurodevelopmental treatment is a comprehensive management approach to motor recovery as it relates to activities of daily living (DeGangi and Royeen, 1994). Treatment is aimed at giving the patient control over his / her movement with every treatment performed in a functional situation (Bobath, 1978). It works to facilitate normal movement and inhibit abnormal movement to enable the patient to move normally in all functional tasks. This involves developing a variety of postural sets that make movements easier and automatic, which helps to redevelop normal body scheme (Bobath, 1978).

Two more recent theories relating to the neurodevelopmental approach are that of "forced use" and "motor learning and movement analysis" (Wolf et al., 1989; Jarus, 1994; Fisher and Yakura, 1993). "Forced use" describes the technique of directing the patients attention and effort to the hemiparetic limb to the exclusion of the uninvolved limb. Recent research has shown that the application of forced use can change the functional capacity of even chronic neurological patients (Wolf et al., 1989). "Motor learning" is a set of internal processes that are associated with practice or experience which leads to long-lasting and permanent changes in motor behaviour (Jarus, 1994). Factors which affect motor learning are movement organisation, environmental factors and cognitive processing. It is also believed that "movement analysis" should include all systems that affect movement (Fisher and Yakura, 1993).

Zoltan (1996) suggested that the neurodevelopmental approach was an effective way of restoring motor function and also restoring normal body scheme, which ultimately would assist in restoring higher level visual perceptual skills. However, there is little published evidence on the effectiveness of this approach. Ernst (1990) reviewed the evidence for the use of the neurodevelopmental approach and found that most of the published studies showed that the type of approach used did not influence recovery (Logigian et al., 1983; Lord and Hall, 1986; Dickstein et al., 1986; Basmajian et al., 1987). All these studies compared the neurodevelopmental approach with at least one other approach but all lacked specific information about the actual treatment involved. The studies did not use independent assessors, treatment stated late and was of short duration and most had only small sample sizes.

Adaptive approaches:

1.8.7 Functional approach

The *functional approach* is the repetitive practice of particular tasks, usually activities of daily living, in order to make the patient more independent. The emphasis is on treating the symptom rather than the cause of the problem. For example, a patient with spatial relations problems, will have difficulty dressing. By practising dressing, the patient will learn to dress but will still have the underlying spatial relations problems. Functional or occupational tasks are used in this approach to maximise the patients' independence in the expectation of effective adaptation. This occurs within an environmental context, therefore a variety of functional activities need to be practised in different environments (Zoltan, 1996). Zoltan et al (1986), divide this approach into two aspects:-

Compensation A patient would be made aware of their problems and then taught to compensate of make allowance for it e.g. a patient neglecting one half of space because of unilateral neglect, would be taught to turn his / her head or scan his / her eyes to the affected side. Compensatory behaviours are most successful when they are overlearnt to the point of being automatic.

Adaptation The environment would be changed or adapted to enable the patient to compensate for his / her symptoms e.g. a patient with unilateral neglect would have food and utensils placed on his / her affected side or a patient with figure-ground problems would be encouraged to unclutter their environment, to make it easier to find objects.

The main advantage of the functional approach is that it is more practical and more understandable to the patient than the transfer of training approach. Many Occupational Therapists prefer this approach due to time restraints and pressure to discharge patients safely but quickly, believing that their time is needed facilitating patients to become independent in activities of daily living and that the patients perceptual abilities will improve along with this. There is some evidence of the effectiveness of this approach, which is discussed in section 1.9.3.

1.8.8 Occupational performance approach

Zoltan (1996) explains that the goal of the *occupational performance approach* is to remediate and reduce dysfunction relating to daily living tasks (Christiansen, 1991). The individual is seen as a living open system consisting of many independent and related parts, which can exist only if there is ongoing interaction between the individual and the environment. The relationship of the open system and the environment is viewed as a performance interaction and when described in the context of daily living skills is termed occupational performance. Occupational performance is the "doing part of real life occupation in self care, play, leisure and work" (Abreu et al., 1994). Abreu et al. describe three levels of occupational performance - activities, tasks and roles. They describe occupational dysfunction as being when there is a breakdown in the ability to perform life's roles. Three occupational performance components relate to occupational function - sensorimotor, cognitive and psychosocial. Trombly (1993) summarises the goals of an occupational performance approach as:

- gaining sense of efficiency and feeling competent
- being in control of ones life
- engaging in a life role
- being able to do tasks, made up of activities which are smaller units of behaviour
- having sensorimotor, cognitive, perceptual, emotional, and social abilities
- gaining abilities through practice

1.8.9 Dynamic interactional approach

The final approach described by Zoltan (1996) is the *dynamic interactional approach* which can be viewed as a remedial adaptive approach. The concept of the dynamic interactional approach is that cognition is an ongoing production or outcome of interaction between the individual, the task and the environment (Toglia, 1992). The patients' performance is analysed by examining the underlying condition and processing strategies that change performance. Treatment and evaluation are carried out in a variety of situations or contexts (multi-context) with the goal being to improve the patients ability to "process, monitor and use new information flexibly across task situations" (Toglia, 1992). The skills required to generalise to new learning are the ability to assess the level of difficulty of a task, plan ahead, select appropriate strategies, predict the consequences and monitor performance (Toglia, 1992). Treatment involves "practising targeted processing strategies and self monitoring techniques, in a variety of situations and environments" (Toglia, 1992). Tasks are analysed and upgraded to place additional demands on the impaired processing system and the ability to transfer new learning (Toglia, 1992).

1.8.10 Multicontext approach

Toglia (1991) also describes this ***multicontext approach*** as being based on an organisational framework of learning. She explains that within this framework there are six factors which are interrelated and critical to the process of learning and generalisation, three are external to the learner and three are internal. The external factors are environmental context, nature of the task and learning criteria; the internal factors are metacognition, processing strategies and learners characteristics. Toglia describes this approach as involving patients practising targeted strategies in multiple environments with a variety of tasks and movements required. The treatment components are:

- use of multienvironments
- task analysis and identification of criteria for transfer
- metacognitive training
- emphasis on processing strategies
- relation of new information to previously learned knowledge or skills

In this approach, Toglia believes that transfer of learning may not happen automatically but that it relies on certain conditions which increase the chance of transfer occurring.

A statement to consider was also made by Adams (1989), who suggested that if what is taught is abstract and removed from the context and condition of its application, it will be unrelated to previous experience and learned as an isolated, meaningless structure. Alternatively though, if what is taught is embedded in only one context, such as dressing, the skills learnt may be accessible only in that specific context.

1.8.11 Attentional approach

Riddoch and Humphreys (1994) describe another approach, which is specific to the treatment of unilateral neglect as an attentional disorder. They suggest that different attentional states i.e. engage, disengage and move, arise from different interactions between attentional network components. They also suggest that there are three component attentional mechanisms in the attentional network - maintaining attention at its focus; orienting attention according to data-driven signals; voluntary orienting attention to new locations. These components interact such that activation of one component leads to inhibition of the others.

However, it should be noted that all the approaches described in this section were based on theoretical concepts and there is no scientific evidence for their foundation, apart from the transfer of training and functional approaches, as described in section 1.9.

1.8.12 Approaches chosen

For this study the transfer of training and functional approaches to perceptual treatment were chosen for comparison. The transfer of training approach was chosen as it is a remedial approach which focuses on treating actual perceptual problems with the hope of generalisation to activities of daily living. The functional approach was chosen for comparison in this study as it is an adaptive approach with the focus being on the making the patient independent rather than treating the impairment. Comparison could therefore be made to identify if there were any differences in outcomes between remedial and adaptive approaches. The transfer of training and functional approaches were also the most common approaches used for the treatment of perceptual problems following stroke in occupational therapy departments in Britain at the time of starting the study and there was some evidence of the effectiveness of treatment following either of these approaches, but no comparative studies.

The sensory integrative, Affolter, neurodevelopmental, occupational performance and dynamic interactional approaches were not included in the perceptual treatment study, as they do not focus purely on treating perceptual problems. Riddoch and Humphreys approach was also not chosen as it is concerned with unilateral neglect as an attentional disorder and the perceptual treatment study was intending to treat a combination of different perceptual problems, rather than unilateral neglect alone.

1.8.13 International classification of impairments, disabilities and handicaps

According to the International Classification of Impairments, Disabilities and Handicaps (ICIDH) (WHO, 1980), any illness can be considered at four levels:- pathology, impairment, disability and handicap.

Pathology is the damage or abnormal processes occurring within an organ or organ system inside the body e.g. stroke.

Impairment is the consequences of the underlying pathology i.e. "the loss or abnormality of psychological, physiological or anatomical structure of function", in other words, the disordered function, such as loss of motor, sensory, visual or language ability.

Disability is the personal nuisance caused by the pathology or impairment i.e. "the restriction or lack of ability, resulting from an impairment, to perform an activity within the range considered normal for a human being", in other words, the loss of functional abilities, such as being able to carry out activities of daily living.

Handicap is the consequence of the impairment and disability i.e. "the disadvantage for the individual, resulting from an impairment or disability, that limits or prevents the fulfilment of a role that is normal for that individual" in other words the social disadvantage for the patient, such as role limitations.

The transfer of training approach therefore, is treating the impairment i.e. the disordered function, for example, spatial awareness. The functional approach however, is treating the disability i.e. the loss of functional abilities, for example, the ability to dress.

When considering the clinical intervention, Miller (1984) divides the goals into two main types, restitution and amelioration.

Restitution implies the full or partial regaining of lost functional capacities. This involves the recovery of functions as means, as in the transfer of training approach e.g. improvement in spatial awareness is a means to improving dressing.

Amelioration is concerned with assisting the individual to function as well as possible, despite their handicaps. An approach based on amelioration is one stressing the regaining of functions as ends and plays down the recovery of functions as means, as in the functional approach e.g. improvement in dressing is an end but the spatial awareness problem still exists. Amelioration is therefore a more potentially attainable goal than restitution, for intervention directed at rehabilitation of brain injured subjects. Restitution raises the hope of a complete recovery whereas amelioration accepts that some basic deficits are likely to be permanent.

1.9 Effects of treating perceptual problems

Reviews of the rehabilitation of visuospatial dysfunction by Delis et al. (1983) and Lincoln (1991; 1995), have reported the effectiveness of perceptual retraining techniques. However, most of the studies mentioned in these reviews only deal with left neglect, probably because this is one of the few visuospatial dysfunctions which is relatively well defined and which severely disrupts activities of daily living. Many studies investigating the effect of perceptual rehabilitation using either single case experimental designs or randomised controlled trials have been carried out, some of which will now be discussed in detail. The effects of using the transfer of training and functional approaches will be investigated separately.

1.9.1 Single case experimental design studies following the transfer of training approach

One method of investigating treatment effects is by the use of single case experimental design studies, which evaluate the effectiveness of treatment for individual patients only. The results will not necessarily be the same with another patient but they can be used to evaluate whether improvement during treatment was due to spontaneous recovery, general effects of treatment or the particular treatment given. The advantages of these designs are that they assess therapy for an individual patient, can be carried out as part of routine clinical practice and large numbers of similar patients are not required. There are various different designs that may be used in this way including an ABAB, BCBD or multiple baseline designs.

Studies using this method to evaluate the effect of the transfer of training approach in treating perceptual problems after stroke, have been carried out and have produced differing results (Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Towle et al., 1990; Fanthome et al., 1995; Robertson et al., 1988; Wagenaar et al., 1992; Robertson et al., 1992; Prada and Tallis, 1995).

Four of these single case experimental design studies showed negative results of treating perceptual problems after stroke (Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Towle et al., 1990; Fanthome et al., 1995). Edmans and Lincoln (1989; 1991) evaluated the transfer of training approach to the treatment of visual perceptual problems using multiple baseline single case experimental designs. These studies included three left hemiplegic, four right hemiplegic and one bilateral hemiplegic stroke patients, aged 49 to 65 years and between three and 12 weeks post stroke. The patients were assessed for perceptual and ADL abilities using standardised assessments. They were treated for a variety of perceptual problems, including spatial relations, unilateral neglect, sequencing, body image, colour matching and figure-ground difficulties using activities involving cube copying, 3D copying, scanning from left to right, putting items in size, colour or order sequences. Treatment was given in 45 minute sessions, three times per week, in blocks of six to nine weeks. Baseline measurements, using standardised assessments, were taken weekly for three to six weeks prior to treatment and throughout treatment, by an independent assessor who was blind to the treatment programme. The results showed little evidence of effective treatment for perceptual problems although there was a slight response to treatment for inattention. They found that some patients improved though not specifically with the treatment given suggesting that perceptual stimulation alone may have produced some general improvements. All patients made gradual improvement in activities of daily living during the trial period.

Another study, by Towle et al (1990), evaluated a group treatment programme in which patients with unilateral visual neglect and visuospatial deficits were given practice on perceptual tasks. They used an ABA single case design with six patients, who were aged 56 to 79 years, five with left hemiplegia and one with right hemiplegia. The design included four weeks baseline with no perceptual treatment, eight weeks group treatment of one hour sessions, three times per week, followed by four weeks of no perceptual treatment. The treatment emphasised patients checking their affected side, working systematically and demonstrating how spatial tasks could be verbalised. During the 16 weeks routine therapy continued for all patients. The results however showed that only three patients showed any beneficial effect of this perceptual treatment. The improvements related to treatment were minimal and applied more to visual spatial problems than to unilateral visual neglect. The authors questioned whether the treatment activities used actually treated the intended abilities but stressed the importance of evaluating treatment.

A further study by Fanthome et al (1995) studied 14 left hemiplegic stroke patients with left visual neglect admitted to hospital. The patients were aged 49 to 80 years and were all less than three months post stroke. An AB single case experimental design was used with a baseline of no perceptual treatment for four weeks, followed by four weeks treatment of visual neglect using various computer and wide-angled games and paper and pencil puzzle-type activities using a red line stimulus on the left of the patient. Treatment was given for 2.5 hours per week. The results showed that only three of the 14 patients improved on perceptual test scores and those were the patients with the most severe neglect. They concluded that the transfer of training approach did not appear to improve visual neglect in the majority of patients, although there had been a significant improvement in visual neglect over time, but this was independent of treatment.

However, none of these studies showing negative results (Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Towle et al., 1990; Fanthome et al., 1995), included the effect of other impairments e.g. cognitive impairments, which may have affected the patients opportunity to show recovery in perceptual ability. The treatment activities used in all these studies were the types of activities commonly used in OT Departments, although there was no proof that treatment using these activities actually influenced perceptual ability. The treatment regimes were also similar to those used in OT Departments. These studies did therefore, reflect the normal clinical practice for the treatment of perceptual problems in OT Departments in the UK. Another limitation is that they all evaluated the treatment of a variety of perceptual problems rather than evaluating treatment for one perceptual problem alone, which again may be something akin to normal clinical practice in an OT Department in the UK. Maybe a more concentrated approach to one problem at a time may have produced greater effects. A positive note about all these studies though is that they highlighted the need and attempted to evaluate current treatment practices.

Other single case experimental studies have shown more positive results (Robertson et al., 1988; Wagenaar et al., 1992; Robertson et al., 1992; Prada and Tallis, 1995). Robertson et al. (1988), investigated treatment using microcomputer cognitive remediation programmes with three brain injured patients showing left visual neglect, one following a head injury, one after a stroke and one with a subarachnoid haemorrhage. The patients were aged between 20 and 57 years and varied from eight to 23 weeks post event. Baseline measurements varied between patients and were taken for three to seven sessions during one week prior to the commencement of treatment. Treatment was then given using microcomputer cognitive remediation programmes in 45 minute sessions and each patient received between five and seven sessions of treatment over a period of between three and eight days. The results generally indicated that patients had improved on the specific goals that had been pre-set for them individually. Robertson et al. suggested that this was likely to be due to new verbal regulation strategies and, as the control measures showed no improvement, was not due to spontaneous recovery.

The treatment of patients with visual inattention was also studies by Wagenaar et al (1992), using single case designs with five left hemiplegic patients. The patients were aged 26 to 67 years and were admitted to the study between five and 24 weeks post stroke. They used a BCBD design with the B phases being for two, four or six weeks and C and D phases being for a fixed duration of two weeks. Physical therapy was given during all phases, occupational therapy during B phases, scanning apparatus training in C phase and training on reading tasks in D phases. All treatments were for

30 minutes daily. Baseline measurements were taken at least three times in each treatment phase using standardised assessments by an independent assessor. In addition, wheelchair navigation was assessed. Four out of the five patients showed a significant positive effect of visual scanning training on visual scanning behaviour but this appeared to be restricted to the task which was specifically trained. Overall, no evidence was found for any transfer of visual scanning training effects to the domain of gross motor skills.

Although these two studies (Robertson et al., 1988; Wagenaar et al., 1992) both showed positive results, they only included patients with left visual neglect and gave specific treatment which resulted in improvement on specific target measures alone. The treatment given to achieve this improvement was very intensive over a short period of time but it is not known if these resulting would be long lasting. It is doubtful whether OTs could offer this intensity of treatment in normal clinical practice due to pressures on staff time. There is more pressure on health service staff to discharge patients from hospital as soon as possible and follow up their treatment on an out-patient basis. This is due to the combined effects of the NHS Community Care Act (1990) and the Health of the Nation white paper (1992). The NHS Community Care Act (1990) instigated the establishment of NHS Trusts and the Health of the Nation white paper (1992) set out to improve NHS accountability systems and developed the concept of targets to improve quality of care, reduce waiting times and increase efficiency and value for money. The impact of the results of the Robertson et al. (1988) and Wagenaar et al. (1992) studies is therefore reduced as it is unlikely to be feasible to replicate this intensity of treatment in the present day clinical climate. Another limitation is that the patients' motivation for improvement may have been heightened as a result of the intensity of the attention they were receiving, which may also have affected the results.

Two further studies investigated the effect of left upper limb activation / stimulation in the recovery of left visual neglect (Robertson et al., 1992; Prada and Tallis, 1995). Robertson et al. (1992) carried out trials with three patients with left hemiplegia and left sided neglect, using limb activation contralateral to the cerebral lesion, to reduce visual neglect. The first was a 30 year old patient with marked unilateral neglect and some control over the left arm, who was 22 weeks post stroke. The baseline phase was for six weeks and treatment was given for four hours per day on 11 days over an eight week period. The treatment used a combination of perceptual anchoring training with left arm activation procedures and produced improvements. The second patient was a 61 year old with left visual neglect and hemianopia, 11 weeks post stroke. This patient received treatment for two hours per day for five days after a baseline phase of five days. The treatment for this patient used the same method as for the first patient, but stimulated left arm activation using an avoidance conditioning procedure, again producing positive results. The last patient was a 62 year old also with left visual neglect who was five weeks post stroke. The baseline phase was for six days and treatment focused on cueing for left arm activation using the avoidance conditioning procedure, without explicit instructions for perceptual anchoring. Again this patient showed positive results. All three patients improved on neglect measures but not on the control measures indicating that this improvement was not likely to be due to spontaneous recovery.

The other study using upper limb stimulation was by Prada and Tallis (1995). They studied two patients with left hemiplegia and severe perceptual problems including tactile neglect using an ABAB multiple baseline single case design. One patient was 71 years old, nine weeks post stroke and suffered with tactile and visual neglect. The other patient was 69 years old, six weeks post stroke and suffered from mild tactile neglect and moderate visual neglect. Baseline and treatment phases were each for one month. During the baseline phases both patients received standard therapy and during the treatment phases they received stimulation to their affected upper limb, using a contingency electrical stimulator. This treatment was for three hours per day in addition to their ongoing therapy. The results showed that both patients showed a significant improvement on perceptual abilities during the study and there was a significant difference between the treatment and baseline phases. This study did not investigate the impact of the improvement on ADL as the authors felt that the ADL test batteries available were insufficiently sensitive.

These studies (Robertson et al., 1992; Prada and Tallis, 1995) also showed positive results but again this was for the treatment of neglect only and involved intensive treatment for many hours at a time. However, there is more possibility of incorporating treatment similar to that used by Robertson et al, and Prada and Tallis, into normal clinical practice which make the results from these studies more relevant to the needs of a greater number of stroke patients.

All these single case experimental design studies included the use of standardised assessments but there was no mention by Robertson et al. (1988) or Prada and Tallis (1995) as to whether these assessments were completed by an independent assessor. It is presumed that they were, otherwise the results from these studies could have been open to bias. Some of the studies mentioned (Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Robertson et al., 1988; Wagenaar et al., 1992; Robertson et al., 1992), only included young patients, under the age of 70 years. As many stroke patients with perceptual problems are over this age, it is important to know if these results will be applicable to them. These studies investigated the effect of treating perceptual problems on perceptual ability but did not all investigate the effect on ADL (Towle et al., 1990; Fanthome et al., 1995; Wagenaar et al., 1992). This is seen as a limitation, as what is important to patients is whether the improvement in perceptual ability will affect their everyday life.

Overall, the evidence about the effectiveness of the treatment of perceptual problems is inconclusive. There is evidence though, to show that the treatment of unilateral neglect can improve target measures. However, patients for single case experimental designs are selected patients. They may have be "selected" as being patients likely to show improvement after treatment or may be those that have severe problems which do not appear to be responding to treatment. Randomised controlled trials are therefore needed to eliminate any such bias.

1.9.2 Randomised controlled trial studies following the transfer of training approach

Randomised controlled trials (RCT) are trials where groups of patients receiving the same treatment are compared. They include larger numbers of similar patients who are randomly allocated to the different groups, each group receiving a different treatment. The random allocation should be objective, resulting in the groups being comparable and avoiding the possibility of patient selection bias. Each group should therefore include a similar variation of patient characteristics and levels of ability.

Group studies (not all were RCTs) have found significant differences between control groups of conventional rehabilitation and experimental groups receiving specialised perceptual treatment of various kinds, suggesting that their treatment techniques were of value in the remediation of perceptual problems (Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985).

Diller et al. (1974) in one of a series of studies involving both right and left hemiplegic stroke patients, investigated the effect of perceptual treatment following the transfer of training approach. The experimental group received 10 one-hour training sessions of treatment in copying block designs, in addition to their routine rehabilitation therapies and the control group received 10 additional hours of standard rehabilitation. They found that the experimental group improved more on transfer of training activities, i.e. block designs and in five areas of occupational therapy, than the control group. The five areas of occupational therapy were; attitude and mood, consistency and attention, amount of help required in self care activities, eye / hand co-ordination and areas such as compensating for unilateral neglect. However, this study was carried out in America where there is a different health care system and patients may therefore have been selected as being suitable candidates for rehabilitation, rather than being a true cross-section of the stroke population. Also there are no details of the contents of the standard rehabilitation received.

Another study carried out by Diller's colleagues was that of Weinberg et al. (1979) who studies 53 patients who had left hemiplegia and neglect, with a mean age of 65 years. The patients were at least four weeks post stroke and were in-patients in a rehabilitation unit. They were randomly assigned to two groups, 30 in the experimental group and 23 in a control group. The experimental group received a treatment programme incorporating spatial organisation and scanning training with sensory awareness training, for one hour per day for four weeks. The control group received one extra hour each day of standard rehabilitation in occupational therapy or physiotherapy, thus both groups received an equal amount of additional treatment. Analysis of results from a battery of psychological tests showed the perceptual performance of the experimental group exceeded that of the control group. Patients in the experimental group with severe impairments improved more than those with mild impairment.

A further study by Weinberg et al. (1982) included 35 left hemiplegic patients with visuo-cognitive problems but without unilateral visual neglect, who were randomly assigned to two groups. The experimental group consisted of 17 patients, with a mean age of 64.2 years and mean of 13.5 weeks post stroke. They entered a training programme for one hour daily for a month to establish a systematic strategy of organising complex visual material. The control group of 18 patients had a mean age of 66.8 years and mean of 15.4 weeks post stroke. They received extra rehabilitation therapy for one hour daily and were re-examined after a month. Outcome measures included 21 tests of either verbal-cognitive or visuo-cognitive abilities. The overall results showed that the experimental group had improved significantly more than the control group on performance on visuocognitive tasks. Both groups improved on many of the individual tests in the battery but the effects of training were relatively small when considered on a test by test basis.

However, both of these studies by Weinberg et al. only included left hemiplegic patients, either with unilateral neglect and spatial problems (Weinberg et al., 1979) or without neglect (Weinberg et al., 1982). Both studies randomly assigned patients to the two treatment groups but there may have been some bias in the selection of patients for these studies. The Weinberg et al., 1979 study does not include the number and types of patients excluded from the study and the Weinberg et al. 1982 study excluded ten patients because they were in an unrelated study and 37 because they were expected to have a length of stay of less than one month.

A study carried out by Young et al. (1983) included 27 left hemiplegic patients who were aged 40 to 80 years. They were divided into three groups, matched for age, education, degree of unilateral neglect and time post stroke. Group 1 received additional routine occupational therapy; group 2 received 20 minutes each of routine occupational therapy, cancellation training and visual scanning training; group 3 received 20 minutes each of block design training, cancellation training and visual scanning training. Each patient received their additional treatment for one hour per day for 20 days. The results showed that groups 2 and 3 improved on measures of visual scanning (cancellation tasks), reading and writing, significantly more than did group 1 and group 3 improved significantly more than group 2 on the same measures. The authors concluded that their results indicated that block design training enhanced the effect of visual scanning training techniques in the remediation of perceptual problems in left hemiplegics. There is no mention in this study though of where these patients were from or how they were selected, suggesting there could have been some selection bias. Again, there is no mention of how these patients were then "matched" or how many were in each group. It is presumed that there were nine in each group if the groups were "matched".

Gordon et al. (1985), completed a further study comparing conventional treatment and specific perceptual treatment. They assigned patients to either an experimental or control group, depending on the rehabilitation service in which they were placed. All patients were from two comparable in-patient services and the two groups were alternated every six months. The patients were all left hemiplegics, at least four weeks post stroke and aged 40 to 85 years. There were 48 patients in the experimental group and 29 in the control group. Treatment was for 35 hours over seven weeks (i.e. one hour per day) and for the experimental group included basic visual scanning, somatosensory awareness, size estimation training and complex visual perceptual organisation. The control group received additional conventional or leisure therapy for the same amount of time. They were reassessed on discharge from rehabilitation and again 4 months later on a psychometric test battery. At rehabilitation discharge the experimental group performed better than the control group in perceptual functioning but not in non-specific generalisation abilities or in mood. However, 4 months after discharge the experimental group had reached a plateau, whereas the control group had continued to improve such that the performance of the experimental group was equivalent to that of the control group. Again, as with the Young et al. study, selection bias could have occurred in this study as the patients were not randomly allocated other than by place of rehabilitation. The study would have been more "controlled" if patients had been randomly allocated from both locations.

A study that investigated effects of perceptual treatment in patients slightly later post stroke was by Soderback and Normell (1986), who studied patients referred to three rehabilitation clinics. The patients were aged 24 to 64 years and were between two and seven months post stroke. They were divided into two groups according to the clinic that they had been referred to. The experimental group of 13 patients received treatment for 40 minutes per day, five days per week for 3 months based on a 900 page training manual for intellectual function training. The training manual consisted of six sections - visual perceptual ability, spatial ability, verbal ability, numerical ability, memory ability and logical ability. The control group of 13 patients received conventional rehabilitation for the same additional amount of time. Outcome measures included an intellectual function assessment and three psychometric test batteries. The results showed there was a significant difference between groups on the intellectual function assessment except for long-term memory, with the experimental group improving more than the control group. This improvement was still evident six months later. The authors concluded that the improvement was related to the specific type of task being trained. The limitations of this study include that it did not state what type of patients were included, i.e. right and / or left hemiplegic patients, again it did not relate the treatment effects to ADL abilities and there was no description of the content of the conventional rehabilitation. There was also some confusion in the text as initially they stated that 31 patients were included (16 in the experimental group and 15 in the control group) but then only discussed the results of 13 patients in each group.

A limitation of all these group studies mentioned so far (Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985; Soderback and Normell, 1986) was that they were all carried out in countries other than Britain (America, Canada and Sweden), where the health care systems are different. This may have affected the selection of the patients included and the patients may not have been representative of the stroke population in the UK Another limitation was that the outcome measures used in each study were similar to the treatment activities. Treatment may well therefore have affected these outcome measures but there is no mention of whether the effects generalised to other areas e.g. ADL. It is these practical implications of treatment that are of importance to the patients, as this affects how dependent / independent they are, otherwise the treatment effects may be irrelevant to them. The effect of treatment on ADL is also important as one of the reasons frequently cited for treating perceptual problems was that patients with perceptual problems tend to be more dependent and therefore stay in hospital longer. It is also important to note the improvement of the control group in ADL terms for comparison. Another limitation of these studies is that they did not describe the contents of the conventional therapy, in terms of strategies and techniques used. This may have influenced the results as the patients in the experimental groups also received conventional therapy.

Another study that showed positive results of perceptual treatment was that of Ladavas et al. (1994), who studied patients later post stroke. They studied 12 left hemiplegic stroke patients with visual and tactile neglect. The patients were aged 43 to 83 years, were at least six months post stroke and were assigned to three groups. One group received overt orienting where patients were induced to orient both attention and eyes towards the cued position, one group received covert orienting where the patients were induced to orient attention only towards the cued position whilst keeping their eyes at fixation and a control group. Treatment was given one hour daily over six weeks using microcomputers. The results showed a clear-cut improvement in visual neglect with overt and covert orienting being equally effective in improving neglect. No noticeable treatment effect was found on tactile neglect measures. However, the patients were assigned to each group, rather than being randomly allocated to each group and therefore there could have been some selection bias. There was the possibility that the patients with more severe problems could have been assigned to the control group whereas those with less severe problems, thought more likely to improve with treatment, could have been assigned to the two treatment groups. It was also not clear whether the control group received computer treatment aimed at rehabilitation of motor deficits or if this was non-computer based treatment. If it was the latter, the improvement seen may just have been as a result of using computer based treatment. A positive point though is that these patients were later post stroke and therefore at a time when spontaneous recovery would be less likely to occur.

Some randomised controlled trails however found negative results when using the transfer of training approach in comparison with conventional therapy (Robertson et al., 1990; Taylor et al., 1971; Lincoln et al., 1985; Hajek et al., 1993). Robertson et al (1990) followed up their previous single case experimental designs (Robertson et al., 1988) with a randomised controlled trial to evaluate their microcomputer treatment techniques in a larger sample of patients. Thirty six patients, 33 hemiplegic patients with left unilateral neglect, two head injured patients and one who had had surgery for the excision of a meningioma, were randomly allocated to two groups. The experimental group included 20 patients with a mean age of 64.2 years and mean of 19.2 weeks post onset. They received a mean of 15.5 hours treatment using microcomputer neglect programmes for seven weeks. The control group had a mean age of 63.1 years and mean of 10.8 weeks post stroke. They received a mean of 11.4 hours of recreational programmes on a microcomputer over the seven weeks. In contrast to their single case design study, Robertson et al (1990) found no significant difference in perceptual ability between these groups after the seven weeks treatment or at follow up six months later. The study also indicated that little improvement in unilateral neglect had been made by either group of patients. However, this study investigated the effects of two microcomputer treatment programmes but did not include a group who received no computerised treatment (as a control group) for comparison. It is difficult therefore to identify if there was any general effect of computerised treatment for the patients in this study. The results from their previous study (Robertson et al., 1988) showed positive results of using microcomputer treatment techniques, but these were not evident in the RCT study. This may be because less intensive treatment was given to patients in the RCT. Another limitation of this study was that it did not evaluate if any effects of treatment generalised to ADL.

Two studies, which compared perceptual treatment and conventional treatment, producing negative results, were carried out by Taylor et al. (1971) and Lincoln et al. (1985). Taylor et al. (1971) studied 47 left hemiplegic patients, aged 40 to 70 years and between 14 and 180 days post stroke. They were randomly assigned to a control group of standard treatment involving treatment directed at gross motor function (21 patients) or to an experimental group (26 patients) with treatment directed to perceptual and cognitive deficits which used a combination of sensory integrative and transfer of training approaches. All patients received this additional treatment for 20 treatment days. No significant difference was found between the perceptual retraining group and the standard gross motor training control group, on activities of daily living or perceptual ability, after the 20 days of treatment. All patients accomplished a significant improvement in both perceptual and ADL ratings.

Similarly, Lincoln et al. (1985) conducted a study comparing conventional occupational therapy and perceptual retraining, for head injured and stroke patients with impairment of visual perception. There were six head injured patients and 27 stroke patients, 14 with right hemisphere damage and 13 with left hemisphere damage. Patients were aged 17 to 69 years and were on average two months post stroke or head injury. They were randomly allocated to the two groups, 17 to the perceptual retraining group and 16 to the conventional therapy group, and received treatment for four hours per week for four weeks. The perceptual retaining group were treated using perceptual treatment activities commonly found in OT departments and the conventional therapy group were treated using activities not designed to improve perceptual ability. No significant differences were found between the groups on measures of visual perception or activities of daily living. Both groups showed improvement on most perceptual tasks and a marked improvement in self care activities of daily living.

However, there is some doubt about the "controlled" nature of these experiments (Taylor et al., 1971; Lincoln et al., 1985). The control group in the Taylor et al. study received practice on spatial relations tasks such as pegboard and parquetry block designs, verbal instruction in dressing and proprioceptive stimulation. The Lincoln et al. study similarly included games, craftwork and gardening within their conventional therapy. These activities may have included aspects of perceptual ability, causing an overlap between the treatment and control group. This therefore may have reduced the impact their perceptual retraining, particularly since patients in both groups of both studies improved in perceptual and ADL abilities. These two studies also attempted to treat a mixture of perceptual problems rather than just one specific problem, which again may have reduced the impact of any improvement over the four week treatment period.

Another study, by Hajek et al. (1993) evaluated the effectiveness of a visuo spatial training programme with 20 left hemiplegic stroke patients on a Stroke Unit. The patients were aged 50 to 84 years, the experimental group (10 patients) being a mean of 72 days post stroke and the control group (10 patients) being a mean of 63 days post stroke. The experimental group received four weeks visuo spatial treatment using microcomputer programmes plus routine therapy and the control group received routine therapy only. Treatment was for three 30 minute sessions per week. The results showed no significant difference between groups in terms of perceptual ability. However, although the patients did not significantly improve in their visuo spatial skills, there was a significant improvement in both groups in the Barthel ADL index scores over the four weeks. However, some patients in the experimental group may have had less motivation to carry out the microcomputer treatment, as Hajek et al. had commented that some patients refused or hesitated to consent to the study because it involved computer treatment. If the motivation levels for completing treatment were different in each group, this may been responsible for the lack of difference between groups. Another factor is that the computer treatment used in this study and the Robertson et al. study in 1990, may be ineffective in improving perceptual ability. Both Hajek et al. and Lincoln et al. suggested that the effects of their experimental treatment may have been masked by the general therapies received by the patients because they were on an intensive rehabilitation / stroke unit.

A limitation generally of the studies showing both positive and negative results of perceptual retraining (Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985; Soderback and Normell, 1986; Ladavas et al., 1994; Robertson et al., 1990; Taylor et al., 1971; Lincoln et al., 1985; Hajek et al., 1993), was that they all included small sample sizes and did not explain how they decided whether they had included sufficient patients to detect differences between the groups of patients. The studies which claimed that they randomly allocated patients to the different group lacked details of how the groups were actually randomised (Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Robertson et al., 1990; Taylor et al., 1971; Lincoln et al., 1985; Hajek et al., 1993). Apart from the Soderback and Normell study and the Ladavas et al. study, most studies treated patients as in-patients in hospital, early after stroke or head injury, at a time when spontaneous recovery would be most likely and treated patients for between 2-5 hours per week for 4-7 weeks.

Overall these group studies have shown that the most positive results in treating perceptual problems following the transfer of training approach have been with left hemiplegic patients with unilateral neglect. Treatment was most effective when it was intensive i.e. 40-60 minutes per day over a period of at least four weeks and when the outcome measures were similar to the treatment tasks. Little evaluation of the generalisation of this treatment had taken place.

1.9.3 Single case experimental design studies following the functional approach

Little has been done to evaluate the functional approach except at the Institute of Rehabilitation Medicine, New York by Webster et al. (1984) and Gouvier et al. (1984), who used a combination of the transfer of training and functional approaches. Webster et al. (1984) used multiple baseline single case experimental designs which involved training three male patients, who all had left hemiplegic strokes with left hemianopia and left-sided inattention, on visual scanning tasks (visual scanning training) and obstacle course performance during wheelchair navigation (position training). The patients were aged 54 to 77 years and were between one and 18 months post stroke. The visual scanning training consisted of treatment on a visual scanning board, where patients were trained to identify coloured lights along the length of an elongated oval board using a systematic left to right search. Position training involved the patients being trained to position their wheelchair in relation to other objects e.g. corners or door frames. Treatment was for 45 minutes daily, five times a week but each patient received different amounts of treatment. The first patient had nine sessions of each type of treatment, the second had six sessions of visual scanning and nine sessions of position training and the third patient had 12 sessions of visual scanning training After treatment the patients showed improved performance on visual scanning tasks and in wheelchair navigation through the obstacle course. This improvement in scanning skill was maintained by all three patients when followed up one year later. The authors suggested that scanning training generalised to other tasks dependent on visual scanning and that patients could be taught to compensate by learning to systematically scan the environment.

Following on from Webster et al.'s work, Gouvier et al. (1984) also carried out single case experimental designs on two men with left hemiplegic strokes, left hemianopia and left inattention, aged 43 and 58 years, one eight weeks post stroke and one six months post stroke. The patients were trained to systematically scan the environment from left to right whilst stationary and then whilst moving. Their treatment was similar to that used in Webster et al. study in 1984, in that they used scanning training on the scanning board of lights but they also included a mobile scanning phase where patients were taught to systematically look left to right whilst driving their wheelchairs. Patient 1 had three stationary scanning and navigation performance sessions after the baseline measurement, followed by four sessions of mobile scanning. Patient 2 had five stationary scanning and navigation performance session after the baseline measurement, followed by seven sessions of mobile scanning. After treatment, both patients showed improved performance on the wheelchair obstacle course in terms of the number of contacts with obstacles and in terms of left to right scanning. Gouvier et al also reported that there was increased motivation for the patients to improve their safety when navigating their wheelchairs as this was likely to improve their ability to return to driving cars later.

Both of these studies (Webster et al., 1984; Gouvier et al., 1984) report the association between visual scanning training and wheelchair navigation but this was in male patients only. It is therefore not known whether these results would be replicated with female patients, although there is no reason to suspect any difference. A limitation of these studies was that they failed to mention whether the outcome measures were assessed by an independent assessors who was blind to the treatment being carried out at each assessment stage. If they did not include an independent assessor, the results could have been open to bias by the assessor. Another limitation was that they appeared to have used the same tool for the assessments and treatment. This could have produced a learning effect resulting in the patients improving over time irrespective of whether they were receiving treatment or not. Both of these studies were carried out in New York where there is a different health system to Britain and the patients may therefore not be representative of the stroke population in Britain. Treatment in America is centred around patient's insurance companies (Baum, 1992) as opposed to the National Health Service in Britain. The insurance companies are likely to want to see positive results and this may influence the motivation of patients to do well. The patients may also have had increased motivation to improve as they could see a direct relevance of the treatment to their everyday functional needs i.e. wheelchair navigation relates to returning to driving. Unfortunately, these studies only related visual scanning training to wheelchair navigation and did not relate the results to other ADL activities such as personal care or domestic tasks.

Although these two studies (Webster et al., 1984; Gouvier et al., 1984) have shown improvement in patients' abilities in wheelchair navigation, many stroke patients in Britain, particularly early after their stroke, are not encouraged to self-propel their wheelchairs. There is much controversy in this country about the use of self-propelling wheelchairs with early stroke patients. Blowers (1988) and Ashburn and Lynch (1988) documented the advantages and disadvantages of the early use of wheelchairs in the treatment of stroke patients respectively. Blowers (1988) described the advantages of using wheelchairs but explained that they should be used with hospitalised patients suffering from moderate or severe strokes only. He suggested that the wheelchair should have large wheels at the back and swinging detachable footrests and be propelled by the patients' sound hand and foot. The advantages he described included:-

- encouragement of a good sitting position which stimulated trunk control
- good support for the affected upper limb

- facilitation of transfers as the wheelchair could be placed in the optimum position
- speeds up independence and boosts morale
- encouragement of socialisation
- improvement in spatial awareness
- may help with preparation for walking with patients who can use both lower limbs but have poor trunk control
- eases the transportation of patients to treatment areas
- allows visitors to take patients off the ward
- prepares non-walkers for the future

Blowers advocated the use of wheelchairs and claimed that the disadvantages rarely caused difficulties and were therefore outweighed by the advantages. Ashburn and Lynch (1988) on the other hand reported the disadvantages as being:-

- limitation of the opportunity for daily practice of sensory motor skills in standing
- wheelchair use may become the patients' normal form of mobility and delay retraining of essential skills
- prolonged immobilisation causes increased flexion, learned nonuse, contractures and deformities
- patients remain dependent for other functional and personal activities
- self-propelling wheelchairs can lead to problems with posture and positioning and strenuous effort can lead to associated reactions
- wheelchair mobility difficult for patients with hemianopia, perceptual or fatigue problems

- depressed or frustrated patients may like the independence but this covers up the problems as it is a substitute for personal independence
- staff and patients may see wheelchair mobility as the patients' main mode of mobility and encourage and reinforce this rather than standing or walking

Ashburn and Lynch therefore discourage the use of wheelchairs long-term but support their use in the short term but only as part of a goal-orientated programme. This limits the relevance of the Webster et al. and Gouvier et al. studies to the present needs in many hospitals in this country.

1.9.4 <u>Randomised controlled trial following neither the transfer of training nor the functional approach</u>

Another study from New York by Rossi et al. (1990) studied right and left hemiplegic patients with hemianopia or unilateral neglect, to investigate the effect of Fresnel prisms. They had an experimental group of 18 patients, with a mean age of 72.6 years and mean of 4.4 weeks post stroke. They were treated using 15 diopter plastic press-on Fresnel prisms, which were attached to the patients' spectacles and were worn for all daytime activities. The control group of 21 patients had a mean age of 63.3 years and mean of 4.7 weeks post stroke. This control group received no additional treatment. Both groups received routine physical therapy, occupational therapy and speech therapy, ADL training and table top visual perceptual retraining tasks. Baseline measurements were taken on visual perception and ADL using standardised assessments. After four weeks treatment the experimental group performed significantly better than the control group on perceptual tasks but there was no significant difference on Barthel ADL index scores. They concluded that treatment with prisms improved visual perceptual test scores but not ADL function. However, although there was no significant difference between the groups, all patients improved in ADL function. This may have been due to the choice of ADL assessment used in this study, i.e. Barthel ADL index. The Barthel ADL index may not be sensitive enough to detect minor changes in functional ability sufficient to differentiate between the groups, particularly as the patients were being treated early after their stroke when they would be expected to improve in ADL ability. The Barthel ADL index only comprises of gross ADL functions and a difference may have been detected between the groups, if a more detailed ADL assessment had been used. Another limitation of this study was that it presumably was limited to patients who normally wore spectacles, although patients who did not normally wear spectacles could have been given plain spectacles with Fresnel prisms attached. If this was so, it limits the relevance of the results of this study to clinical practice. Patients who do not normally wear spectacles may not conform to wearing plain spectacles with Fresnel prisms attached, as some people dislike the thought of wearing spectacles under any circumstances. This treatment could also prove costly, if used in addition to standard therapy, particularly if this treatment does not generalise to improvement in ADL, greater than would be expected without this additional treatment. Alternatively, if this treatment did generalise to ADL functions, scarce occupational therapy time could be saved and used more effectively on other aspects of rehabilitation. It should be noted that the cost of Fresnel prism spectacles would be cheaper than occupational therapy. Further research is therefore needed into the effectiveness of the use of Fresnel prism spectacles.

The findings of the studies mentioned in this section have shown inconclusive results as to whether the transfer of training approach or the functional approach is the most effective in treating perceptual problems after stroke. Most of the studies indicating positive results in treating perceptual problems, involved treating left hemiplegic patients with unilateral neglect and this often required intensive treatment over several weeks. However, as this is likely to be difficult to achieve in general clinical practice, it is important to evaluate a treatment regime which is more practical. The effectiveness of perceptual treatment using treatment methods similar to those generally used in OT departments and following a regime which OTs would be more likely to achieve, needs to be evaluated. Similarly perceptual problems have been found to be common in both right and left hemiplegic stroke patients (see section 1.4) indicating that effective treatment is needed for all patients and not just left hemiplegic patients with unilateral neglect. A comparison of these two approaches (transfer of training and functional) is therefore needed for all stroke patients with any perceptual problems. Any improvement in perceptual abilities is only relevant to patients if it improves their independence in everyday life. Therefore the impact of perceptual treatment on ADL also needs to be considered.

1.10 Effect of other impairments

Recovery following a stroke may be influenced by many factors other than perceptual ability and functional ability. Patients may suffer other deficits such as aphasia, visual disturbances, sensory loss, cognitive disturbances, apraxia or mood disturbances, which may influence their ability to recover or their rate of recovery after a stroke. This was supported by Zoltan et al. (1986) who described various disorders as being likely to complicate or mask perceptual problems, such as aphasia, vision, sensory loss and cognitive disorders of attention, memory, initiation, planning and organisation, problem solving.

Adams and Hurwitz (1963) described these impairments as being mental barriers to recovery from stroke. They investigated patients who were on long stay wards rather than active treatment wards because they were still not independent in walking or self care. Forty five stroke patients (14 male and 31 female, with mean ages of 75.2 and 71.5 years respectively) were assessed for appearance and mood, level of consciousness, speech, behaviour, memory, intellect and body awareness. Adams and Hurwitz concluded that the following impairments all represented barriers to recovery and give a full description of what is meant by each of these impairments:

- impaired comprehension
- neglect
- denial of disease
- postural imbalance
- body image disturbance
- defective localisation of objects in space (space blindness)
- apraxia

- motor perseveration
- loss of recent memory
- loss of confidence
- true depression
- being inattentive
- not wanting to do activities
- emotional lability

However, Adams and Hurwitz only assessed patients in the long stay wards and not those in the active treatment wards and assessed the patients retrospectively. They assessed 45 patients who had a mean age of 75.2 years for men and 71.5 years for women. As this study included only a small number of older patients, the mental barriers described may be associated with the general ageing process rather than the stroke. The results implied that these “mental barriers” were associated with poor physical function but they may be associated just with the severity of stroke suffered by these patients in the long stay wards and are not necessarily the cause of the physical dysfunction. As the patients in this study were on long stay wards, the mental barriers described may also be the results of patients becoming institutionalised.

Some of the main barriers to recovery are now discussed separately, including details of how they influence recovery and evidence to support this.

1.10.1 Aphasia

Patients suffering from aphasia may have difficulty in understanding what is required of them during assessment and treatment. Zoltan et al. (1986) acknowledged this suggesting that aphasic stroke patients may lack the ability to communicate, which may make it difficult for therapists to assess them perceptually. Tests not requiring verbal answers still involve the patients having to understand verbal, written or gestured instructions. Timed tests may also cause difficulty for these patients. De Renzi and Spinnler (1966) found that aphasic patients scored lowest on immediate memory tests and questioned whether this was due to the patients lacking time to analyse and formulate mental answers. However, language difficulties were still found to be significant in memory tests, even when patients did have longer intervals before giving their answers.

Smith (1985) studied 42 dysphasic stroke patients with a mean age of 65.7 years and mean of 24 months post stroke, who were living at home. She found that the presence of dysphasia related to everyday communicative activities. However, this was a small study and Smith does not state how many of these patients lived with carers. Carers may have assisted patients in these types of activities rather than encouraging them to participate independently.

Language has also been found to be closed related to body scheme (Sanguet et al., 1971; Hecaen et al., 1956). Sanguet et al. (1971) suggested that receptive aphasia was related to finger recognition and right / left discrimination deficits. However, this study only included young (mean ages 45.8 years for left hemiplegic patients and 47.6 years for right hemiplegia patients) and excluded those with mental impairment or confusion. Hecaen et al. (1956) stated that verbal experience was conceived as a point of reference to the outside world. They suggested that if the balance between language and body was upset, the patient loses his/her verbal body image and cannot name or point to the various parts of the body. This study though was based on six patients who had had cerebral cortex excisions following earlier brain trauma.

1.10.2 <u>Visual loss</u>

Visual loss may cause associated perceptual difficulties (Zoltan et al., 1986). This could include visual field loss; decreased convergence causing difficulties with depth perception; blurred vision causing difficulty detecting edges and lines leading to poor form, size and figure ground perception; double vision or nystagmus (Zoltan et al., 1986). However, patients suffering from pure hemiapopia should have the ability to compensate for their lack of vision by turning their head but may require more specific cues initially.

1.10.3 <u>Sensory loss</u>

Zoltan et al. (1986) explained that sensory loss may cause impaired motor planning for body parts, limb agnosia and an inability to localise touch, pressure and pain. This was supported by Bobath (1978) who also suggested that sensory loss may impair patients' appreciation of size, shape and form, although this was not supported with evidence.

Affolter (1981), in a study comparing normal children, sensory deprived children and brain damaged adults, suggested that patients who receive inadequate or distorted sensory information from their environment, fail in everyday tasks. There may be differences between the difficulties experienced by sensory deprived children and adults due to the children experiencing a developmental problem and adults experiencing an acquired problem.

DeSouza (1983) also suggested that distorted sensory interpretation leads to distortion of motor response as sensations form the basis of judgement, movement and activity. However, she gave no research evidence to support this. This was supported by Walker and Lincoln (1991) who studied 60 consecutively admitted stroke patients and found a significant correlation between kinaesthetic sensation and dressing ability. They suggested that patients needed to be aware of where their limbs were in space and to be able to feel the garments. The Walker and Lincoln study included a wide age range of patients (21 to 79 years), both right and left hemiplegic patients, early post stroke.

1.10.4 Cognitive dysfunction

Patients suffering from poor recent memory or poor reasoning ability are likely to have difficulties in rehabilitation in terms of problems of carry-over from one session to another and difficulty planning and problem solving during activities. Evidence from studies investigating the influence of cognitive disorders on recovery after stroke have shown cognitive dysfunction to be a major barrier to recovery (Feigenson et al, 1977; Kotila et al., 1984; Ebrahim et al., 1985b; Wade et al., 1989).

Feigenson et al. (1977) studied 318 patients on admission to a Stroke Rehabilitation Unit until discharge from this unit. They found that some factors adversely affected outcome and some factors were unrelated to outcome. Adverse factors included severe weakness on admission, cognitive dysfunction, perceptual deficits and poor motivation and those unrelated to outcome included sensory loss, dysphasia and age. This study though was limited to patients who had a close family member of friend to participate in the discharge planning, resulting in the study including a selected group of patients. It was also unclear whether the outcome measures were standardised.

Kotila et al. (1984), also demonstrated that "impairment of intelligence and memory, visuoperceptual deficits and non adequate emotional reactions" all had a negative influence on outcome at one year post stroke. This study used standardised assessments for intellectual ability, memory, visual perception and emotional reactions but failed to use standardised assessments for ADL ability.

In another study, Ebrahim et al. (1985b) found that functional ability, as measured on a ten point dichotomous scoring ADL scale, strongly correlated with cognitive ability at six months post stroke. However, this study assessed 189 patients but only 22 were assessed as having cognitive problems at six months post stroke.

A further study by Wade et al. (1989) also demonstrated a close association between cognitive deficits after a stroke and severity of stroke, whether judged in terms of motor loss, functional (ADL) loss or in terms of sensory loss but found no evidence for any independent influence on recovery. Standardised assessments were used to assess motor power and ADL but sensory loss was tested clinically.

Lincoln et al. (1989) also found that an assessment of overall cognitive function had a significant predictive contribution in the level of functional abilities achieved. This was supported by Edmans et al. (1991) who also suggested that lack of improvement could be due to cognitive problems such as poor concentration, memory difficulties, dyspraxia or depression.

1.10.5 Apraxia

Apraxia is difficulty in performing skilled, purposeful movements without the loss of motor power, sensation, co-ordination, dementia or unco-operativeness, which by definition is therefore likely to cause the patient difficulties in carrying out functional tasks. This was supported by Sundet et al. (1988) who found that apraxia in right hemiplegic patients, as assessed by imitation of gestures, correlated significantly with independence in personal and instrumental ADL tasks. This study included a large number of patients but all the right hemiplegic patients were aphasic, suggesting that language ability may also have been correlated with apraxia and ADL ability.

Miller (1988) explained that dyspraxia is not the only reason for failure of execution of tasks but that several other disorders may account for this and may coexist with dyspraxia, namely dysphasia in that the patient may not have understood the instruction, impaired visual spatial functioning, attention, concentration or intellectual capacity.

Another study (Foundas et al., 1995), found a correlation between apraxia and mealtime behaviour of ten aphasic patients, using gestures to verbal command and imitation assessments. However, in this study only three of the patients had any evidence of hemiparesis, thus eliminating any result of ADL ability being effected by overall physical ability.

In contrast, Walker and Lincoln (1991) found virtually no correlation between apraxia, as assessed by a combination of gestures to verbal command and imitation of gestures, and dressing abilities. Only 15 of the 60 patients in this study had apraxia and Walker and Lincoln generally found that dressing ability was heavily overshadowed by the patients' physical abilities.

1.10.6 <u>Anxiety and depression</u>

Anxiety and depression are likely to make rehabilitation difficult for patients as they may have decreased motivation to participate in assessments and treatment due to being preoccupied with their worries and thoughts. DeSouza (1983) also noted that one of the major factors affecting the success of stroke rehabilitation was the patients' own determination and motivation to improve functionally. The nature of depression is that depressed patients are likely to have a decreased ability for motivation. This finding was supported by Zigmond and Snaith (1983), who suggested that patients may find that symptoms of their illness may distress them to such as extent as to lead to a poor response to treatment. Ebrahim et al. (1987), also demonstrated that mood disturbance at six months post stroke was strongly associated with functional ability, limb weakness and with longer hospital stay. This suggests that slow recovery and institutionalisation may be responsible for mood disturbances.

Similarly, Robinson et al. (1983) found that in 103 patients, the severity of impairment in functional activities (ADL) and intellectual function were significantly correlated with the severity of post stroke depression early after stroke Sixty one of the patients in their study were reassessed after six months and were found to have made a significant improvement in functional impairment (Robinson et al., 1984). However, the depressed patients remained more impaired that the non-depressed patients.

A further study by Sinyor et al. (1986) also indicated that depression was common after stroke. They demonstrated that depression was associated with the level of functional impairment in 64 depressed stroke patients early after stroke and suggested that it may cause a negative impact on the rehabilitation process and outcome. They followed up 25 of these patients, six months after discharge and still found a significant correlation between depression and functional status.

All these studies (Ebrahim et al., 1987; Robinson et al., 1984; Sinyor et al., 1986) used standardised assessments for mood and functional ability but the Robinson et al. and Sinyor et al. studies had small numbers of patients.

Thus the effect of any of these impairments has been shown to be associated with functional ability, highlighting the complexity and trauma of stroke. It is therefore important to consider the effect of these impairments, the "invisible consequences of stroke", during any study which involves investigating the association between the treatment of impairments after stroke and functional recovery. For this reason they were incorporated into the design of the current study.

1.11 Influence of stroke units

As the current research was carried out on a stroke unit, the concept of this type of unit and the evidence of the effectiveness of this type of unit will now be reviewed. Stroke units have been defined as units where "care is organised and co-ordinated by a multi-disciplinary team of professional staff who are interested and knowledgeable about stroke" (Dennis and Langhorne, 1994).

The development of these stroke units started in America in the 1960's when doctors began setting up stroke intensive care units, run along similar lines to coronary care units (Langhorne and Dennis, 1998). This model though, did not generally become adopted in America or Britain and soon declined with new approaches taking over in the 1970's. These new approaches were models of stroke care. Patients whose treatment followed these new models, received prolonged periods of rehabilitation and were treated from the acute stages. Various models were developed, including stroke units, mobile stroke teams and acute rehabilitation teams. However, in 1988, the Kings Fund Consensus Conference (1988) stated that "stroke services in the United Kingdom were generally haphazard and poorly tailored to the patients' needs" and suggested that stroke care should be more co-ordinated. Since then, many studies have been conducted to evaluate the effectiveness of co-ordinated stroke care which will now be examined in detail.

Evidence has shown that stroke units save lives and are beneficial to stroke patients in terms of recovery (Langhorne et al., 1993). Many studies have demonstrated these beneficial effects of stroke units by comparing them with conventional wards (Garraway et al., 1980a; Garraway et al., 1980b; Smith et al., 1982; Stevens et al., 1984; Indredavik et al., 1991; Kalra et al., 1993; Juby et al., 1996; Drummond et al., 1996; Lincoln et al., 1997).

Garraway et al. (Garraway et al., 1980a; Garraway et al., 1980b; Smith et al., 1982), carried out a randomised controlled trial comparing elderly patients with acute stroke on a 15 bedded stroke unit with those on any of 12 medical units. The patients were randomly allocated to either the stroke unit (155 patients) or medical unit (152 patients) on admission. They were assessed on discharge from hospital or at 16 weeks post stroke if they had not been discharged. One hundred and one stroke unit patients and 91 medical unit patients were followed up one year after stroke. The patients were assessed on eight ADL tasks (getting in and out of bed, dressing, indoor mobility, using the toilet, personal hygiene, cooking a simple meal, feeding themselves and controlling their environment in terms of heating, lighting and communication) in a purpose-built unit designed to have similar features to a patients' own home. They were classed as independent if they were able to complete all tasks without human assistance and dependent if they failed one task or more i.e. required human assistance or were unable to complete the task. The results showed that a significantly higher proportion of patients were independent in self care when discharged from the stroke unit, compared with the medical unit. The one year follow up of this trial however showed that the improvement in functional outcome at the time of discharge had disappeared by one year. The authors suggest that this may be due to overprotection by families of patients treated on the stroke unit or patients being discharged from the medical unit before reaching their best potential. They also suggested that the improvement may be due to the co-ordinated approach to rehabilitation involving nurses as well as therapists on the stroke unit. The patients in the stroke unit received less therapy over a shorter period of time but a higher proportion received occupational therapy sooner after admission, which led the authors to suggest that early intervention may be more effective than a late concentrated effort.

Another study, by Stevens et al. (1984), also compared functional ability in patients randomly allocated to two groups, a specialist 20 bedded stroke rehabilitation ward and conventional treatment on general wards. The patients were randomised after diagnosis and preliminary treatment had been completed and were assessed at four month intervals to one year post stroke. This study included 228 patients, 112 on the stroke rehabilitation ward and 116 on conventional wards. The patients were assessed on four ADL tasks, walking, toiletting, dressing and eating and the amount of hours of therapy they received. The only significant difference found between the groups was on the one year assessment on dressing, when the stroke rehabilitation ward patients were more independent. Overall there was a greater amount of therapy given to patients on the stroke rehabilitation wards from all therapies. Although there were staff shortages for occupational therapy and speech and language therapy, there was still a significant difference in the number of patients receiving occupational therapy and speech and language therapy, with more of the stroke rehabilitation ward patients receiving these therapies than those on the conventional wards.

The major limitation of these studies (Garraway et al., 1980a; Garraway et al., 1980b; Smith et al., 1982; Stevens et al., 1984) is that they did not use standardised outcome measures of ADL and did not explain whether the assessments were carried out by one person or several people. If more than one person completed each assessment, inter-rater reliability studies would have been required to ensure that there was no difference in the scoring by the raters. This could have caused a lack of objectivity leading to variations in scoring as to whether patients were considered to be independent or not. The studies (Garraway et al., 1980a; Garraway et al., 1980b; Smith et al., 1982; Stevens et al., 1984) do not state whether the assessors were blind to the treatment group. If the assessors were not blinded, they could have led to bias favouring one or other ward setting, which may have increased the treatment effect.

Two further studies (Indredavik et al., 1991; Kalra et al., 1993) investigated differences in mortality, discharge destination and functional abilities, between stroke patients on stroke units and general medical wards. Indredavik et al. (1991) conducted a large randomised controlled trial comparing 220 patients on a six bedded stroke unit and on six general medical wards. The patients were randomly allocated on admission with 110 being admitted to the stroke unit and 110 to the general medical wards. The mean ages of the groups were 72.2 years for the stroke unit group and 73.7 years for the general medical wards group. Patients were only permitted to stay on the stroke unit for a maximum of six weeks. If they had not been discharged by then, they were transferred to general medical wards, rehabilitation clinic or nursing homes. Outcome was measured at six weeks and one year post stroke on functional state (Barthel ADL index), proportion at home, proportion in institutions and mortality rate. The results showed that functional state was found to be significantly better for patients treated on the stroke unit at both the six weeks and one year assessments. Significantly more stroke unit patients were at home on both assessments and significantly more general medical wards patients were in institutions on both assessments. Mortality was significantly higher at six weeks post stroke for the patients on general medical wards but there was no significant difference at one year post stroke. Indredavik et al. concluded that stroke unit care improved clinical outcome compared to general medical ward care and that the most important factor was early and intensive rehabilitation including nursing input into the rehabilitation programme. They also suggested that it was difficult to isolate specific components which were important to these results but that an integrated approach, acute treatment, early mobilisation /

rehabilitation, improved education for staff, patients and carer, would affect all aspects of treatment.

The other study by Kalra et al. (1993), studied 245 stroke patients, who were stratified into three groups according to prognosis i.e. good, intermediate or poor prognosis. Patients were randomly allocated to a 13 bedded stroke rehabilitation unit (124 patients) or general medical wards (121 patients), two weeks after stroke. Outcome was measured in terms of functional abilities by using the Barthel ADL index, mortality, discharge destination and length of stay in hospital. They found that functional abilities at discharge for the good and poor prognosis patients were comparable in both settings. However, stroke rehabilitation unit patients with intermediate prognosis had better functional abilities on discharge than general medical ward patients. Kalra et al. found no significant difference between ward groups for the good prognosis patients on discharge destination or length of stay. When the poor prognosis patients were considered, there was a significantly higher mortality rate and longer length of stay for the general medical ward patients but when the intermediate prognosis patients were considered, a higher number of the stroke rehabilitation unit patients were discharged home and they had a shorter length of stay. Kalra et al. concluded that stroke rehabilitation units improved outcome and reduced length of stay without increasing therapy time. However they suggested that their effectiveness may be enhanced by patient selection.

The influence of stroke units on patients five years post stroke, has been investigated by Indredavik et al. (1997 and 1998). Indredavik et al. (1997 and 1998) followed up

77 of the 220 patients from their original study (Indredavik et al., 1991), five years post stroke. They compared the patients who had been treated on the combined acute and rehabilitation stroke unit with those who had been treated on the general medical wards, in terms of the proportion who were at home, the proportion who were in an institution, mortality and functional state as measured on the Barthel ADL index (Mahoney and Barthel, 1965). The results showed that patients who had been treated on the stroke unit included a significantly higher number who were living at home, a significantly lower number who were dead and functional state was significantly better, than patients who had been treated on the general medical wards. There was no significant difference between patients who had been treated on the stroke unit or those treated on the general medical wards as to how many were in institutions at five years post stroke. However, this may be because many of the patients who were more severely disabled from their stroke, had died within the five years. Indredavik et al. (1997) concluded that treatment on a stroke unit improved the long term outcome for patients, in terms of survival, ability to live at home and functional state. Indredavik et al., (1998) also examined whether stroke unit care affected the patients' quality of life, five years after stroke. The results showed that patients treated on the combined acute and rehabilitation stroke unit had higher scores than patients treated on the general medical wards, on the Frenchay Activities Index (Holbrook and Skilbeck, 1983) and Nottingham Health Profile (Hunt et al., 1991) (on energy, physical mobility, emotional reaction, social isolation and sleep categories) but there was no significant difference in pain. Patients who were independent in ADL scored as having better quality of life than patients who were dependent. Indredavik et al., (1998) concluded that stroke unit care improved various aspects of quality of life for patients five years after stroke and

that this was largely attributable to the treatment provided in the acute stages. However, approximately 20% of these five year follow up patients could not be assessed on the Nottingham Health Profile due to aphasia. These patients may have had poorer quality of life due to their language problems but similar numbers of such patients would have been expected to be in either group.

Similar results were found in all of these studies (Garraway et al., 1980a; Garraway et al., 1980b; Smith et al., 1982; Stevens et al., 1984; Indredavik et al., 1991; Kalra et al., 1993; Indredavik et al., 1997 and 1998) despite differences in which patients were included or excluded, time post stroke when entered each trial, settings and countries for each trial, outcome measures used, whether the assessments were standardised or not, time when therapy commenced and the amount of therapy included. All these studies included large numbers of patients. As the results of the studies showed significant differences, the numbers of patients included should have been enough to ensure sufficient statistical power to overcome the effects of random error. Langhorne and Dennis (1998, p14) however, suggest much larger numbers were needed. Apart from the Stevens et al. study and the Indredavik et al. study, the studies did not explain how randomisation had taken place, which could have led to bias in patient selection. The majority of the studies also did not document whether they used assessors who were blind to the treatment setting, which could have influenced their results favourably in respect of one or other setting. Indredavik et al., were the only study group to comment on this factor and who accounted for it in their results. Despite all the variations incorporated in these papers, the findings still appear to come to same conclusions - that stroke unit care is more beneficial to stroke patients than care on general medical wards. The main reasons given for this also appear to be similar i.e. co-ordinated approach to stroke care, early initiation of multi-disciplinary rehabilitation, nursing staff involvement in rehabilitation and improved education for staff, patients and carers.

A review of the literature which examined the effectiveness of stroke rehabilitation was carried out by Ottenbacher and Jannell (1993). They investigated existing clinical trials of stroke rehabilitation programmes between 1960 and 1990, which aimed to improve functional outcome and discharge destination. This involved conducting a meta-analysis of 36 stroke rehabilitation trials which included 3717 stroke patients. They concluded that the average stroke patient receiving focused stroke rehabilitation performed better than 65.5% of those in the comparison groups. They also suggested that the improvement in performance appeared to be related to early treatment but not to the duration of treatment. However, it should be noted that these were not all randomised controlled trials and these differences may have occurred due to bias in the selection of patients in each group.

Similarly though, Langhorne et al. (1993) completed an overview of 10 randomised controlled trials, from 1962 to 1993, which compared stroke patients on specialist units with those on general wards. This overview included 1586 patients with 766 being on the specialist units and 820 being on the general wards. The studies followed patients up to one year post stroke. Their results showed that stroke specialist units reduced mortality, reduced length of stay, reduced chance of living in an institution at one year post stroke and improved functional independence (Langhorne et al., 1993;

Dennis and Langhorne, 1994). However, they also suggested that more remedial therapy was given on the specialist units that on general wards. From the results of this overview, Dennis and Langhorne (1994) advocated that there was a need for specific services for stroke patients which followed either stroke units or stroke team models. They also advocated that there should be nursing staff involvement in rehabilitation therefore continuing the rehabilitation process over 24 hours and that the strongest benefits had been found with intermediate severity stroke patients. Finally, they queried whether the effectiveness of specialist stroke units was due to a total package of care or particular components as few of the trials in the overview had given details of the process of care on their unit.

The findings of the Ottenbacher et al. meta-analysis and the Langhorne et al. overview were corroborated by the Stroke Units Trialists' Collaboration (1997) which consisted of representatives from each of the trials included. The Stroke Units Trialists' Collaboration carried out a systematic review of 19 randomised controlled trials (three of which included two treatment arms) which involved a total of 3249 stroke patients. Twelve of these trials (2060 patients) compared stroke units with general medical wards, six trials (647 patients) compared mixed assessment / rehabilitation units with general medical wards and four trials (542 patients) compared stroke units with mixed assessment / rehabilitation units. Their objectives were to define the characteristics and determine the effectiveness of stroke unit care compared to conventional care. Their results showed that stroke units were associated with a reduction in death, dependency and the need for institutional care at one year post stroke. These benefits were independent of age, severity of stroke or variation in type of stroke unit organisation.

The distinctive aspects of the stroke unit care determined by the Stroke Unit Trialists Collaboration were also documented by Langhorne (1997). These were:-

- co-ordinated and organised in-patient care with weekly meetings
- multi-disciplinary team care involving medical, nursing and therapy staff
- programmes of education and training for staff, patients and carers
- involvement of carers in rehabilitation
- staff interest and expertise in stroke.

As has been shown, there is much evidence in the literature describing the benefits of co-ordinated stroke care, most of which is compiled in a new book, Stroke Units: An evidence based approach by Peter Langhorne and Martin Dennis (1998). The authors describe the evidence showing that "patients receiving stroke unit care are more likely to survive, return home and regain physical independence and an apparent reduction in secondary complications of stroke and an increase in the number of physically independent survivors".

This was also shown to be true in another randomised controlled study evaluating the effect of a stroke rehabilitation unit on functional and psychological outcome (Juby et al., 1996). Juby et al. carried out a randomised controlled trial comparing stroke patients on the Nottingham Stroke Unit with those on general medical and health care of the elderly wards, which included 315 patients admitted to hospital. One hundred and seventy six patients were randomly allocated to the stroke unit and 139 to the conventional wards, within the first five weeks post stroke. The ages of patients ranged from 26 to 88 years for the stroke unit group and 38 to 89 years for the conventional wards group. Patients were assessed on entry to the trial and at three, six and 12 months post stroke. The results showed a significant difference in personal ADL at three and six months but not at 12 months, with the stroke unit patients being more independent. Stroke unit patients were also significantly more independent on extended ADL measures at six and 12 months. There was no significant difference between groups in mood at three and six months but the stroke unit patients had a better mood at 12 months. There was a significant difference in adjustment at six months with the stroke unit patients being able to cope better psychologically.

Also from this study, Drummond et al. (1996) completed a more detailed analysis of ADL ability, in comparing outcome between patients on the stroke unit and those on medical or health care of the elderly wards. They investigated the individual tasks of the ADL assessments used in the trial at 3, 6 and 12 months after stroke. They concluded that stroke unit rehabilitation improved feeding, dressing and household abilities more than occurred on conventional wards, whereas mobility improved equally in both settings. The authors felt that these results were due to the policies and procedures adopted by the Occupational Therapists on the stroke unit, rather than just the OT intervention. This was because the nursing staff on the stroke unit had been trained to continue rehabilitation with patients, particularly in tasks such as feeding, dressing, and kitchenwork. Other reasons given were that any aids required by patients at meal times were readily available on the stroke unit and patients often went home at weekends and were encouraged to continue kitchen rehabilitation with relatives. Generally they felt that there was more emphasise on functional ability by all staff on the stroke unit than on general medical wards whereas mobility was seen as a priority on all wards.

Again from this study, Lincoln et al. (1997) investigated the effect of perceptual assessment and treatment on the stroke unit compared to that provided on medical or health care of the elderly wards. Perceptual ability was assessed on entry to the trial and at three, six and 12 months after stroke. The results indicated that there was no significant difference in perceptual ability between stroke patients on the stroke unit and general medical wards on entry to the trial but that the stroke unit patients had significantly less perceptual impairment at all stages after stroke, i.e. at 3,6 and 12 months. Perceptual ability was found to be a significant predictor of outcome 12 months after stroke. Lincoln et al. suggested that these differences were due to the increased awareness and recognition of perceptual problems by staff on the stroke unit. They also suggested that stroke unit staff, of all disciplines, adjusted their treatment when perceptual problems were present and used general perceptual treatment strategies to reduce the effect of these perceptual problems.

Although this literature shows the effectiveness of various stroke units, there is little written evidence to show what actually constitutes a stroke unit in terms of the process of rehabilitation for the patients. What does a stroke unit really consist of in terms of philosophies, care and treatment given to patients? How and why does a stroke unit differ from a general medical or health care of the elderly ward, to be able to produce these effects?

In order to try to answer these questions, the philosophies, policies and procedures used on the Nottingham Stroke Unit were examined. These were investigated to examine how and why this stroke unit differed from the general wards in the same hospital.

1.11.1 The Nottingham Stroke Unit

The Nottingham Stroke Unit opened in 1983 and is a 15 bedded in-patient unit which included a rehabilitation flat with en suite bathroom and direct access to the rehabilitation kitchen. This stroke unit normally accepted patients from general medical or health care of the elderly wards within the Nottingham Health district, but did not take admissions directly from Accident and Emergency or the community. Patients could be male or female, aged 21-90+ years, with the average age of the patients being approximately 65 years. The average length of stay was normally 6 - 7 weeks and there was an annual throughput of approximately 120 patients per year, of whom about 80% were discharged to their own home (unpublished stroke unit annual statistics). There were no set criteria for admission to the stroke unit but patients were generally at a stage in their recovery from the stroke, when they were able to participate in the intensive rehabilitation offered on the stroke unit. There were written philosophies, policies and procedures for this stroke unit.

1.11.2 Staffing

The staffing consisted of-

- Consultant Physician, Senior Registrar and Senior House Officer - all shared with other wards
- Trained nurses and auxiliaries)
- Physiotherapists)
- Occupational Therapists) - all ward based and for stroke unit only
- Speech and Language Therapist)
- Clinical Psychologist)
- Social Worker - for stroke unit only but based off the stroke unit
- Dietician) - shared with other wards and based
- Pharmacist) off the stroke unit
- Community Liaison Nurse)
- Activities Nurse - ward based and for stroke unit only
- Others including Chiropodist, Aromatherapist, Hairdresser and Volunteers - shared with other wards and based off the stroke unit

1.11.3 Philosophies of Nottingham Stroke Unit

The stroke unit seeked to provide an effective and efficient multi-disciplinary approach to rehabilitation. The aim was to enable patients to live as independently and with the best quality of life as possible, in the community following discharge. Furthermore, a high level of professional competence in all aspects of care was aimed for, which included the psychological needs of the patient and family. There was also a responsibility to teach other professionals all aspects of stroke care.

1.11.4 Aims of Nottingham Stroke Unit

The aims of the stroke unit were-

1. To maximise the possible recovery from stroke and to help each patient reach their potential
2. To give intensive and continuous rehabilitation involving the patient, his/her carers and the multi-disciplinary team
3. To encourage the patient to be as independent as was appropriate at every stage of recovery and to take responsibility for themselves as far as possible
4. To provide information and counselling support
5. To make the Unit routine as near "normal" for each patient as possible e.g. bed times
6. To make the ward look more like a home than a hospital as far as was possible

1.11.5 Policies of Nottingham Stroke Unit

The major policies of the stroke unit included-

- Blanket referral for rehabilitation for all patients admitted to this stroke unit i.e. all patients were automatically referred for rehabilitation on admission to the stroke unit
- A 24 hour approach by all the multi-disciplinary team

- Staff training regarding all the philosophies, policies and procedures used on the stroke unit on induction and this training was then ongoing
- Policies regarding positioning, moving and handling patients, transfers, washing and dressing, dysphagia, continence, wheelchair use, home visits, self medication, discharge planning, named nurse, health promotion and secondary prevention
- Open visiting to enable more carer involvement
- Carers involvement in rehabilitation

1.11.6 Procedures of Nottingham Stroke Unit

The procedures of the stroke unit included-

- Rehabilitation primarily followed the Bobath concept but other theoretical models were considered where appropriate
- Encouragement for patients to take responsibility for themselves where appropriate, i.e. doing as much as possible for themselves, providing they use the correct movement patterns and encouraging patients to make decisions for themselves
- Set procedures regarding positioning, moving and handling patients, transfers, washing and dressing, meal times, continence, self medication, discharge planning
- All patients were encouraged to sit in a variety of chairs during the day rather than just in their wheelchair and where appropriate they were encouraged to stand regularly
- All patients wore their own clothes and got dressed every day, including wearing shoes rather than slippers

- All patients ate their meals in the dayroom rather than by their bed
- Patients did not rest on their beds except when they went to bed at night
- Set procedure for discharge i.e. access visit / home visit, day visit and overnight stay prior to discharge
- Involvement of relatives / carers throughout the rehabilitation process by all disciplines
- All aids belonged to the stroke unit and were therefore available at all times
- Multi-disciplinary meetings were held regularly in the form of multi-disciplinary handovers, case conferences and family case conferences which included goal setting and care planning. Multi-disciplinary senior staff meetings were also held regularly
- Initial assessments general involved the use of standardised assessments
- Leisure Therapy was encouraged daily in the form of gardening, craft work or outings to shops, cinema, theatre or pub for patients and relatives
- Relatives and carers support group meetings and teaching sessions

This description therefore gives an overview of the philosophies, policies and procedures used on the Nottingham Stroke Unit, the setting for this current study.

1.12 Objective of the study

Perceptual problems have been shown to be a common consequence of stroke (see section 1.4) and affect the patients' ability to perform in activities of daily living (see section 1.6) suggesting that these problems should be treated.

There are various approaches which may be used in the treatment of perceptual problems (see section 1.8). Treatment of perceptual problems following these approaches has been shown to be effective with some patients, mainly left hemiplegic patients with unilateral neglect, following intensive treatment. The limitations have shown that it is not clear whether a remedial or adaptive approach is more effective in treating perceptual problems after stroke (see section 1.9).

Other impairments also affect patients' recovery after stroke including speech and language, cognitive and physical abilities (see section 1.10).

This study aimed to compare perceptual treatment following a remedial approach (transfer of training) and an adaptive approach (functional). It was to include patients of all ages, male and female, following left or right hemiplegic stroke, who were admitted consecutively to the Nottingham Stroke Unit between 1992 and 1994. Assessments were to be carried out using standardised procedures of perceptual ability, ADL ability and that of other impairments likely to influence perceptual ability (see sections 1.5, 1.7 and 1.10 respectively). The consequences of conducting this study on the Nottingham Stroke Unit were also to be considered (see section 1.11).

The objective of the study was to identify whether the transfer of training or functional approach to the treatment of perceptual problems gave a greater improvement in perceptual ability or functional ability.

The research hypothesis was that treatment following the transfer of training approach would produce a greater improvement in perceptual ability and that treatment following the functional approach would produce a greater improvement in functional ability.

CHAPTER TWO - METHOD

METHOD

2.1 Ethical approval

Ethical approval to undertake this study, was granted from the Nottingham City Hospital Ethics Committee on 28.1.92 (see appendix 2). As stipulated in their letter of approval, a simple explanation about the study was given to patients, in order to gain their consent to participation (see appendix 3).

2.2 Selection of patients

Patients were selected from those admitted consecutively to the Nottingham Stroke Unit and the inclusion criteria for the study were as follows:-

1. Patients had to be well enough to be assessed on the Rivermead Perceptual Assessment Battery (RPAB) (Whiting et al, 1985). This included being able to see, hear, understand English enough to complete the assessments and to follow the instructions and to not have such marked psychiatric problems that these would affect their ability to complete the RPAB.

2. They had to have sufficient functional use of one hand, in order to complete the RPAB and to carry out perceptual treatment activities, i.e. sufficient ability to pick up and move objects / cards with one hand.

3. They had to give consent to participate in the treatment. If patients were unable to give verbal consent, permission for them to enter the study was sought from their nearest relative. Consent to participation in this study was then documented in the patients' medical notes.

The Nottingham Stroke Unit has been fully described in section 1.11. It should be noted that during the study period, patients being admitted to the Stroke Unit had already been selected as being suitable for participation in an evaluation study that was being carried out (Juby et al., 1996). For this evaluation study, all stroke patients who were medically stable, able to transfer with a maximum of two nurses, had no discharge date planned, able to tolerate 30 minutes treatment sessions, able to do two out of being able to eat, drink or wash their face and able to toilet themselves prior to the stroke were randomly allocated to either the Stroke Unit or to the control group (health care of the elderly and general medical wards). Therefore, the patients on the Stroke Unit during the perceptual treatment study were not a specific group of patients being admitted to the Stroke Unit, but they were all broadly suitable for rehabilitation.

2.3 Procedure

The procedure of the study was as follows (see flow chart in figure 1):-

1. All patients admitted to the Stroke Unit were assessed on the Stroke Unit by the ward Occupational Therapist (OT) or the research OT, for perceptual ability using the full RPAB and for ADL ability using the Barthel ADL index (Mahoney and

Barthel, 1965) using the scoring by Collin et al, (1988) and Edmans ADL index (Edmans and Webster, 1997), within two weeks of admission to the Stroke Unit. The standard administration and scoring procedures were used for each assessment. Both the perceptual and ADL assessments took approximately one hour to complete and were completed over 2 consecutive days. Details of these assessments are shown in tables 2 - 4. The ward Physiotherapist assessed all patients on the Rivermead Motor Assessment (RMA) - Gross Function scale (Lincoln and Leadbitter, 1979), on admission to the Stroke Unit.

2. Perceptual problems were identified on the basis of having a score which was two standard deviations or more below the mean on four or more subtests of the RPAB. This criterion was based on that in the manual, but a slightly higher level was used as these patients were older than those in the original RPAB validation. If perceptual problems were identified, an explanation was given to the patient about what these problems were and how they might affect the patient in everyday life. It was explained that this study was being carried out to investigate the treatment of these problems. Explanation was given that there were two main treatment approaches currently used and the research was to identify which approach was most effective in treating these problems. The patients were asked if they were willing to participate and that it would involve being treated by an additional OT for some of their treatment over the following six weeks, followed by a repeat assessment of their abilities (see appendix 3).

Figure 1

Procedure of the study

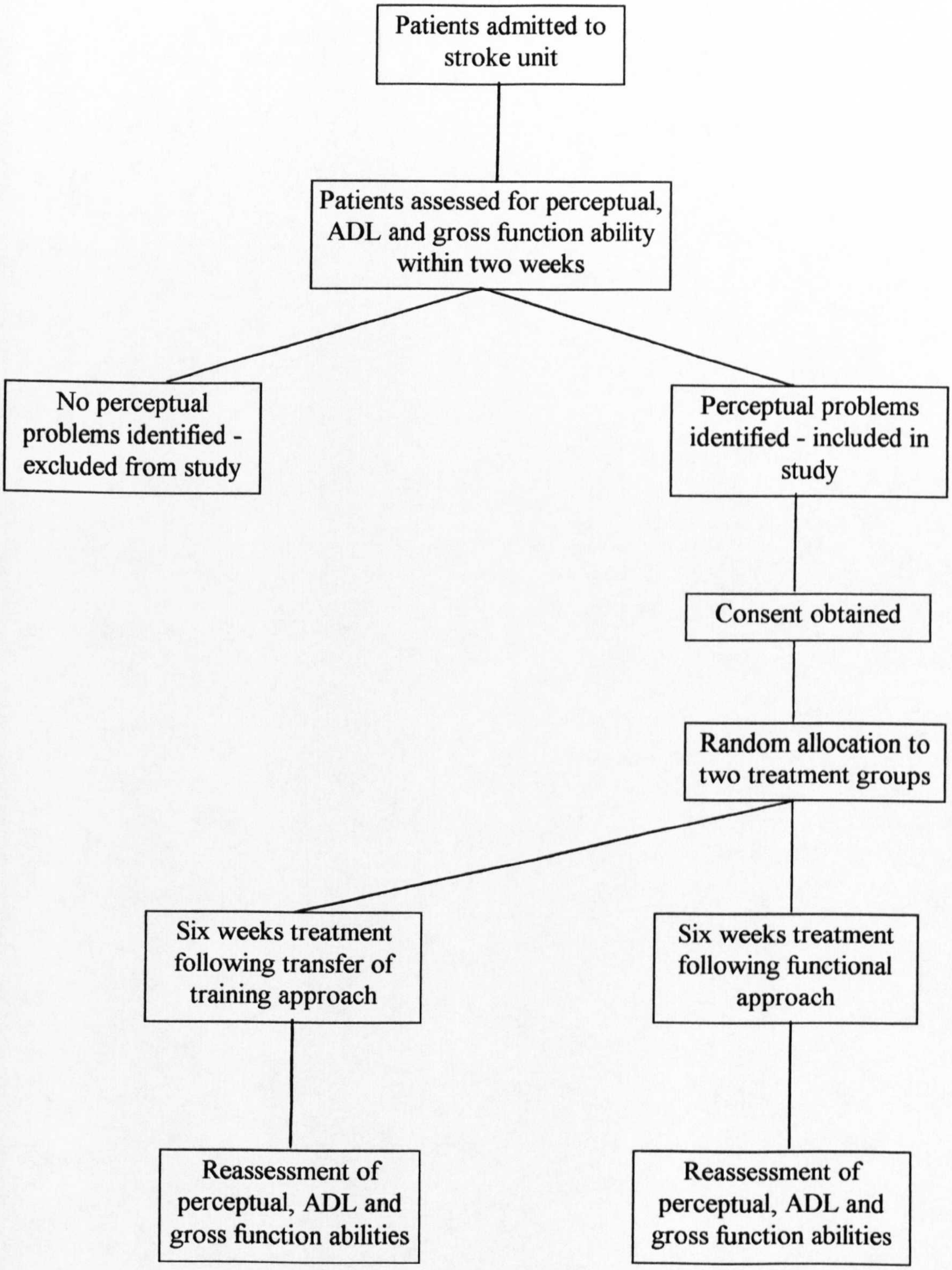


Table 2

THE RIVERMEAD PERCEPTUAL ASSESSMENT BATTERY (Whiting et al., 1985)

TEST TITLE	DESCRIPTION
1. PICTURE MATCHING	Tests the ability to match identical pairs of picture cards while discriminating from other similar pictures. A simple confidence-boosting task.
2. OBJECT MATCHING	Tests form constancy through the ability to match real objects according to shape. Colour is kept constant in order not to provide an additional cue or distraction.
3. COLOUR MATCHING	Assesses the subjects' ability to recognise different shades of the same colour as belonging together. Coloured blocks must be placed in columns below the correct stimulus colour.
4. SIZE RECOGNITION	Form constancy is tested by investigating the subjects' ability to recognise and match two-dimensional objects despite differences in size.
5. SERIES	Assesses sequencing through the ability to arrange a series of pictures in size order.
6. ANIMAL HALVES	Tests object completion through the ability to put together two separate parts of familiar figures to complete the whole.
7. MISSING ARTICLE	A slightly more complex object completion task. Tests the ability to recognise that a picture is incomplete and select the missing part.
8. FIGURE GROUND DISCRIMINATION	Assesses figure-ground discrimination through the ability to recognise an individual object when presented as part of a complex picture.
9. SEQUENCING PICTURES	Tests the ability to recognise a set of pictures as forming a sequence and thus involves understanding picture content.
10a. BODY IMAGE **10b. BODY IMAGE**	Assesses the ability to recognise separate parts of the body as belonging to a whole and to assemble them in the correct relationship to one another. Measures the ability to recognise parts of a face and place them in the correct relationship to one another.
11. RIGHT/LEFT COPYING SHAPES	Tests for inattention through the ability to copy correctly to left and right of the midline. It also assesses spatial awareness.
12. RIGHT/LEFT COPYING WORDS	A further test for inattention, assessing the ability to copy words to left and right of the midline.
13. THREE DIMENSIONAL COPYING	Assesses form constancy and spatial awareness by requiring the subject to copy a three dimensional model.
14. CUBE COPYING	Tests spatial awareness through the ability to copy a two dimensional design using cubes.
15. CANCELLATION	Measures visual scanning ability by requiring the subject to select one letter consistently from a number of similar letters.
16. SELF IDENTIFICATION	Assesses the subjects' ability to copy the assessor's actions involving the body.

Table 3

BARTHEL ADL INDEX (Collin et al, 1988)

PATIENTS NAME: .... **HOSP NO:** ....

			DATES				
ACTIVITY	**ABILITY**	**SCORE**					
BOWELS	Incontinent (or needs to be given enema)	0					
	Occasional accident (once per week)	1					
	Continent	2					
BLADDER	Incontinent or catheterised and unable to manage	0					
	Occasional accident (max once per 24 hours)	1					
	Continent (for over 7 days)	2					
GROOMING	Needs help with personal care	0					
	Independent face/hair/teeth/shaving (implements provided)	1					
TOILET USE	Dependent	0					
	Needs some help but can do something alone	1					
	Independent (on and off, dressing, wiping)	2					
FEEDING	Unable	0					
	Needs help cutting, spreading butter etc.	1					
	Independent (food provided in reach)	2					
TRANSFER	Unable - no sitting balance	0					
	Major help (one or two people, physical) can sit	1					
	Minor help (verbal or physical)	2					
	Independent	3					
MOBILITY	Immobile	0					
	Wheelchair independent including corners etc.	1					
	Walks with help of one person (verbal or physical)	2					
	Independent (but may use any aid e.g. stick)	3					
DRESSING	Dependent	0					
	Needs help but can do about half unaided	1					
	Independent (including buttons, zips, laces etc.)	2					
STAIRS	Unable	0					
	Needs help (verbal, physical, carrying aid)	1					
	Independent up and down	2					
BATHING	Dependent	0					
	Independent (or in shower)	1					
	TOTAL	**/ 20**					

Table 4

EDMANS ADL INDEX FOR STROKE PATIENTS

PATIENTS NAME: .... HOSP NO: ....

- Activities should be observed or questioned
- Activities should be what the patient does rather than what he/she can do
- Activities should be what the patient does with everyone, i.e. not what they do with a physiotherapist only
- Abilities should be irrespective of whether an aid or special equipment is used
- If the patient did not carry out the activity before admission, score as appropriate but mark it "n/a"
- If the patient is aiming for wheelchair mobility rather than walking, please alter "walking" to "wheelchair mobility"
- Please put appropriate score for each activity in boxes on right hand side of page

			DATES				
ACTIVITY	**ABILITY**	**SCORE**					
WASHING							
Top half:	Needs full help	0					
	Washes face and chest only	1					
	Needs help to wash one arm and back only	2					
	Independent	3					
Lower half:	Needs help from 2 people	0					
	Stands with 1 person to wash own bottom	1					
	Stands with supervision to wash own bottom	2					
	Independent	3					
Bathing/shower:	Needs help from 2 or more people/bath hoist	0					
	Needs help from 1 person, not using bath hoist	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					

ACTIVITY	ABILITY	SCORE	DATES				
GROOMING							
Comb hair:	Needs full help	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Clean teeth (own or dentures):	Needs full help	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Shave/make up:	Needs full help / stopped since illness	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					
DRESSING							
Top half:	Needs full help	0					
	Needs help to put one arm into sleeve	1					
	Needs help with fastenings only	2					
	Independent	3					
Lower half: (including standing up)	Needs help from 2 people	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Shoes:	Needs help with both shoes	0					
	Needs help with 1 shoe	1					
	Needs help with shoe fastenings	2					
	Independent	3					
	TOTAL	**/ 9**					
MEAL TIMES							
Swallowing:	Needs NG tube/PEG, special diet or full help	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Drinking: (excluding swallowing problems)	Needs full help	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Eating: (excluding swallowing problems)	Needs full help	0					
	Needs help to cut up food	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					

			DATES				
ACTIVITY	**ABILITY**	**SCORE**					
BASIC MOBILITY							
Sitting:	Needs help from 2 or more people	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Standing:	Needs help from 2 or more people	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Transfers:	Needs help from 2 or more people or hoist	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					
ADVANCED MOBILITY							
Walking: (10 metres)	Unable to walk	0					
	Walks with help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Stairs:	Unable to climb stairs	0					
	Climbs stairs with help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Getting up from the floor:	Needs help from 2 or more people / hoist	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					
BED MOBILITY							
Getting into bed:	Needs help from 2 or more people / hoist	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Moving around in bed:	Needs help from 2 or more people / hoist	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
Getting out of bed:	Needs help from 2 or more people / hoist	0					
	Needs help from 1 person	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					

			DATES				
ACTIVITY	**ABILITY**	**SCORE**					
KITCHEN ACTIVITIES							
Making hot drink:	Dependent / not yet assessed	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Making a snack:	Dependent / not yet assessed	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Making a meal:	Dependent / not yet assessed	0					
	Needs minimal help	1					
	Needs supervision	2					
	Independent	3					
	TOTAL	**/ 9**					
HOUSEWORK ACTIVITIES							
Basic cleaning:	Dependent / not yet assessed	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
General laundry:	Dependent / not yet assessed	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
Ironing:	Dependent / not yet assessed	0					
	Needs minimal help	1					
	Needs supervision only	2					
	Independent	3					
	TOTAL	**/ 9**					

3. When consent had been obtained, patients were then randomly allocated to either the transfer of training or functional approach for perceptual treatment. Envelopes had been prepared prior to the start of the study by the research OT with numbers taken from random number tables. Odd numbers signified that patients would follow the transfer of training approach and even numbers signified that patients would follow the functional approach. This method was continued until there were 40 patients in each group.

4. Perceptual treatment was given for two and a half hours per week for six weeks, in addition to their general OT treatment. The perceptual treatment was given by a combination of the research OT and ward OT. The amount of treatment time was chosen as this was thought to be a realistic amount achievable in normal clinical practice. See section 2.5 for details of the perceptual treatment given.

5. Details for each patient, of every attendance for any OT treatment, were recorded in an OT register by the ward OT. The amount of time spent on each treatment was also recorded in this register, in terms of number of half hour units per treatment session.

6. At the end of the six weeks treatment, the patients were reassessed on the RPAB, Barthel ADL index and Edmans ADL index by an assessor who was blind to the treatment approach given i.e. an independent assessor. For practical reasons the independent assessor discussed the patients' functional ability with the primary nurses. The ward OT also completed the Barthel ADL index and Edmans ADL. The

patients were also reassessed on the RMA Gross Function scale by the Physiotherapist.

2.4 Additional assessments

The ability to complete the RPAB and to respond to treatment, may be influenced by factors other than perceptual ability, as previously mentioned. Therefore to identify these problems and to investigate their effect, the results of the following assessments were collated by the research OT. To prevent the patients having to undergo two batteries of assessments, the assessments were chosen as those already being routinely carried out by the Stroke Unit staff of each discipline, most of which had evidence of validity and reliability.

2.4.1 Speech and Language Therapist

One Speech and Language Therapist assessed all the patients for dysphasia, dysarthria and articulatory dyspraxia, in a standardised way, using an assessment that was not published (see appendix 4). This included ratings of auditory comprehension, expressive language, articulatory dyspraxia, reading comprehension and dysarthria.

Auditory comprehension rating was based on auditory input only and excluded the use of situational understanding and help given by non-verbal cues. Expressive language was based on spoken output only and reference to non-verbal communication was specifically excluded. Articulatory dyspraxia and reading comprehension were rated on information relating to these two abilities alone. Dysarthria rating was based on the percentage of words that were intelligible in a general conversation in a quiet room. All sections of the assessment were graded 0 to 5 and patients were classified as to whether these problems were present, absent or the patient could not be assessed for any reason.

Speech and language assessments were required for this study as the patient's abilities in terms of auditory comprehension, expressive language, articulatory dyspraxia, reading comprehension and dysarthria may affect the patients' response to perceptual assessment and treatment.

2.4.2 Psychologist

The Psychologist assessed premorbid IQ level using the Shortened National Adult Reading Test (Nelson, 1982, Beardsall and Brayne, 1990), memory using the Wechsler Memory Scale - Revised (Wechsler, 1987), reasoning using Word Fluency from the Multilingual Aphasia Examination (Benton and Hamsher, 1989) and Cognitive Estimates (Shallice and Evans, 1978), limb dyspraxia using the apraxia test by Kertesz and Ferro (Kertesz and Ferro, 1984) and anxiety and depression using the Hospital Anxiety and Depression Scale (Zigmond and Snaith, 1983).

The National Adult Reading Test (NART) (Nelson, 1982) has been shown to estimate premorbid IQ in hospital patients. The test consists of a list of 50 irregular words of varying difficulty and according to the accuracy of pronunciation, a full-scale IQ is predicted. However, this can be a lengthy test and can cause distress for elderly people. To overcome this, the shortened NART was developed (Beardsall and Brayne, 1990). In this case, the patient only reads the first half of the test and a prediction analysis determines the score for the second half, giving a total NART score. Total NART scores were found to be highly significantly correlated with full NART score. The shortened NART was chosen for use in this study as patients were likely to be of all ages and the IQ level was needed to interpret the RPAB scores, as presented in the RPAB manual. According to their performance, patients were classified as being at above average, average or below average IQ level.

The Wechsler Memory Scale - Revised (Wechsler, 1987) was used to identify verbal and visual memory. Verbal memory was assessed using the Logical Memory test where a short story is read to the patient who then recalls what can be remembered immediately. A second story is then read for the patient to recall. The patient is then asked 30 minutes later to recall what can be remembered of both stories. Each story has 25 scoring units in it and the patient is scored according to the number of units recalled. Visual memory was assessed using the Visual Reproduction subtest, where the patient is shown a simple diagram for 10 seconds and is then asked to reproduce it from memory. There are four diagrams, three contain a single figure and the fourth contains two designs, one of three and one of two geometric elements. The patient is asked to reproduce them again after 30 minutes. The patient's memory ability was required to determine whether memory deficits had any affect on perceptual treatment, such as whether the patient could retain information during and between treatment sessions.

Reasoning ability was assessed by the Word Fluency section of the Multilingual Aphasia Examination (Benton and Hamsher, 1989). In this test the patient has to say as many words as he/she can beginning with a certain letter. The patient is given one minute per letter and there are three letters used - C, F and L. Scoring depends on the number of words said for each letter. Cognitive estimates (Shallice and Evans, 1978) were also used as a test of reasoning ability. This test consists of a series of questions to the patient, requiring reasoning / judgement to answer them. A reasonable answer is all that is required as the absolute answer is not known. The questions are ones that can be answered using general knowledge available to most people, but where no immediately obvious strategy is available. Scoring is dependent on how reasonable or bizarre the answer is. Reasoning and judgement are generally thought to be attributable to frontal lobe problems but are likely to affect the patients' ability to complete tasks on the RPAB and during perceptual treatment.

The Kertesz and Ferro apraxia assessment (Kertesz and Ferro, 1984) was used to assess limb apraxia. This assessment consists of 20 items in four descriptive categories - facial, intransitive (upper limb), transitive (instrumental) and complex. The patient is asked to carry out each movement on command first. If no response is made or an incorrect response is made, the patient is shown the movement and encouraged to imitate it. Each item is graded 0 to 3, ranging from unrecognisable performance to good performance. Apraxia required assessing for this study to determine whether the presence of limb apraxia influenced the patient's response to treatment of perceptual problems.

To assess the presence of anxiety or depression, the Hospital Anxiety and Depression scale (Zigmond and Snaith, 1983) was used. This is a widely used, self assessment scale which has been found to be a reliable instrument to detect clinically significant anxiety and depression and to be a valid measure of severity of mood. It includes 14 statements with four categories to describe how often these statements occur for the patient. Seven statements relate to anxiety and seven to depression. As mentioned in section 1, the presence of anxiety and depression is known to affect the patient's response to treatment.

Patients were classified according to the presence or absence of memory, reasoning, limb dyspraxia, anxiety or depression problems to determine if the presence of any of these problems influenced the effect of perceptual treatment.

2.4.3 Physiotherapist

The Physiotherapists assessed motor function using the Rivermead Motor Assessment (RMA) (Lincoln and Leadbitter, 1979) and sensation using the Nottingham Sensory Assessment (Lincoln et al, 1991).

The Rivermead Motor Assessment (Lincoln and Leadbitter, 1979) is an assessment of physical recovery from hemiplegia following stroke. It is divided into three sections - gross function, leg and trunk function and arm function. The gross function only was used for this study to give an overview of the patient's gross physical ability. This section included 13 ranked tasks ranging from being able to sit independently with feet unsupported for 10 seconds to being able to hop on the affected leg, five times on the spot. Items in each section are in ranked order and each item is scored either 0 or 1, i.e. being able to do the item or not. Patients are allowed three attempts at each task and the assessment is stopped after three consecutive item failures. All tasks should be carried out independently. Originally there was evidence of validity and reliability for patients under 65 years only. However, Adams (1992) has since assessed the scalability and test-retest reliability of the gross function section with patients over 65 years and found the scale to be very reliable for this age group.

The Nottingham Sensory assessment (Lincoln et al, 1991) was use to assess sensory awareness. This assessment includes the patients' ability to feel certain stimuli i.e. hot and cold, sharp and light touch, position and movement of limbs. The patient is blindfolded throughout the assessment to allow the patient to use sensation only. The assessment is divided into three sections - tactile sensation, kinaesthetic sensation and stereognosis. Tactile sensation includes the awareness of temperature, light touch, pressure, pain, tactile localisation, bilateral simultaneous touch, and two-point discrimination. Kinaesthetic sensation includes the appreciation of movement, the awareness of direction of movement sense and joint position sense. Each item of the assessment is scored as absent, impaired or normal.

Patients were classified according to the presence or absence of sensory problems to identify if the presence of sensory problems influenced the effect of perceptual treatment.

2.5 Perceptual treatment

Specific perceptual treatment was given for 2.5 hours per week for 6 weeks, usually in the form of 30 minute sessions daily, Monday to Friday, by the research Occupational Therapist or ward Occupational Therapist. This was thought to be a realistic amount of treatment that could be offered in normal clinical practice in hospital. The perceptual treatment was given at varying times of the day, to fit in with the multi-disciplinary clinical therapy times. The perceptual treatment was given in addition to the patients' routine therapy given by the ward multi-disciplinary team. That meant though that the transfer of training group also received routine practice in activities of daily living tasks, such as washing, dressing and kitchen tasks, in order to make them independent to permit discharge home. However, the activities of daily living practice received by the transfer of training group did not include specific perceptual treatment.

Perceptual treatment sessions varied in content according to the patients' problems and progress in treatment. All perceptual treatment was recorded for each session, including the variety and grading (when appropriate) of activities used, length of time on each activity and how the patient performed on each activity.

Strategies used in the treatment of perceptual problems by either the transfer of training or functional approaches are well described by Zoltan, Siev and Freishtat (Siev and Freishtat, 1976; Zoltan et al., 1986). The strategies used in this study included some from Zoltan et al, 1986 and some that the author had found to be effective from her own observations, clinical practice and experience. The strategies used have been divided into general strategies for any perceptual problems and specific strategies for individual perceptual problems, which may have been used with patients following either the transfer of training or functional approaches. General strategies included:-

- Adapting the complexity of the task that the patient was doing, i.e. starting with simple tasks and gradually building up to more complicated tasks (Hecaen and Assal, 1970)
- Using demonstration, imitation, or gesture, to facilitate the patient during activities
- Deciding whether to use verbal or written instructions
- Remembering that one of the accepted elements of learning is by repetition and practice
- Reinforcing positive behaviours rather than negative ones
- Giving general mental stimulation to encourage active participation by the patient
- Facilitating the patient by staging components i.e. breaking down tasks into stages and encouraging the patient to complete one stage at a time
- Facilitating the patient by giving verbal or physical cues and prompting
- Trying to establish set patterns and routines for carrying out each activity, i.e. being systematic
- Ensuring consistency in approach and method of treatment by the whole team

Perceptual problems were divided into five main problem areas for ease of identifying strategies and treatment. These areas were body image / body scheme, unilateral neglect, spatial relations, apraxia and sequencing, agnosia (Siev and Freishtat, 1976; Zoltan et al,. 1986). The aims of treatment, specific strategies used, and some examples of treatment activities, using the transfer of training and functional approaches, for each problem area were as follows:-

2.5.1 Body image / body scheme

Aim: To increase the patient's awareness of the relationship of parts of the body and how they are needed in order to carry out activities.

Strategies used by either approach:

- Encouraging the patient to verbalise parts of their body during functional activities or when using appropriate puzzle type activities (Anderson and Choy, 1970)
- Encouraging the patient to identify parts of the body on themself or on the therapist to improve their recognition of parts of their body (Anderson and Choy, 1970)
- Encouraging the patient to verbalise the position of parts of their body, to improve their body awareness (Anderson and Choy, 1970)

Transfer of training activities:

- Assembling manikin puzzles of a man, woman or a face
- Drawing and naming parts of a body, stick man or a face
- Using clothes cards to identify where they fit on a body

Functional activities:

- Washing - using instructions such as wash your arm, face or chest, touch or name parts of the body, or using a mirror during cleaning teeth or combing hair

- Dressing - using instructions such as put your left arm into the sleeve, push clothes over your right shoulder, put your watch on your right wrist
- Transfers - using instructions such as hold your wrist

2.5.2 Unilateral neglect

Aim: To make the patient aware of both sides of the environment.

Strategies used by either approach:

- Placing objects to be used during the activity, initially in midline and graduating by moving the objects further to the patient's affected side (Burt, 1970)
- Encouraging staff to approach the patient from the patient's affected side (Burt, 1970)
- Placing the stimulus on the patient's affected side, e.g. wash kit / clothes / tapping the table etc. (Burt, 1970)
- Prompting and encouraging the patient to look to their affected side (Burt, 1970)
- Using activities that cross the patient's midline
- Emphasising the patient's affected side during activities (Burt, 1970)
- Adapting the environment to make tasks easier for the patient, e.g. positioning objects so the patient was aware of where the object was (Pigott and Brickett, 1966)
- Using environmental landmarks, e.g. the edge of table / carpet / window or a red line on affected side of the task (Diller, 1981; Pigott and Brickett, 1966). The patient was taught to look to their affected side to locate the edge of furniture / red

line etc., in order to orientate the patient to that side and the patient was taught to work back to midline to find the objects or task in hand

Transfer of training activities:

- Drawing / copying a house, clock etc.
- Cancellation tasks (Diller and Weinberg, 1977), maze or word search puzzles
- Using a red line on the affected side as a stimulus (Diller 1981)
- Using computer games with a touch screen (Robertson et al., 1988)
- Using a visual field scanner (similar to Diller's "scanning machine") (Diller and Weinberg, 1977)
- Any wide angled games which require the patient to scan the visual field e.g. large sized dominoes

Functional activities:

- Washing - following general strategies e.g. putting objects to the affected side of the wash bowl or washing the affected arm
- Dressing - crossing legs when dressing the lower half of the body, putting clothes or check list on the affected side, putting tape round sleevehole of affected arm or dressing the affected arm first
- Grooming - using a mirror and ensuring the patient shaves both sides of their face
- Eating - encouraging the patient to turn the plate round to find their food
- Transfers - moving towards a chair or similar on the affected side of the patient
- Gardening / kitchen tasks - tasks involving crossing midline or putting items on the affected side of the patient

- Reading a paragraph aloud or copying a paragraph

2.5.3 Spatial relations

Aim: To make the patient aware of the relationship of objects to other objects or to themself, to identify the foreground from the background, positions in space, and depth and distances.

Strategies used by either approach:

- Encouraging the patient to use a variable numbers of objects in the task i.e. starting with a few items and building up to having lots of items around in a cluttered surrounding (Hecaen and Assal, 1970)
- Encouraging the patient to pick out objects in the foreground from the background (Taylor, 1969)
- Encouraging the patient to find items from a contrast background or from a similar background
- Encouraging the patient to trace around outlines of objects, pictures etc., to facilitate identification of objects and positions
- Encouraging the patient to identify overlapping figures or items
- Encouraging the patient to verbalise the relationships of items to themself or items to each other, during functional or transfer of training tasks
- Deciding the terms to be used in verbal instructions, e.g. in and out, front and behind, right and left (Taylor, 1969)

- Trying to relate the terms used to other objects, e.g. move towards the chair or person
- Encouraging the patient to verbalise the recognition of shapes and positions in 2-Dimensional and 3-Dimensional situations
- Encouraging the patient to verbalise the recognition of the depth and distance of objects etc.

Transfer of training activities:

- Varieties of domino type games e.g. spot on, heads and tails, symmetry or jigsaw dominoes, connect or triominoes
- What's in the square puzzle
- Cards to make 2-Dimensional block design type patterns (Wechsler, 1955)
- 3-Dimensional block design tasks (Wechsler, 1955)
- Cube or 3-Dimensional copying tasks (Anderson and Choy, 1970)
- Geometrix puzzle

Functional activities:

- Washing - putting soap on contrasting colour cloth and progressing to using white soap on a white cloth or sink, identifying the relationship of objects e.g. soap to soap dish, flannel to water, toothbrush to toothpaste
- Dressing - finding clothes in a cluttered drawer or in a pile on the bed, using a contrasting colour background, arranging clothes so sleevehole is visible or outlining sleevehole with red tape or marking back of clothes (Burt, 1970)

- Kitchen tasks - putting teabags into a teapot, identifying the relationship of objects needed for the task, filling the kettle, teapot etc., finding objects in cluttered surroundings
- Meal times - facilitating the awareness of the relationship of food to cutlery, cutlery to mouth and cutlery to plate
- Gardening - facilitating the awareness of relationship of plants, pots and compost
- Stairs - facilitating the awareness of relationship of stairs to feet and depth and distance of stairs

2.5.4 Apraxia and sequencing

Aim: To improve the patient's sequencing ability.

Strategies used by either approach:

- Facilitating the awareness of the correct sequence of an activity by carrying out activities using the same order and environment each time
- Facilitating the patient by using written or pictorial cues about the order or sequence of the activity
- Encouraging the patient to verbalise or gesture the next stage of the activity
- Encouraging the patient to select items in the correct order, initially by the therapist putting items out in the correct order and graduating to putting items out in a random order
- Using frequent repetition of each activity, in the hope that the method of carrying out the activity will become automatic to the patient

Transfer of training activities:

- Playing cards - sequencing the suit
- Lexicon cards - sequencing the alphabet
- Sequencing numbers on a clock face
- Sizing cards, graded cylinders etc. to be arranged in correct sequence order
- Sequence of events cards to be arranged in correct sequence order
- Computer games, including use of touch screen which involve sequencing

Functional activities:

- Washing - using a set sequence and asking questions such as "what do you do next?"
- Dressing - using a set sequence, giving clothes in the correct order and later in a random order, using a check list to assist patient
- Grooming - using a set sequence e.g. shaving, cleaning teeth, brushing hair
- Transfers - using set sequential method, used by all staff
- Kitchen tasks - using check list e.g. shopping, recipe, sequence of task
- Gardening - potting plants in correct sequence of activity

2.5.5 Agnosia

Aim: To improve the patient's ability to distinguish differences in form, colour etc. depending which agnosia the patient has.

Strategies used by either approach:

- Encouraging the patient to recognise differences and similarities between items
- Starting with items that are very different and graduating to items that are very similar, with subtle variations, e.g. shapes, sizes, colours
- Encouraging the patient to verbalise differences, i.e. naming objects and differences between objects

Transfer of training activities:

- Variety of domino type games e.g. matching numbers, colours, shapes, pictures, symmetrical and reversed shapes etc.
- Colour and shape matching blocks
- Inset placing games involving recognition of similarities and differences
- Challenge games involving recognition of similarities and differences
- What's in the square puzzle involving recognition of similarities and differences
- Look a likes games involving recognition of similarities and differences

Functional activities:

Recognition in everyday situations of objects, colours, sizes and subtle variations in form, colour e.g. tins, fruits, vegetables, plates and saucers etc., according to which agnosia the patient has, during:-

- Washing
- Dressing
- Bathing
- Kitchen tasks

- Shopping
- Gardening

2.6 Statistical Analysis

Data can be analysed by either parametric or nonparametric statistical tests. Parametric tests are used with interval (numbering) data, which is the most powerful for analysis, as the difference between any two neighbouring points on the measurement scale is identical. Nonparametric tests are used with nominal (naming) or ordinal (ranking) data. Interval data can be treated as ordinal data to allow the use of nonparametric analysis.

Analyses used in this study were calculated on an "intention to treat" basis i.e. statistics included all patients at the end of the treatment trial, whether or not they completed their six weeks treatment. The following statistical tests were used in this study:-

2.6.1 Parametric tests

- mean - average value of data
- standard deviation - average deviation of data from the mean, 95% of observations lie within the mean $\pm$ two standard deviations
- range - spread of data, minimum to maximum
- t-test - to compare the difference between data from two independent samples, for interval data

- analysis of covariance - statistical technique combining linear regression and analysis of variance, to adjust for the effect of one variable

2.6.2 Nonparametric tests

- median - value that is half way when data is in ranked order, i.e. 50th percentile. It is not influenced by extreme values and is useful when data is skewed and not a normal distribution
- interquartile range - range from 25th percentile to 75th percentile
- range - spread of data, minimum to maximum
- chi-squared test - to compare the difference between data from two independent samples, for nominal data
- Mann-Whitney U test - to compare the difference between data from two independent samples, for ordinal data
- Wilcoxon matched pairs signed ranks test - to compare the difference between paired data from one sample, for ordinal data, i.e. is one of the pair greater than the other of the pair?
- Spearman rank correlation coefficient - to examine the relationship between two variables, for ordinal data
- Kappa coefficient of agreement - to measure the agreement between raters on categorical variables
- logistic regression - to find the combination of variables that maximise the separation between two groups

2.6.3 Confidence intervals

Confidence intervals show the range of values within which the true population mean (interval data) or median (ordinal data) is likely to lie. 95% confidence intervals are supplied for comparisons of means (interval data) and medians (ordinal data).

2.6.4 Power of the study

The power of the study is the probability of rejecting the null hypothesis when it is false, i.e. when it should be rejected (Siegel and Castellan, 1988). In this study, this would mean claiming that there was a difference between the effects of the transfer of training and functional approaches in treating perceptual problems, when this was true. Siegel and Castellan (1988) explain that there are two types of errors that can occur, type I and type II. A type I error is when the null hypothesis is rejected when it is true, i.e. in this study, stating that there is a difference in outcome between the two treatment approaches when there is no difference. A type II error is when the null hypothesis is accepted when it is false, i.e. in this study, stating that there is no difference in outcome between the two treatment approaches when there is a difference. If the sample size is too small, the study will lack power for statistical analysis.

The power of this study was calculated at a probability of 5% (probability of committing a type I error) and a power of 90% (probability of avoiding committing a type II error) (Bourke et al, 1985). Unpublished observations on the Nottingham

Stroke Unit showed that the standard deviation of the Barthel ADL index total scores on admission to the Stroke Unit was 2.5. In order to detect a difference of 2 points on the Barthel ADL index total scores, between the 2 groups, the power calculation showed that 33 patients would be needed in each group. As 40 patients were included in each group, this study should therefore be able to detect such a difference if it exists.

2.7 Inter-rater reliability

To identify any variation in scoring technique, inter-rater reliability studies were carried out between the ward and research OT's and also between the ward OT and the independent assessor, on the RPAB. Details are given in appendices 5 and 6.

CHAPTER THREE - RESULTS

RESULTS

3.1 Patients

The patients were identified from those admitted to the Nottingham Stroke Unit between May 1992 and July 1994, excluding February and March 1994, when the ward OT was on sick leave. During this time 158 patients were admitted. There were 80 suitable patients for the study and 78 patients were excluded for the following reasons:- 63 had no perceptual problems, nine were transferred back to medical, surgical or health care of the elderly wards before assessment and random allocation, one did not have a stroke, one had a marked psychiatric overlay, three did not understand English and one died. The selection of suitable patients took 25 months to complete.

3.2 Patient characteristics and impairments

The biographical characteristics and impairments of the patients in each treatment group are shown in table 5.

The scores from the NART assessment were used to categorise patients into three groups according to their level of IQ, i.e. above average, average or below average. This information was needed in order to interpret the RPAB scores from the RPAB manual. The presence or absence of dysphasia, dysarthria, articulatory dyspraxia, reasoning problems, memory problems, depression, anxiety, limb dyspraxia and sensory problems were recorded rather than raw scores on each assessment. This was to examine the effect of the presence of these disabilities rather than the effect of the severity of them. Also, more than one assessment was used to assess some abilities i.e. memory and reasoning abilities.

Comparison of these characteristics and impairments between the two treatment groups, showed no significant difference using a t-test on age ($t=0.82$, $p>0.05$), or using chi-squared tests on sex, side of stroke, handedness, presence of a carer, IQ level, presence of dysphasia, dysarthria, articulatory dyspraxia, reasoning problems, memory problems, depression, anxiety, limb dyspraxia and sensory problems (chi-squared = 0.00-1.47, $p>0.05$).

There was a significant difference between groups using t-tests on days post stroke ($t=2.12$, $p<0.05$), with the transfer of training group patients being slightly longer post stroke than the functional group.

3.3 Comparison of treatment groups on length of stay and amount of OT received

Details of the length of stay on the stroke unit, number of OT attendences and amount of OT treatment received, in terms of number of half hour treatment units, for each treatment group are shown in table 6. Comparison of these details showed no significant difference between groups using a t-test on length of stay ($t=-0.80$, $p>0.05$), or using Mann-Whitney U tests on OT attendences ($U=597.5$, $p>0.05$) and OT treatment time ($U=723.0$, $p>0.05$).

Table 5
Biographical characteristics and impairments of patients in each treatment group

		Transfer of Training Approach (n=40)	Functional Approach (n=40)
Age in years	Mean	69.75	67.85
	Standard deviation	9.10	11.38
	Range	47 - 84	26 - 86
		t=0.82 NS	ci (-2.69, 6.49)
Sex	Male	18	22
	Female	22	18
		chi squared =0.45	NS
Side of stroke	Left	24	21
	Right	16	19
		chi squared =0.20	NS
Days post stroke	Mean	37.68	31.15
	Standard deviation	16.60	10.13
	Range	16 - 84	14 - 56
		t=2.12 $p<0.05$	ci (0.38, 12.67)
Carer	With	25	26
	Without	15	14
		chi squared =0.00	NS
IQ	Above average	3	2
	Average	37	38
	Below average	0	0
		chi squared =0.00	NS
Handedness	Left	1	2
	Right	39	38
		chi squared =0.00	NS
Hand used for RPAB	Dominant	25	21
	Non dominant	15	19
		chi squared =0.81	NS
Dysphasia	Present	12	14
	Absent	28	26
		chi squared =0.06	NS
Dysarthria	Present	9	6
	Absent	31	34
		chi squared =0.33	NS

		Transfer of Training Approach (n=40)	Functional Approach (n=40)
Articulatory dyspraxia	Present	6	5
	Absent	34	35
		chi squared =0.00	NS
Reasoning problems	Present	25	23
	Absent	7	11
		chi squared =0.46	NS
Memory problems	Present	32	31
	Absent	4	6
		chi squared =0.09	NS
Depression	Present	8	13
	Absent	24	21
		chi squared =0.79	NS
Anxiety	Present	14	9
	Absent	18	25
		chi squared =1.47	NS
Limb dyspraxia	Present	3	6
	Absent	33	31
		chi squared =0.45	NS
Sensory problems	Present	28	27
	Absent	9	7
		chi squared =0.01	NS

p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Some patients were unable to be assessed for reasoning, memory, depression, anxiety, limb dyspraxia or sensory problems due to speech and language difficulties i.e. dysphasia, dysarthria or articulatory dyspraxia.

Table 6

Comparison of treatment groups on length of stay and amount of OT received

		Transfer of Training Approach (n=40)	Functional Approach (n=40)
Length of stay (weeks)	Mean	9.20	9.27
	Standard deviation	4.12	4.23
	Range	2.8 - 18.4	1.8 - 23.0
		t=-0.08 NS	ci (-1.93, 1.78)
OT attendences	Median	17.00	23.00
	Interquartile range	10.25 -= 25.75	17.00 - 28.00
	Range	0 - 47	3 - 52
		M-W U=597.5 NS	ci (-10.00, 0.00)
OT treatment time (half hour units)	Median	34.50	40.50
	Interquartile range	20.00 - 56.00	29.00 - 52.75
	Range	0 - 91	5 - 96
		M-W U=723.0 NS	ci (-14.00, 7.00)

p = probability
NS = not significant, p > 0.05
ci = confidence interval

3.4 Comparison of treatment groups on perceptual total scores

Mann-Whitney U tests were used to determine the probability of a difference occurring by chance between the transfer of training and functional groups on initial and final RPAB total scores. The results are shown in table 7.

These showed no significant difference between groups on initial RPAB total scores or on final RPAB total scores.

3.5 Comparison of treatment groups on functional total scores

Mann-Whitney U tests were also used to compare the difference between the transfer of training and functional groups on initial and final Barthel ADL index and Edmans ADL index total scores. The results are shown in table 8.

These showed no significant difference between groups on either initial or final Barthel ADL index or Edmans ADL index total scores.

3.6 Comparison of treatment groups on gross function scores

Mann-Whitney U tests were also used to compare the difference between the transfer of training and functional groups on initial and final RMA gross function scores. The results are shown in table 9.

Table 7

Comparison of treatment groups on perceptual total scores

		Transfer of Training Approach (n=40)	Functional Approach (n=40)
RPAB			
Initial total score	Median	100.50	99.90
	Interquartile range	52.95 - 124.73	76.35 - 124.68
	Range	17.70 - 170.70	0.00 - 189.90
		M-W U = 798.0 NS	ci (-19.80, 18.79)
Final total score	Median	126.30	120.70
	Interquartile range	69.55 - 151.88	87.20 - 144.28
	Range	15.70 - 190.40	0.00 - 199.60
		M-W U = 786.0 NS	ci (-22.99, 21.71)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Table 8

Comparison of treatment groups on functional total scores

		Transfer of Training Approach (n=40)		Functional Approach (n=40)
BARTHEL ADL				
Initial total score	Median	9.00		9.00
	Interquartile range	7.00 - 10.00		7.00 - 10.00
	Range	2 - 18		1 - 19
		M-W U = 768.0	NS	ci (-1.00, 2.00)
Final total score (nurses)	Median	11.50		13.00
	Interquartile range	9.00 - 15.00		10.25 - 17.00
	Range	6 -20		0 - 20
		M-W U = 691.0	NS	ci (-3.00, 1.00)
Final total score (OT)	Median	12.00		13.00
	Interquartile range	10.00 - 15.75		11.00 - 17.00
	Range	3 - 20		0 - 20
		M-W U = 674.5	NS	ci (-3.00, 1.00)
EDMANS ADL				
Initial total score	Median	28.50		29.00
	Interquartile range	22.25 - 35.00		22.00 - 33.75
	Range	8 - 57		11 - 62
		M-W U = 776.5.0	NS	ci (-4.00, 5.00)
Final total score (nurses)	Median	36.50		42.00
	Interquartile range	28.25 - 48.75		35.25 - 57.50
	Range	12 - 74		0 - 78
		M-W U = 670.0	NS	ci (-12.00, 3.00)
Final total score (OT)	Median	39.50		47.00
	Interquartile range	34.00 - 53.25		37.00 - 58.00
	Range	12 - 76		0 - 77
		M-W U = 646.5	NS	ci (-12.00, 2.00)

U = Mann-Whitney U test
NS = not significant, p > 0.05

p = probability
ci = confidence interval

Table 9

Comparison of treatment groups on gross function total scores

		Transfer of Training Approach (n=40)		Functional Approach (n=40)
RMA GROSS FUNCTION				
Initial total score	Median	1.00		1.00
	Interquartile range	1.00 - 2.00		1.00 - 3.00
	Range	0 - 13		0 - 13
		M-W U = 787.5	NS	ci (0.00, 1.00)
Final total score	Median	3.00		5.00
	Interquartile range	1.25 - 6.00		2.00 - 7.50
	Range	1 - 13		0 - 13
		M-W U = 723.0	NS	ci (-2.00, 1.00)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

These showed no significant difference between groups on either initial or final gross function scores.

3.7 Comparison of treatment groups on individual RPAB subtests on both initial and final assessments

If a patient scored two standard deviations or more below the mean of the normal sample in the RPAB manual on individual RPAB subtests, a criterion score of 1 was given for that subtest.

The proportion of patients in each group, scoring below their expected levels (criterion levels) on individual RPAB subtests, on the initial assessment are shown in figure 2.

The investigation of individual subtests of the RPAB showed that the transfer of training group and functional group had a similar pattern of test scores. In both groups, Right / Left Copying Shapes, Right / Left Copying Words and Cube Copying were the most difficult tasks. Mann-Whitney U tests were calculated, showing there was no significant difference between groups on any of the RPAB subtests, with U values ranging from 666.5 to 795.0. Details are shown in table 10.

Comparison of the two groups on the individual RPAB subtests on the final assessment are shown in figure 3. Mann-Whitney U tests again showed no significant difference

Table 10

Comparison of treatment groups on individual RPAB subtests on both initial and final assessments

	Initial assessment (n=80)		Final assessment (n=80)	
RPAB subtest	U	p	U	p
Picture Matching	756.5	NS	731.0	NS
Object Matching	770.5	NS	761.0	NS
Colour Matching	754.0	NS	682.5	NS
Size Recognition	780.5	NS	757.5	NS
Series	765.0	NS	742.5	NS
Animal Halves	777.0	NS	759.5	NS
Missing Article	781.0	NS	727.0	NS
Figure Ground	687.0	NS	735.0	NS
Sequencing Pictures	776.5	NS	676.0	NS
Body Image	666.5	NS	714.5	NS
R/L Copying Shapes	795.0	NS	791.5	NS
R/L Copying Words	793.0	NS	753.5	NS
3D copying	753.5	NS	748.5	NS
Cube Copying	780.5	NS	778.0	NS
Cancellation	790.0	NS	786.5	NS
Self Identification	781.5	NS	642.5	NS

U = Mann-Whitney U test   p = probability   NS = not significant, $p > 0.05$

Figure 2

Percentage of patients scoring below their expected levels on initial RPAB subtests

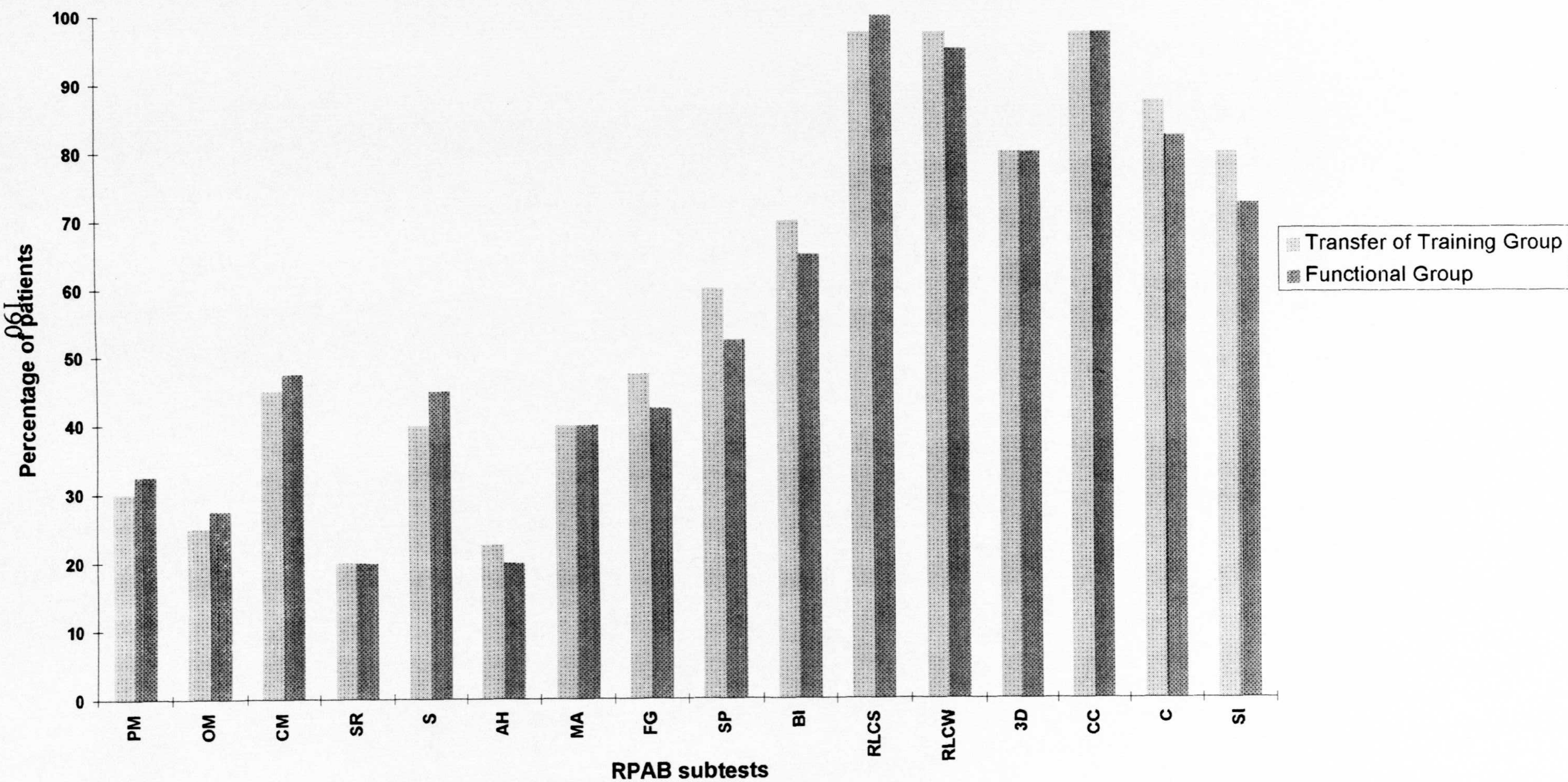
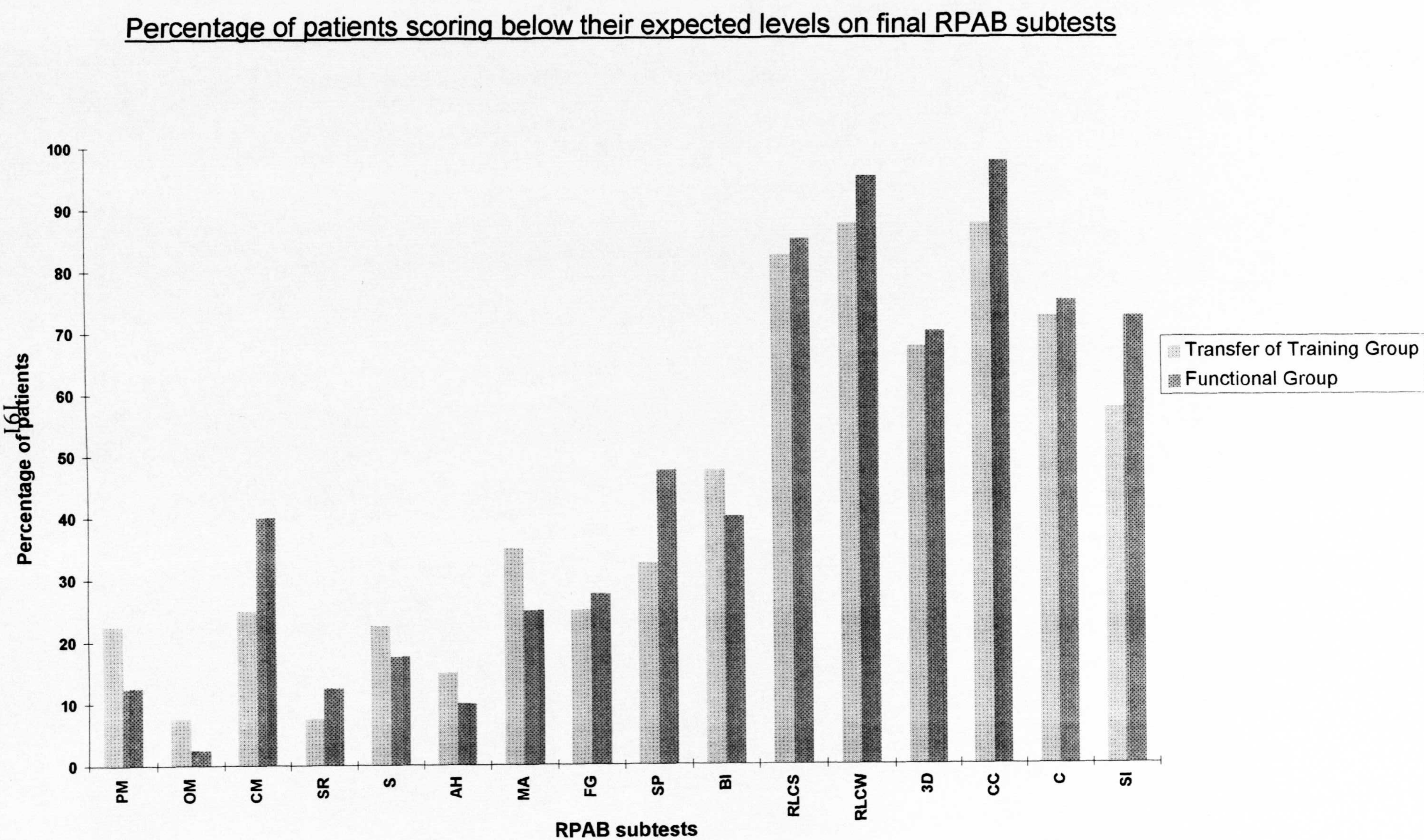


Figure 3


Percentage of patients scoring below their expected levels on final RPAB subtests
Percentage of patients
0
10
20
30
40
50
60
70
80
90
100
PM
OM
CM
SR
S
AH
MA
FG
SP
BI
RLCS
RLCW
3D
CC
C
SI
RPAB subtests
Transfer of Training Group
Functional Group

between groups on any of the RPAB subtests, with U values ranging from 642.5 to 791.5. Details are also shown in table 10.

3.8 Comparison of individual RPAB subtests between initial and final assessments for each treatment group

The proportion of patients in each treatment group, scoring below their expected levels on individual RPAB subtests on initial and final assessments are shown in figures 4 and 5.

The investigation of individual subtests of the RPAB again showed that the transfer of training group and functional group had a similar pattern of test scores. In both groups, Right / Left Copying Shapes, Right / Left Copying Words and Cube Copying were the most difficult tasks. To compare the difference between initial and final assessments for each group, Wilcoxon Matched Pairs Signed Ranks tests were calculated between the individual RPAB subtest scores on initial and final assessments for each treatment group. Details are shown in table 11.

The transfer of training group showed a significant improvement ($z=2.01-3.33$, $p<0.05-0.001$) between initial and final assessments on all subtests except Picture Matching, Series, Animal Halves, Missing Article and 3D copying ($z=0.79-1.85$, $p>0.05$).

Figure 4

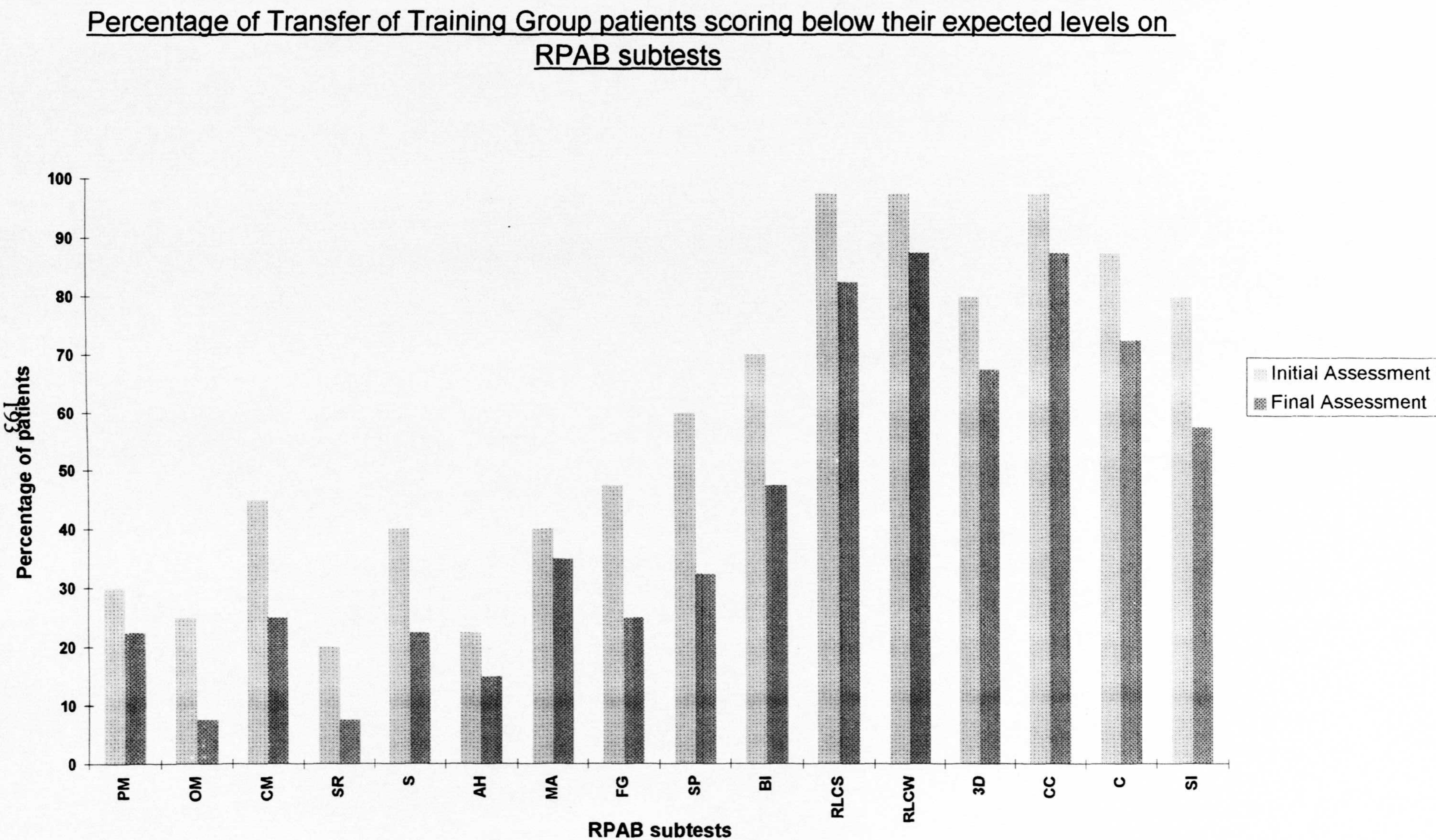

Percentage of Transfer of Training Group patients scoring below their expected levels on RPAB subtests
100
90
80
70
60
50
40
30
20
10
0
Percentage of patients
PM
OM
CM
SR
S
AH
MA
FG
SP
BI
RLCS
RLCW
3D
CC
C
SI
RPAB subtests
Initial Assessment
Final Assessment

Figure 5

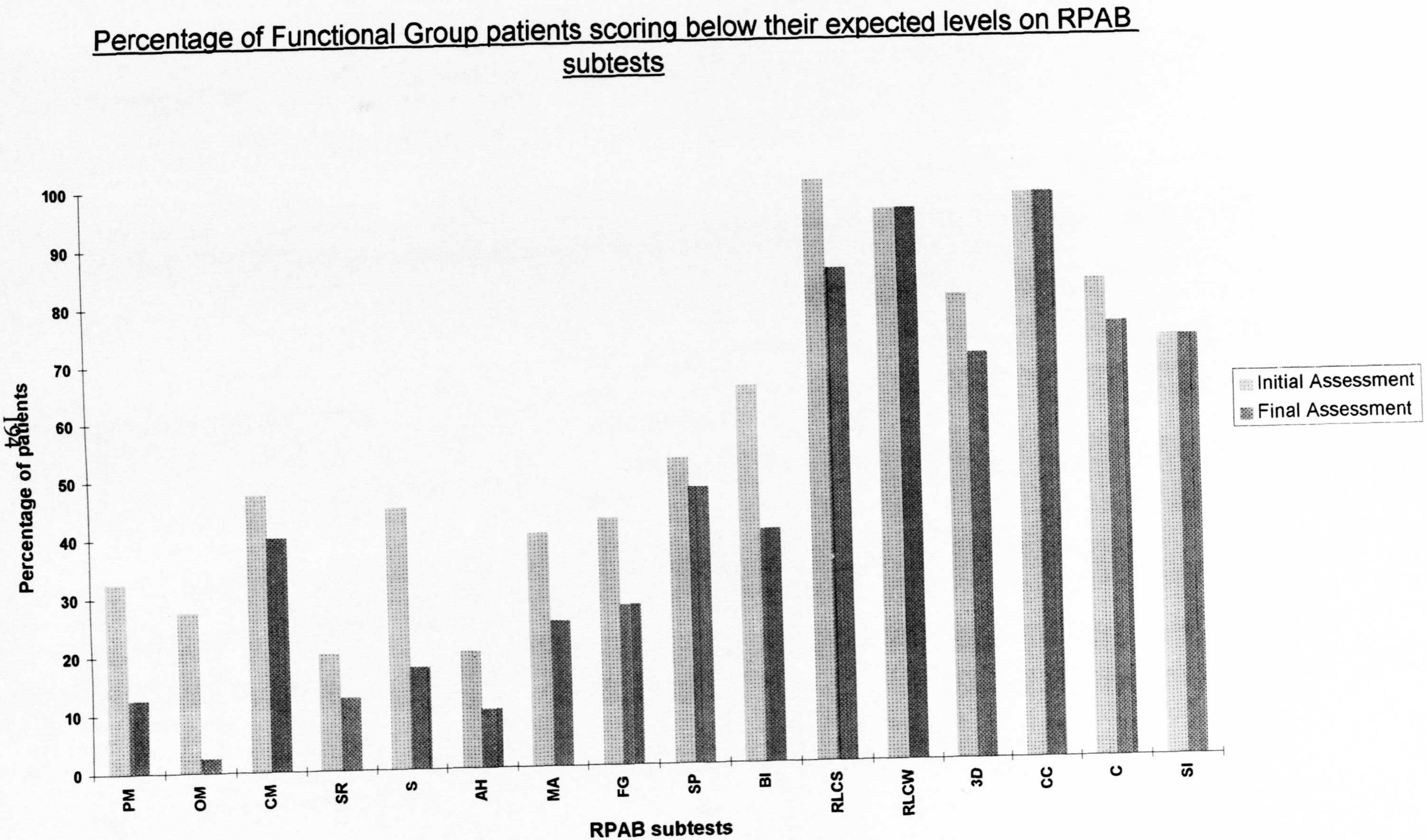

Percentage of Functional Group patients scoring below their expected levels on RPAB subtests
Percentage of patients
100
90
80
70
60
50
40
30
20
10
0
PM
OM
CM
SR
S
AH
MA
FG
SP
BI
RLCS
RLCW
3D
CC
C
SI
RPAB subtests
Initial Assessment
Final Assessment

Table 11

Comparison of individual RPAB subtests between initial and final assessments for each treatment group

RPAB subtest	Transfer of Training Group (n=40)		Functional Group (n=40)	
	z	p	z	p
Picture Matching	1.53	NS	2.34	*
Object Matching	2.01	*	2.80	**
Colour Matching	2.85	**	1.75	NS
Size Recognition	2.20	*	1.86	NS
Series	1.85	NS	2.70	**
Animal Halves	0.80	NS	1.11	NS
Missing Article	0.79	NS	1.85	NS
Figure Ground	3.30	**	1.99	*
Sequencing Pictures	3.33	***	1.20	NS
Body Image	3.32	***	2.65	**
R/L Copying Shapes	3.02	**	3.71	***
R/L Copying Words	3.24	**	3.65	***
3D copying	1.23	NS	1.66	NS
Cube Copying	2.60	**	2.39	*
Cancellation	2.21	*	2.44	*
Self Identification	2.28	*	1.33	NS

z = Wilcoxon Matched Pairs Signed Ranks test
p = probability
NS = not significant, $p > 0.05$
* = $p < 0.05$
** = $p < 0.01$
*** = $p < 0.001$

The functional group showed a significant improvement ($z=1.99-3.71$, $p<0.05-0.001$) between initial and final assessments on all subtests except Colour Matching, Size Recognition, Animal Halves, Missing Article, Sequencing Pictures, 3D copying and Self Identification ($z=1.11-1.86$, $p>0.05$).

3.9 Comparison of perceptual and functional total scores between initial and final assessments

The perceptual and functional total scores were compared between initial and final assessments for all patients (n=80). Wilcoxon Matched Pairs Signed Ranks tests were calculated between initial and final assessments for RPAB, Barthel ADL index (as assessed by nurses and OTs), Edmans ADL index (as assessed by nurses and OTs) and RMA gross function total scores. The RPAB total scores showed a highly significant improvement over time ($z=6.02$, $p<0.001$) as did the Barthel ADL index total scores (nurses, $z=6.72$, $p<0.001$, OT, $z=7.20$, $p<0.001$), Edmans ADL index (nurses, $z=7.01$, $p<0.001$, OT, $z=7.65$, $p<0.001$) and RMA gross function ($z=6.62$, $p<0.001$).

3.10 Comparison of changes in perceptual ability between treatment groups

Although these results showed a highly significant change over time, some patients perceptual ability improved and some deteriorated or remained at the initial level.

The number of patients whose criterion total score (i.e. the number of RPAB subtests in which the patient scored below their expected level) improved or did not improve over the six weeks was investigated.

This showed that 27 (67.5%) transfer of training group patients and 25 (62.5%) functional group patients improved, i.e. 52 (65%) patients in total improved, whilst 13 (32.5%) transfer of training group patients and 15 (37.5%) functional group patients, a total of 28 (35%) patients, did not improve. There was no significant difference between treatment groups in the proportion that improved or did not improve (chi-squared = 0.22, $p>0.05$).

3.11 Comparison of improvers and non-improvers

The biographical characteristics and impairments of the patients in who improved in perceptual ability or did not, are shown in table 12. Comparison of these characteristics and impairments showed no significant difference using t-tests on age or days post stroke (t=-1.13, -1.03) or using chi-squared tests on sex, presence of a carer, IQ level, presence of dysarthria, articulatory dyspraxia, reasoning problems, memory problems, depression, anxiety and sensory problems (chi-squared = 0.00-3.52). There was a significant difference between groups using chi-squared tests on side of stroke, handedness, hand used to complete the RPAB, presence of dysphasia and limb dyspraxia (chi-squared = 5.79-17.09, $p<0.05$-0.001) indicating that right handed patients, patients with left hemiplegic stroke, patients without dysphasia, patients

Table 12

Biographical characteristics and impairments of improvers and non-improvers

		Improvers (n=52)	Non-Improvers (n=28)
Age in years	Mean	67.85	70.57
	Standard deviation	11.20	8.22
	Range	26 - 85	58 - 86
		t=-1.13 NS	ci (-7.52, 2.07)
Sex	Male	27	13
	Female	25	15
		chi squared =0.22	NS
Side of stroke	Left	38	7
	Right	14	21
		chi squared =17.09	p<0.001
Days post stroke	Mean	33.23	36.61
	Standard deviation	14.48	13.19
	Range	14 - 84	17 - 76
		t=-1.03 NS	ci (-9.93, 3.18)
Carer	With	37	14
	Without	15	14
		chi squared =3.52	NS
IQ	Above average	2	3
	Average	50	25
	Below average	0	0
		chi squared =1.47	NS
Handedness	Left	0	3
	Right	52	25
		chi squared =5.79	p<0.05
Hand used for RPAB	Dominant	38	8
	Non-dominant	14	20
		chi squared =14.75	p<0.001
Dysphasia	Present	11	15
	Absent	41	13
		chi squared =8.72	p<0.01
Dysarthria	Present	11	4
	Absent	41	24
		chi squared =0.56	NS

		Improvers (n=52)	Non-Improvers (n=28)
Articulatory dyspraxia	Present	5	6
	Absent	47	22
		chi squared =2.14	NS
Reasoning problems	Present	32	16
	Absent	14	4
		chi squared =0.77	NS
Memory problems	Present	41	22
	Absent	7	3
		chi squared =0.93	NS
Depression	Present	12	9
	Absent	33	12
		chi squared =1.73	NS
Anxiety	Present	15	8
	Absent	30	13
		chi squared =0.14	NS
Limb dyspraxia	Present	2	7
	Absent	45	19
		chi squared =7.96	$p<0.01$
Sensory problems	Present	38	17
	Absent	11	5
		chi squared =0.00	NS

p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Some patients were unable to be assessed for reasoning, memory, depression, anxiety, limb dyspraxia or sensory problems due to speech and language difficulties i.e. dysphasia, dysarthria or articulatory dyspraxia.

without limb dyspraxia and patients who used their dominant hand to complete the RPAB, were more often in the improvers group.

Details of the length of stay on the stroke unit, number of OT attendences and amount of OT treatment received, in terms of number of half hour treatment units, for the improvers and non-improvers are shown in table 13. Comparison of these details showed no significant difference between groups using a t-test on length of stay ($t=1.79$, $p>0.05$). However, there was a significant difference between groups using Mann-Whitney U tests on OT attendences and OT treatment time ($U=434.5$, 417.5, $p<0.01$), indicating that those patients who received more occupational therapy, improved more in terms of their perceptual ability.

Mann-Whitney U tests were used to determine the probability of a difference occurring by chance between the improvers and non-improvers on initial and final RPAB total scores, on initial and final Barthel ADL index and Edmans ADL index total scores and on initial and final RMA gross function scores. Results are shown in tables 14-16. These showed no significant difference between groups on initial RPAB total scores so the improvers did not start at a different level of perceptual ability. There was also no significant difference between groups on either initial or final Barthel ADL index total scores, Edmans ADL index total scores or RMA gross function scores so that improvement in perceptual ability was not associated with a higher initial ability or final ability.

Table 13

Comparison of improvers and non-improvers on length of stay and amount of OT received

		Improvers (n=52)	Non-improvers (n=28)
Length of stay (weeks)	Mean	9.84	8.11
	Standard deviation	4.30	3.66
	Range	2.6 - 23.0	1.8 - 15.0
		t=1.79 NS	ci (-0.19, 3.63)
OT attendences	Median	25.00	15.50
	Interquartile range	15.25 - 29.75	10.00 - 23.00
	Range	0 - 52	3 - 37
		M-W U=434.5 p<0.01	ci (2.00, 12.00)
OT treatment time (half hour units)	Median	45.00	31.00
	Interquartile range	27.25 - 58.75	17.50 - 40.50
	Range	0 - 96	5 - 62
		M-W U=417.5 p<0.01	ci (6.00, 24.00)

p = probability
NS = not significant, p > 0.05
ci = confidence interval

Table 14

Comparison of improvers and non-improvers on perceptual total scores

		Improvers (n=52)	Non-Improvers (n=28)
RPAB			
Initial total score	Median	103.00	91.45
	Interquartile range	76.05 - 126.60	53.73 - 121.15
	Range	0 -189.9	31.4 - 166.2
		M-W U = 636.0 NS	ci (-11.39, 29.30)
Final total score	Median	139.45	97.85
	Interquartile range	104.15 - 168.25	58.48 - 127.53
	Range	21.5 - 199.6	0.0 - 182.9
		M-W U = 376.0 $p < 0.001$	ci (18.60, 58.99)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Table 15

Comparison of improvers and non-improvers on functional total scores

		Improvers (n=52)		Non-Improvers (n=28)
BARTHEL ADL				
Initial total score	Median	9.00		9.00
	Interquartile range	7.00 - 10.00		7.00 - 12.50
	Range	1 - 19		1 - 18
		M-W U = 666.0	NS	ci (-2.00, 1.00)
Final total score (nurses)	Median	11.50		13.00
	Interquartile range	9.25 - 15.75		9.25 - 16.75
	Range	5 - 20		0 - 19
		M-W U = 695.5	NS	ci (-3.00, 2.00)
Final total score (OT)	Median	12.50		13.00
	Interquartile range	10.00 - 16.00		11.00 - 17.00
	Range	6 - 20		0 - 19
		M-W U = 696.5	NS	ci (-2.00, 2.00)
EDMANS ADL				
Initial total score	Median	29.00		28.50
	Interquartile range	22.00 - 33.75		23.50 - 37.25
	Range	9 - 62		8 - 59
		M-W U = 693.0	NS	ci (-6.00, 4.00)
Final total score (nurses)	Median	39.00		46.00
	Interquartile range	30.50 - 53.75		29.00 - 57.50
	Range	19 - 78		0 - 72
		M-W U = 701.5	NS	ci (-10.00, 7.00)
Final total score (OT)	Median	44.00		42.50
	Interquartile range	34.00 - 56.25		36.25 - 58.75
	Range	23 - 77		0 - 69
		M-W U = 714.0	NS	ci (-7.00, 7.00)

U = Mann-Whitney U test
NS = not significant, $p > 0.05$
p = probability
ci = confidence interval

Table 16

Comparison of improvers and non-improvers on gross function total scores

		Improvers (n=52)		Non-Improvers (n=28)
RMA GROSS FUNCTION				
Initial total score	Median	1.00		1.50
	Interquartile range	1.00 -2.00		1.00 - 3.75
	Range	0 - 13		0 - 11
		M-W U = 614.0	NS	ci (-1.00, 0.00)
Final total score	Median	4.00		5.00
	Interquartile range	2.00 - 6.75		2.00 - 6.00
	Range	1 - 13		0 - 13
		M-W U = 701.5	NS	ci (-2.00, 1.00)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

The results in table 13 showed that patients in the improvers group received significantly more occupational therapy treatment than patients in the non-improvers group. Therefore an analysis of covariance was calculated to adjust for the effect of the amount of occupational therapy treatment received by patients. An analysis of covariance is designed for use with parametric data, but there is no alternative available for use with non-parametric data. The results are shown in table 17. Analysis of these results showed that the amount of occupational therapy treatment received had a significant effect on ADL total scores ($p>0.05$), as assessed using either the Barthel ADL index or the Edmans ADL index. However, the amount of occupational therapy treatment received had no significant effect on the perceptual total score. The results indicated that the amount of occupational therapy treatment was not responsible for the difference in perceptual total scores nor the lack of difference in ADL total scores between patients in the improvers and non-improvers groups.

Although the univariate statistical analysis showed a significant difference between improvers and non-improvers on side of stroke, handedness, hand used to complete the RPAB and presence of dysphasia and limb dyspraxia, this does not account for the fact that these impairments may be related and in the same patients. Each variable cannot be assumed to be independent of each of the other variables.

Multivariate statistical analysis however, takes into consideration the combined effects of the variables. Multivariate statistical analysis examines the relationship between an outcome variable and a number of explanatory variables. This type of analysis is therefore more appropriate when attempting to identify a model for improvement.

Table 17

Effect of amount of OT treatment received by improvers and non-improvers

Variable	degrees of freedom	f - statistic	significance
TOTAL2	1, 79	13.54	***
ANOVA			
Covariate T6	1, 79	1.49	NS
ANCOVA	2, 79	7.56	**
BTOTOT	1, 79	0.03	NS
ANOVA			
Covariate T6	1, 79	5.43	*
ANCOVA	2, 79	2.73	NS
EDTOTOT	1, 79	0.16	NS
ANOVA			
Covariate T6	1, 79	4.40	*
ANCOVA	2, 79	2.28	NS

ANOVA - analysis of variance
ANCOVA - analysis of covariance
TOTAL2 - final perceptual total score on RPAB
BTOTOT - final ADL total score on Barthel ADL index
EDTOTOT - final ADL total score on Edmans ADL index
T6 - amount of OT treatment time over 6 week trial period
NS - not significant, $p > 0.05$
p - probability
*** - $p < 0.001$
** - $p < 0.01$
* - $p < 0.05$

A discriminant function analysis to identify any abilities which would discriminate between those who improved or did not could not be carried out. The only abilities where a significant difference between groups was found, were for nominal data. A discriminant function analysis cannot be performed under these circumstances. However, a logistic regression analysis can be calculated for nominal data, to find the combination of variables that maximise the separation between the improvers and non-improvers. This was calculated using the variables in table 12 which showed a significant difference between improvers and non-improvers, i.e. side of stroke, handedness, hand used to complete the RPAB, presence of dysphasia and limb dyspraxia. These variables were therefore regressed against perceptual improvement.

The results of the logistic regression are shown in table 18. Seven patients were excluded from this calculation as they had been unable to be assessed for limb dyspraxia due to speech and language difficulties (five from the improvers group and two from the non-improvers group).

These results showed that 38 patients (80.1%) who improved in perceptual ability were correctly predicted by the model as being improvers and 20 patients (76.9%) who did not improve were also correctly predicted by the model as being non-improvers. However, 15 patients were misclassified by the model, six who were observed as being improvers and nine who were observed as being non-improvers. The results showed that for 79.5% of the patients, the combination of these variables correctly predicted whether they would be in the improvers or non-improvers group. However, the individual variables were all not significant, indicating that the individual

Table 18

Predictive variables of improvers and non-improvers

Variable	B	df	significance
hand used for RPAB	1.10	1	NS
presence of dysphasia	-0.14	1	NS
dominant side	-8.95	1	NS
presence of limb dyspraxia	-0.82	1	NS
side of stroke	1.04	1	NS

B - regression coefficient
df - degrees of freedom
NS - not significant, $p > 0.05$
p - probability

variables did not predict whether the patients would be in the improvers or non-improvers groups.

Side of stroke was found to be a significant factor as to whether patients improved in perceptual ability or did not (chi-squared = 17.09, $p<0.001$). Investigation was therefore carried out using Mann-Whitney U tests to determine any differences between left and right hemiplegic stroke patients in perceptual ability. This showed a significant difference between left and right hemiplegic stroke patients on RPAB total scores at both initial and final assessment (initial RPAB total score: U=538.5, $p<0.05$; final RPAB total score: U=400.0, $p<0.001$). These results indicated that left hemiplegic patients scored higher than right hemiplegic patients on both initial and final RPAB total scores.

One reason for this may be that left hemiplegic patients tended to use their dominant hand and right hemiplegic patients tended to use their non-dominant hand to complete the RPAB. Hand used to complete the RPAB had been found to be a significant factor as to whether patients improved in perceptual ability or did not (chi-squared = 14.75, $p<0.001$). Investigation was again therefore carried out using Mann-Whitney U tests to determine any differences in perceptual ability between patients, according to the hand they used to complete the RPAB. This showed a significant difference between patients using their dominant hand and patients using their non-dominant hand, on RPAB total scores at both initial and final assessment (initial RPAB total score: U=462.5, $p<0.01$; final RPAB total score: U=373.0, $p<0.001$). These results indicated that patients using their dominant hand scored higher than patients using their non-dominant hand, on both initial and final RPAB total scores.

The investigation of individual subtests of the RPAB on both initial and final assessments, showed that the patients using their dominant or non-dominant hand had a similar pattern of test scores to those shown in figures 2 and 3. Again, both groups found Right / Left Copying Shapes, Right / Left Copying Words and Cube Copying to be the most difficult tasks. Mann-Whitney U tests were calculated, showing there was no significant difference between groups on most of the RPAB subtests on initial assessment (U values ranging from 607.0 to 775.5) except for Right Left Copying Shapes, Right Left Copying Words, Cube Copying, Cancellation and Self Identification (U values ranging from 309.5 to 561.0, $p<0.05$ to <0.001). This revealed that a higher percentage of patients using their non-dominant hand had problems on Right Left Copying Shapes, Right Left Copying Words and Cube Copying, whereas a higher percentage of patients using their dominant hand had problems on Cancellation and Self Identification. Details are shown in table 19.

Mann-Whitney U tests were also used to compare these two groups on the individual RPAB subtests on the final assessment. These results showed no significant difference between groups on seven of the RPAB subtests, with U values ranging from 593.5 to 778.5 and a significant difference on nine of the RPAB subtests (U values ranging from 214.0 to 540.0, $p<0.05$ to <0.001). On all these nine RPAB subtests, a higher percentage of patients using their non-dominant had problems. Details are also shown in table 19.

Table 19

Comparison of patients using their dominant or non-dominant hand on individual RPAB subtests on both initial and final assessments

	Initial assessment (n=80)		Final assessment (n=80)	
RPAB subtest	U	p	U	p
Picture Matching	735.5	NS	7778.5	NS
Object Matching	762.0	NS	755.0	NS
Colour Matching	695.0	NS	639.0	NS
Size Recognition	725.0	NS	769.0	NS
Series	622.0	NS	722.0	NS
Animal Halves	668.0	NS	749.5	NS
Missing Article	672.0	NS	599.0	*
Figure Ground	772.5	NS	593.5	NS
Sequencing Pictures	775.5	NS	526.5	**
Body Image	607.0	NS	519.5	**
R/L Copying Shapes	484.5	**	409.0	***
R/L Copying Words	309.5	***	214.0	***
3D copying	755.0	NS	580.0	*
Cube Copying	561.0	*	557.5	*
Cancellation	531.5	*	489.5	**
Self Identification	536.0	*	540.0	*

U = Mann-Whitney U test p = probability NS = not significant, $p > 0.05$
* = $p < 0.05$ ** = $p < 0.01$ *** = $p < 0.001$

However, a correlation between side of stroke, handedness and hand used to complete the RPAB, would be expected. Patients with left hemiplegic stroke more often used their right hand to complete the RPAB and the right hand was dominant for the majority of patients in the study. Only 3/80 (3.75%) patients were left handed. Similarly, patients with right hemiplegic stroke more often used their left hand to complete the RPAB, i.e. their non-dominant hand. As the majority of the patients in the study were unable to use their affected hand to complete the RPAB, there was an obvious relationship between side of stroke, handedness and hand used to complete the RPAB.

Therefore a logistic regression analysis was calculated using the variables side of stroke, presence of dysphasia and presence of limb dyspraxia, to regress against perceptual improvement. The results showed that 80.9% were correctly predicted as being improvers and 73.1% were correctly predicted as being non-improvers. 16 patients were misclassified, 9 who were observed as being improvers and 7 who were observed as being non-improvers. The combination of the variables overall correctly predicted 78.1% patients. When considering the individual variables, only side of stroke correctly predicted whether the patients would be in the improvers or non-improvers groups (side, $B=2.17$, $p<0.01$). The addition of dysphasia and limb dyspraxia made no significant difference (dysphasia, $B=-0.13$, $p>0.05$; limb dyspraxia, $B=-0.64$, $p>0.05$).

This highlights the benefits of using both univariate and multivariate statistical analysis. The univariate analysis showed that five variables significantly discriminated between improvers and non-improvers. However, through the use of multivariate statistical analysis, it could be seen that only side of stroke was responsible for the significant difference in perceptual improvement between improvers and non-improvers.

3.12 Relationship between perceptual total and functional total scores

It is important to the rehabilitation of stroke patients, to know whether the presence of perceptual problems has any effect on functional performance. Therefore, to identify the relationship between perceptual and functional abilities, Spearman Rank Correlation Coefficients were calculated between the RPAB total scores and the Barthel ADL index and Edmans ADL index total scores on initial and final assessments for all patients (n=80).

These indicated a highly significant relationship between perceptual and ADL abilities on both initial and final assessments. Details are shown in table 20.

Table 20

Relationship between perceptual and functional total scores for treatment groups

(n=80)

	rs	p
Initial assessment		
RPAB total score with Barthel ADL total score	0.43	***
RPAB total score with Edmans ADL total score	0.51	***
Final assessment		
RPAB total score with Barthel ADL total score - nurses	0.35	***
RPAB total score with Barthel ADL total score - OT	0.42	***
RPAB total score with Edmans ADL total score - nurses	0.42	***
RPAB total score with Edmans ADL total score - OT	0.51	***

rs = Spearman rank correlation coefficient
p = probability
*** = $p < 0.001$

CHAPTER FOUR - DISCUSSION

DISCUSSION

4.1 Comparison between treatment groups

The results from this study showed that there was no significant difference between the transfer of training approach and functional approach, in the effectiveness of treating perceptual problems following stroke or the generalisation of this treatment to everyday activities. These results therefore support the findings of the randomised controlled studies described in section 1.9 (Robertson et a., 1990; Taylor et al., 1971; Lincoln et al., 1985; Hajek et al., 1993) which also found that the transfer of training approach did not improve perceptual ability more than conventional therapy. Although these studies included little description of the conventional therapy used, it was likely to have been similar (except for that used in the Robertson et al study) to that used with the functional approach patients, as this was the most common form of conventional therapy at the time these studies were carried out. The treatment for the transfer of training group was similar to that used by Taylor et al. and Lincoln et al. and included some use of microcomputers although not as much as in the Robertson et al. and Hajek et al. studies.

Although previous studies have shown the transfer of training approach to be ineffective (Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Towle et al., 1990; Fanthome et al., 1995; Robertson et al., 1990; Taylor et al., 1971; Lincoln et al., 1985; Hajek et al., 1993), this approach was still often employed by specialist clinicians in an attempt to improve perceptual ability in stroke patients. Non-specialist clinicians recently have a tendency to spend more time assessing patients and seem to have less time to engage in actual treatment (authors' clinical observations). These non-specialist clinicians frequently prefer the functional approach, believing it to produce more improvement in perceptual and functional abilities than the transfer of training approach. Neither of these two points of view have been shown to be true in this study, as there was no significant differences between the two approaches to treatment.

In contrast, the results of the current study did not support other randomised controlled studies, which found the transfer of training approach to perceptual treatment to be more effective than conventional therapy (Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985; Soderback and Normell, 1986; Ladavas et al., 1994).

However, most of these studies which showed that the transfer of training approach produced improvement, were for the treatment of left hemiplegic patients with unilateral neglect alone. A limitation of the current study could be that it included treatment of mixed perceptual problems rather than just unilateral neglect. It may be that if neglect alone had been treated using these two approaches, a difference might have been found between the treatment groups.

Another difficulty which arose in this study was that the patients following the transfer of training approach also needed to do ADL tasks, such as dressing and kitchenwork, as part of their routine rehabilitation. The research OT had explained the study to all staff on the ward to try to ensure that no perceptual training was included during these activities, but the patients still needed to practice these activities.

The choice of strategies used in the treatment may have been a reason for this lack of difference between the two treatment approaches. The basic strategies used in the treatment were similar for both groups, as described in section 2.5. This included strategies such as building from simple to complex tasks; staging components of each task; the choice of instructions, cues or prompts; and the use of demonstration, imitation, gesture, repetition, reinforcement, mental stimulation and a systematic method. It may be that the choice of the strategies used in treatment has more effect than the approaches to treatment. In other words, it may be more important to decide how treatment is to be given rather than what treatment is to be given.

Another reason could be that there were insufficient subjects in each group to detect a difference. When the study was designed, the power of the study was calculated as shown in section 2.6, which showed that 33 patients would be needed in each group. Consequently the study included 40 patients in each group to ensure there were sufficient numbers to detect a difference if it existed. However the results from this study showed that the standard deviation of the Barthel ADL index total scores on admission for the patients as a whole (n=80), was 3.4 and therefore was somewhat larger than the 2.5 that the original power of the study calculations had be based on. The results of this change in standard deviation of Barthel ADL total scores on admission indicated that the sample studied were therefore more varied than that on which the power calculation was based. With a standard deviation of 3.4, the power calculation showed that 61 patients would have been needed in each group, suggesting that there were insufficient patients in each group to detect any differences if they existed. There are two main reasons why this difference occurred. Firstly, the stroke unit had changed hospital site since the study had been designed and patients may therefore have been a slightly different group to those on the previous site e.g. more widespread variation in severity of stroke. The authors were unable to predict that this change of hospital site would make such a difference. Secondly, the patients on the stroke unit were selected for participation in the stroke unit evaluation study (Juby et al., 1996) and maybe they were less selective than the patients previously admitted to the stroke unit.

A further reason for the lack of difference between the two treatment approaches may be due to the amount of treatment given, as there are no finite optimum amounts or duration of treatment. The amount chosen for this study was based on what was practical in an OT department i.e. half an hour per day. This was similar to the amount of treatment given in the studies which did not show a difference according to treatment approach used (Robertson et al., 1990; Hajek et al., 1993). However, the studies which indicated the most effective treatment gave more intensive treatment i.e. 40-60 minutes per day, but for a similar number of weeks i.e. 4-7 weeks (Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985; Soderback and Normell, 1986; Ladavas et al., 1994).

4.2 Factors affecting assessments of patients

The study indicated that patients in either treatment group improved significantly in perceptual ability. This may have been because both treatment approaches were effective in treating these problems or it could also have been due to the influence of other factors. One reason for the significant improvement identified between the initial assessment and the assessment six weeks later, could have been due to differences in scoring by the different assessors, i.e. between the ward OT, research OT and independent assessor. The ward OT and research OT carried out the initial assessments and the independent assessor carried out all the assessments after the six weeks treatment. To determine if there were any differences in the scoring between assessors, inter-rater reliability studies were carried out, as described in appendices 4 and 5. These indicated that the scoring between the ward OT and research OT showed there was good inter-rater reliability on all subtests of the RPAB (see appendix 5). Similarly, the inter-rater reliability studies on the scoring between the ward OT and independent assessor also showed good inter-rater reliability on all subtests of the RPAB (see appendix 6). Inter-rater differences in scoring were therefore not responsible for the apparent improvement in perceptual test scores.

For practical reasons, the independent assessor asked the nurse in charge of the ward about the patients functional abilities in order to complete the Barthel and Edmans ADL indices. It was expected that nurses may score ADL ability differently to OTs. The ward OT also therefore completed the Barthel and Edmans ADL indices at the end of the six weeks treatment. As can be seen in table 8, the ward OT generally scored patients slightly more independent in ADL than the nurses had done, on both the Barthel and Edmans ADL indices. As this was the case for patients in both treatment groups, it would not have affected the results when comparing the two treatment groups. The only occasion where this could have made a difference was in comparing functional ability over the six weeks. To account for this, comparisons and correlations were made using both the nurses and OTs' scores. As the results showed in sections 3.9 and 3.12, a highly significant improvement over time was noticed using either the nurses or OTs' scoring and there was a highly significant relationship between perceptual and functional abilities using either the nurses or OTs' scoring.

Another aspect which may have affected the assessments of patients, was that the RPAB may not be sensitive enough to detect minor changes in ability, sufficient to identify differences in the improvement between the two treatment groups. This should not be the case as the test-retest reliability was high, as described in the RPAB manual (Whiting et al., 1985) and in section 1.5. In order to show larger changes in ability, the RPAB total scores were used in the current study, rather than the criterion scores used in previous studies (Edmans and Lincoln, 1987; Edmans and Lincoln, 1990; Edmans and Lincoln, 1989; Edmans and Lincoln 1991; Edmans et al., 1991). There have also been suggestions that the RPAB may be a more global assessment of perceptual ability rather than specific to the individual perceptual problems (Edmans and Lincoln, 1989; Lincoln et al., 1989; Jesshope et al., 1991; Donnelly et al., 1998). This may account for the fact that patients improved overall in perceptual ability but no difference was identified according to the treatment approach used.

The study showed that there was a significant difference in side of stroke between improvers and non-improvers, with the improvers including more left hemiplegic than right hemiplegic patients, and in handedness with the non-improvers including more left handed patients. Therefore, there were more improvers tending to use their dominant hand and more non-improvers tending to use their non-dominant hand. The effects of using the dominant or non-dominant hand when completing the RPAB may therefore have accounted for some of the differences between improvers and non-improvers in this study. The significant difference found between improvers and non-improvers in perceptual ability according to whether the patient used their dominant or non-dominant hand, supports the work of Cramond et al. (1989). Similar results were found irrespective of whether the RPAB total score or individual RPAB subtest criterion scores were considered. This difference indicated that patients using their dominant hand made more improvement in perceptual ability than those using their non-dominant hand. One reason for this may be that patients using their non-dominant hand had poorer dexterity and consequently failed the RPAB subtests due to lack of time rather than perceptual disability. However, this would not have accounted for the lack of differences between the treatment groups as there was no significant difference between treatment groups on side of stroke or handedness.

Investigation of individual subtests when patients were divided according to which hand the patients used to complete the RPAB revealed that a significantly higher percentage of patients using their non-dominant hand had problems on Right Left Copying Shapes, Right Left Copying Words and Cube Copying on initial RPAB assessment and on Missing Article, Sequencing Pictures, Body Image, Right Left Copying Shapes, Right Left Copying Words, 3D Copying, Cube Copying Cancellation and Self Identification on final RPAB assessment. These results correspond with those investigated by Cramond et al. (1989), who found a difference in performance according to whether the dominant or non-dominant hand was used on Right Left Copying Shapes, Right Left Copying Words, 3D Copying and Cube Copying. These results also support those of Matthey et al., (1993) who concluded that only five RPAB subtests were clinically useful i.e. Sequencing Pictures, Right Left Copying Shapes, Right Left Copying Words, 3D Copying and Cube Copying. Matthey et al. (1993) assessed their patients at a similar time post stroke to this study so results were comparable according to time post stroke. Matthey et al. assessed patients between six days and seven months post stroke whereas this study assessed patients between 14 days and 3 months post stroke. These results also give more weight to the suggestion of using short version B of the RPAB (Lincoln and Edmans, 1989) as discussed in section 1.5.

There was also a significant difference between improvers and non-improvers on the presence or absence of dysphasia and limb dyspraxia, with there being significantly less patients with dysphasia or limb dyspraxia in the improvers group. This difference may be due to the dysphasic patients not understanding what to do on the RPAB subtests and the language deficit not changing with time. Similarly, the patients with limb dyspraxia may have been unable to carry out the tasks in the assessment due to the dyspraxia, rather than actual perceptual problems and again the dyspraxia may have persisted over time. Cramond et al. (1989) and Jesshope et al., (1991) support this finding as they also suggested that failure on the RPAB subtests may be due to poor comprehension and limb dyspraxia. Jesshope et al. (1991) concluded that the RPAB validity was still in doubt as patients appear to fail subtests for reasons other than perceptual. However, the results of the logistic regression analysis described in section 3.11, showed that although the model (side of stroke, handedness, hand used to complete the RPAB, presence of dysphasia and presence of limb dyspraxia) predicted 79.5% patients correctly, in terms of whether they improved in perceptual total scores or not, the individual variables did not significantly predict improvement. This was also the case when the model was reduced to side of stroke, presence of dysphasia and presence of limb dyspraxia.

Dysphasia and limb dyspraxia are more common following right hemiplegia (left hemisphere stroke) and less common following left hemiplegia (right hemisphere stroke), as discussed in section 1.1.1. Closer inspection of the data from this study showed that all but one patient with dysphasia were right hemiplegic stroke patients and all patients with limb dyspraxia also had dysphasia, including the seven patients who could not be assessed for limb dyspraxia. These facts demonstrate the close relationship between side of stroke and presence of dysphasia and limb dyspraxia.

The right hemiplegic stroke patients therefore more often had other impairments such as dysphasia and limb dyspraxia. These patients may also have had decreased dexterity caused by using their non-dominant hand to complete the RPAB. Dyspraxia can also affect the patients' ipsilateral hand thus preventing right hemiplegic stroke patients from being able to compensate. These factors may have influenced their ability to complete the perceptual assessment and to carry out perceptual treatment tasks. Side of stroke would therefore appear to be the main contributing factor of improvement in perceptual ability.

4.3 Factors affecting recovery of perceptual problems

The lack of difference between the transfer of training and functional approach groups in this study may be because perceptual treatment is ineffective. This would support the single case experimental designs discussed in section 1.9 (Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Towle et al., 1990; Fanthome et al., 1995) which also found little effect from perceptual treatment. However, the patients in the current study did show improvement in perceptual abilities, although there was no difference according to which approach to treatment had been followed. This indicates that both approaches may be equally effective in treating perceptual problems which would support other single case experimental design studies which found that perceptual ability could be improved by training following the transfer of training approach (Robertson et al., 1988; Wagenaar et al., 1982; Robertson et al., 1992; Prada and Tallis, 1995) or the functional approach (Webster et al., 1984; Gouvier et al., 1984).

The effectiveness of the treatment of perceptual problems in previous studies seemed to be influenced by various key factors, namely, the selection of patients to be treated, the type of perceptual problem being treated, the intensity of treatment to be given and the choice of outcome measure. Studies showing that perceptual treatment was effective mainly included left hemiplegic patients being treated for unilateral neglect, receiving intensive treatment i.e. 40-60 minutes per day for several weeks and with outcomes being measured on assessments similar to the treatment tasks, as discussed in detail in section 1.9. On the other hand, studies showing that perceptual treatment was not effective, tended to include both right and left hemiplegic patients being treated for multiple perceptual problems, receiving less intensive treatment and with outcomes being measured on assessments that were different to the treatment tasks, as was also discussed in section 1.9. This was shown to be the case in this study also.

Perceptual problems have been found to affect the patients response to rehabilitation, as described in section 1.6 (Lorenze and Cancro, 1962; Tsai et al., 1982; Bernspang et al., 1982; Andrews et al., 1980; Whiting et al., 1985; Edmans and Lincoln, 1990; Jesshope et al., 1991; Donnelly et al., 1998). This current study also showed a highly significant correlation between perceptual and functional abilities, which although correlation does not imply cause, suggests that maybe it is not possible to treat one without affecting the other i.e. treatment of perceptual problems should affect functional ability and treatment of functional difficulties should affect perceptual ability. Toglia (1991) supported this statement and suggested that the exclusive use of either abstract tasks (i.e. transfer of training tasks) or functional tasks, resulted in a decreased ability to transfer the skills learned in therapy to other situations. Toglia indicated that patients needed to be able to deal with familiar and new situations to be independent in the community and that they needed to understand the relevance of a treatment to be able to connect it to other experiences. Toglia also suggested that a critical component of treatment was the way in which the task was structured, manipulated and presented to elicit the proper response.

Alternatively, the improvement in perceptual and functional abilities may not be related to the perceptual treatment at all. The improvement may have been as a result of other factors such as the influence of other impairments or spontaneous recovery. At the start of this study it was thought that impairments such as dysphasia, dysarthria, articulatory dyspraxia, limb dyspraxia, memory, reasoning, anxiety, depression or sensory problems, would have an effect on the recovery of perceptual ability after stroke. However, in this study, this was not been shown to be the case. When the patients who improved on perceptual ability over the six weeks treatment were compared with those who did not improve, the only impairments that were related to perceptual improvement were dysphasia and limb dyspraxia. It may have been that the patients with dysphasia were unable to understand what was being requested of them in the treatment sessions and those patients with limb dyspraxia may have been unable to execute the task being requested of them. None of the other impairments listed above appeared to have any impact on the recovery or not of perceptual problems.

The study showed that patients achieved a significant improvement in both perceptual and functional abilities over the six weeks treatment period irrespective of which treatment approach had been followed. These patients ranged from 14 to 84 days post stroke, i.e. 2 to 12 weeks, suggesting that they were at a stage when spontaneous recovery might be expected. However, there was no significant difference between those who improved in perceptual ability or did not, on number of days post stroke on entry to the study. This suggests that the recovery noticed in these patients was probably not due to spontaneous recovery but was due to a treatment effect.

The improvement that patients made in perceptual ability in the current study may have been due to other treatments or general multi-disciplinary treatment. A major limitation of this study was that it was carried out on a specialist stroke unit. On the Nottingham Stroke Unit, staff of all disciplines and grades had previously been taught what perceptual problems were, how to recognise them and how to adapt their treatment and care of these patients according to the perceptual problems identified. Traditionally, all patients on this stroke unit were assessed by an OT for perceptual ability, within two weeks of admission to the unit. If perceptual problems were identified, the OT would explain to the patient, his / her relatives and all staff, what these problems were, how they might affect the patient in hospital and when discharged and how to treat or compensate for these problems. Consequently, the Nottingham Stroke Unit staff of all disciplines and grades, had a heightened awareness of perceptual problems and their treatment, resulting in staff adapting their treatment accordingly. Functional treatments such as washing and dressing were carried out using the same technique by nurses as well as OTs, thus emphasising a 24 hour multi-disciplinary approach to treatment. All patients in this study were therefore receiving this functional treatment from the nurses during their six weeks in the study. The OTs were encouraged not to include aspects of perceptual treatment in functional activities with patients in the transfer of training group, but it was difficult to prevent the nurses and Physiotherapists from incorporating their perceptual awareness in their treatment.

The rehabilitation of a stroke patients in hospital is a complex process involving many different professionals, primarily Doctors, Nurses, Physiotherapists, Occupational Therapists, Speech and Language Therapists, Psychologists, Social Workers, Pharmacists and Dieticians. It is likely therefore, that there will be some overlap of treatment effects between disciplines, making it difficult to identify the effects of one treatment by one individual discipline. The Nottingham Stroke Unit claims to have a multi-disciplinary approach to rehabilitation but in practice it actually follows an interdisciplinary approach. A multi-disciplinary approach implies that many disciplines work together but they may be working individually with no overlap of therapy between disciplines. Interdisciplinary implies that each discipline works with each other discipline and having an overlap of treatment.

The intensive multi-disciplinary treatment received by patients in this study, whilst on the Nottingham Stroke Unit, made it more difficult to show the effectiveness of only one aspect of the patients' treatment. This may therefore be a reason for the lack of difference between the two treatment groups. Lincoln et al. (1997), highlighted that patients treated on the Nottingham Stroke Unit improved in perceptual ability more than those treated on health care of the elderly or general medical wards. They also suggested that this was due to the multi-disciplinary treatment received on the Nottingham Stroke Unit. Other studies have also suggested that any benefits of perceptual treatment might be masked by the effects of other therapies on intensive rehabilitation units or stroke units (Feigenson et al., 1977; Lincoln et al., 1985; Hajek et al., 1993).

The general approach used in the treatment of motor problems for stroke patients on the Nottingham Stroke Unit was the neurodevelopmental approach. This approach would have been used with patients in both the transfer of training and functional approach groups during the study. It may be therefore, that the neurodevelopmental approach had as much or more impact on the perceptual improvement than the transfer of training or functional approaches or than was previously expected. Further research into the influence of the neurodevelopmental approach on perceptual recovery is therefore required.

A final factor that may have influenced the perceptual recovery was that of motivation, attention and concentration. If patients enjoy their treatment it is likely that they will have higher levels of motivation, attention and concentration than if they dislike the type of treatment. Not all patients enjoy activities such as games and puzzles and therefore the effectiveness of the transfer of training type of treatment approach may be influenced by the patients preferences. However, this should not have affected the results in this study in investigating the difference between the two treatment approaches, as there should have been a similar number of patients in each group with the different preferences.

In hindsight, it might have been better to carry out this study on a different ward where staff had less knowledge of perceptual problems. It may also have been better if it had been carried out when the patients were out-patients, when they would have been receiving less other rehabilitation and the chances of spontaneous recovery would have been less. Similarly, maybe perceptual problems cannot be treated specifically in the early stages of rehabilitation. During these early stages, when the patient is often an in-patient in hospital, it is difficult to separate perceptual treatment from other aspects of rehabilitation.

Stroke rehabilitation is multifaceted and as such it may be of more use to heighten the awareness of perceptual problems, their effect on daily life and strategies to use in all aspects of treatment, for staff of all disciplines and grades. If all staff had a better understanding of perceptual problems and strategies for treatment, this could be built into the philosophy of stroke rehabilitation, but the effect of this would also require evaluation.

CHAPTER FIVE - CONCLUSIONS

CONCLUSIONS

The conclusions of the comparison of the transfer of training approach group and the functional approach group are as follows:

There was no significant difference between treatment groups, on any patient characteristics or impairments, except that the transfer of training group patients were slightly more days post stroke.

Similarly, there was no significant difference between these treatment groups on overall perceptual ability, overall functional ability, gross motor function ability or on scores on the individual RPAB subtests on the initial assessment or on the assessment after six weeks treatment.

There was a significant improvement on most individual RPAB subtests between the initial assessment and the assessment after six weeks treatment, for patient receiving treatment following either the transfer of training or functional approach. The particular RPAB subtests showing this improvement varied between the two groups.

There was a significant improvement for all patients between the initial assessment and the assessment after six weeks treatment on overall perceptual and overall functional abilities, including both activities of daily living and gross motor function.

There was no significant difference between treatment groups, following either the transfer of training or functional approach to perceptual treatment, as to how many improved or did not improve in perceptual ability over time.

There was a highly significant correlation between the severity of perceptual and functional abilities on the initial assessment and on the assessment after six weeks treatment, for all patients.

The research hypothesis that treatment following the transfer of training approach would produce a greater improvement in perceptual ability and that treatment following the functional approach would produce a greater improvement in functional ability, was therefore rejected.

CHAPTER SIX - STUDY 2 - COMPARISON OF TREATMENT AND NO TREATMENT GROUPS IN THE MANAGEMENT OF PERCEPTUAL PROBLEMS AFTER STROKE

NO TREATMENT GROUP

6.1 Introduction

The perceptual treatment study showed a lack of significant differences between groups of patients following the transfer of training or functional approaches in the treatment of perceptual problems after stroke.

This could have been attributed to spontaneous recovery or the general effects of patients being on the Nottingham Stroke Unit, as previously mentioned, or it could be that specific perceptual treatment does not improve perceptual or functional abilities.

Ideally the original study should have included a control group receiving no perceptual treatment, who were assessed on entry to the trial and again six weeks later. Patients could then have been randomly allocated to all three groups i.e. transfer of training approach, functional approach and control group. However, at the time the original study was carried out, perceptual treatment was normally offered to patients who presented with perceptual problems on the Nottingham Stroke Unit. It was therefore considered to be unethical to include a control group at that time, as that would have been withdrawing treatment normally offered to patients.

However, the original study indicated that patients improved in perceptual and functional ability and but failed to show that this improvement was due to the perceptual treatment. Perceptual treatment therefore, may not have had any effect on patients' perceptual or functional abilities.

In order to identify whether the lack of significant differences between the treatment groups was due to the effects of spontaneous recovery or the effect of receiving either treatment, patients on the Nottingham Stroke Unit with perceptual problems, who received no perceptual treatment for six weeks were studied.

6.2 Method and selection of patients

Patients were selected from those admitted consecutively to the Nottingham Stroke Unit and the inclusion criteria for the study were the same as in the previous study i.e.:-

1. Patients had to be well enough to be assessed on the RPAB (Whiting et al, 1985). This included being able to see, hear, understand English enough to complete the assessments and to follow the instructions and to not have such marked psychiatric problems that these would affect the results of the RPAB.

2. They had to have sufficient functional use of one hand, in order to complete the RPAB and to carry out perceptual treatment activities, i.e. sufficient ability to pick up and move objects / cards with one hand.

3. They had to give consent to participate in the study. If patients were unable to give verbal consent, permission for them to enter the study was sought from their nearest

relative. Consent to participation in this study was then documented in the patients' medical notes.

It should be noted that during this study period, there was a selected group of patients admitted to the Nottingham Stroke Unit, due to the evaluation study (Juby et al., 1996) having been completed. During the evaluation study (Juby et al., 1996), patients suffering a stroke were randomly allocated to either the stroke unit or general medical wards but after the completion of that study, patients were only admitted to the stroke unit after referral from their consultant. It was therefore at the consultants discretion to decided which patients he / she referred. There were no set criteria for admission to the stroke unit after the evaluation study had been completed, but patients were all broadly suitable for rehabilitation. The criteria for admission to the Nottingham Stroke Unit included being medically stable, being able to transfer with a maximum of two nurses, having no discharge date planned, being able to tolerate 30 minutes treatment sessions, being able to do two out of being able to eat, drink or wash their face and being able to toilet themselves prior to the stroke, as had been used in the evaluation study (Juby et al., 1996) and the perceptual treatment study..

6.3 Procedure

The procedure to the study was the same as in the previous study in terms of selection of patients and assessments used i.e.:-

1. All patients admitted to the Stroke Unit were assessed on the Stroke Unit by the ward OT, for perceptual ability using the full RPAB and for ADL ability using the Barthel ADL index (Mahoney and Barthel, 1965) using the scoring by Collin et al, (Collin et al, 1988) and Edmans ADL index (Edmans and Webster, 1997), within two weeks of admission to the Stroke Unit. The standard administration and scoring procedures were used for each assessment. Both the perceptual and ADL assessments took approximately one hour to complete and were completed over 2 consecutive days. Details of these assessments were shown in tables 2 - 4. The ward Physiotherapist assessed all patients on the Rivermead Motor Assessment (RMA) - Gross Function scale (Lincoln and Leadbitter, 1979), on admission to the Stroke Unit. This was a different Physiotherapist to the original treatment groups study but the same assessments were used as in the original study.

2. Perceptual problems were identified on the basis of having a score which was two standard deviations or more below the mean on four or more subtests of the RPAB. This criterion was based on that in the manual, but a slightly higher level was used as these patients were older than those in the original RPAB validation. If perceptual problems were identified, an explanation was given to the patient about what these problems were and how they might affect the patient in everyday life. It was explained that this study was being carried out to investigate the treatment of these problems. The patients were asked if they were willing to participate and that it would involve being followed up six weeks later by a repeat assessment of their abilities.

3. Details for each patient, of every attendance for any OT treatment, were recorded in an OT register by the ward OT. The amount of time spent on each treatment was also recorded in this register, in terms of number of half hour units per treatment session.

4. OT treatment for functional abilities only was given to patients for the six week trial period i.e. they received general OT treatment but no perceptual treatment, At the end of the six weeks, the patients were reassessed on the RPAB, Barthel ADL index and Edmans ADL index by the ward OT. An independent assessor was not thought to required for this assessment as none of the patients were receiving any additional treatment. The patients were also reassessed on the RMA Gross Function scale by the Physiotherapist.

6.4 Additional assessments

To identify the effects of associated factors which may influence perceptual ability, as for the main study, the results of the following assessments, which were already routinely carried out by the Stroke Unit staff, were again collated by the ward OT.

6.4.1 Speech and Language Therapist

One Speech and Language Therapist assessed all the patients for dysphasia, dysarthria and articulatory dyspraxia, in a standardised way, using an assessment that was not published. This included ratings of auditory comprehension, expressive language, articulatory dyspraxia, reading comprehension and dysarthria. This was a different Speech and Language Therapist to the original treatment groups study but the same assessments were used as in the original study (see appendix 4).

6.4.2 Psychologist

The Psychologist from the original treatment groups study was unable to complete the psychological assessments for this study. Instead, the ward OT carried out the assessments but these were then scored by the Psychologist from the original treatment group study. The assessments included IQ level using the Shortened National Adult Reading Test (Nelson, 1982, Beardsall and Brayne, 1990), memory using the Wechsler Memory Scale - Revised (Wechsler, 1987), reasoning using Word Fluency from the Multilingual Aphasia Examination (Benton and Hamsher, 1989) and Cognitive Estimates (Shallice and Evans, 1978), limb dyspraxia using the apraxia test by Kertesz and Ferro (Kertesz and Ferro, 1984) and anxiety and depression using the Hospital Anxiety and Depression Scale (Zigmond and Snaith, 1983).

6.4.3 Physiotherapist

The Physiotherapists assessed motor function using the Rivermead Motor Assessment (RMA) (Lincoln and Leadbitter, 1979) and sensation using the Nottingham Sensory Assessment (Lincoln et al, 1991).

6.5 Statistical Analysis

As for the main study, the following statistical tests were used in this study:-

6.5.1 Parametric tests

- mean - average value of data
- standard deviation - average deviation of data from the mean, 95% of observations lie within the mean $\pm$ two standard deviations
- range - spread of data, minimum to maximum
- t-test - to compare the difference in interval data from two independent samples.
- analysis of covariance - statistical technique combining linear regression and analysis of variance, to adjust for the effect of one variable

6.5.2 Nonparametric tests

- median - value that is half way when data is in ranked order, i.e. 50th percentile. It is not influenced by extreme values and is useful when data is skewed and not a normal distribution
- interquartile range - range from 25th percentile to 75th percentile
- range - spread of data, minimum to maximum
- chi-squared test - to compare the difference between data from two independent samples, for nominal data.

- Mann-Whitney U test - to compare the difference between data from two independent samples, for ordinal data.
- Wilcoxon matched pairs signed ranks test - to compare the difference between paired data from one sample, for ordinal data, i.e. is one of the pair greater than the other of the pair?
- Spearman rank correlation coefficient - to examine the relationship between two variables, for ordinal data.

6.6 Results

6.6.1 Patients

The patients were identified from those admitted to the Nottingham Stroke Unit between June 1995 and January 1996. During this time 57 patients were admitted and 37 patients were excluded for the following reasons:- 29 had no perceptual problems identified on the RPAB, one was unable to be assessed due to poor eyesight, five were unable to be assessed as they either refused to be assessed, were confused / demented and two were transferred to other treatment units soon after admission to the Stroke Unit (one returned to Scotland and one transferred to a head injury unit). This left 20 suitable patients for this part of the study. This group of patients were classified as the "no treatment group". The selection of these patients took 8 months to complete.

6.6.2 Patient characteristics and impairments

The biographical characteristics and impairments of the patients in both the transfer of training and functional approach groups, classified as the "treatment groups", and the patients in the no treatment group are shown in table 21. Comparison of these characteristics and impairments between these two groups showed no significant difference using t-tests on age or days post stroke (t=-0.02, 0.92), or using chi-squared tests on sex, side of stroke, handedness, hand used to complete the RPAB, carer, IQ, dysphasia, dysarthria, articulatory dyspraxia, reasoning, memory, depression, anxiety, limb dyspraxia and sensation (chi-squared = 0.00-1.87).

6.6.3 Comparison of treatment and no treatment groups on length of stay and amount of OT received

Details of the length of stay on the stroke unit, number of OT attendences and amount of OT treatment received, in terms of number of half hour treatment units, for the treatment and no treatment groups are shown in table 22. Comparison of these details showed no significant difference between groups using a t-test on length of stay ($t=0.22$, $p>0.05$). However, there was a significant difference between groups using Mann-Whitney U tests on OT attendences ($U=489.5$, $p<0.01$) and OT treatment time ($U=536.0$, $p<0.05$) with the no treatment group receiving a higher number of OT attendences and a greater amount of OT treatment time.

Table 21

Biographical characteristics and impairments of treatment and no treatment group patients

		Treatment groups (n=80)	No treatment group (n=20)
Age in years	Mean	68.80	68.85
	Standard deviation	10.28	10.03
	Range	26 - 86	45 - 85
		t=-0.02 NS	ci (-5.13, 5.03)
Sex	Male	40	13
	Female	40	7
		chi squared =0.91	NS
Side of stroke	Left	45	11
	Right	35	9
		chi squared =0.00	NS
Days post stroke	Mean	34.41	30.95
	Standard deviation	14.05	18.57
	Range	14 - 84	11 - 99
		t=0.92 NS	ci (-4.00, 10.92)
Carer	With	51	13
	Without	29	7
		chi squared =0.00	NS
IQ	Above average	5	1
	Average	75	19
	Below average	0	0
		chi squared =0.00	NS
Handedness	Left	3	3
	Right	77	17
		chi squared =1.87	NS
Hand used for RPAB	Dominant	46	8
	Non-dominant	34	12
		chi squared = 0.16	NS
Dysphasia	Present	26	9
	Absent	54	11
		chi squared =0.62	NS
Dysarthria	Present	15	1
	Absent	65	19
		chi squared =1.34	NS

		Treatment groups (n=80)	No treatment group (n=20)
Articulatory dyspraxia	Present	11	4
	Absent	69	16
		chi squared =0.12	NS
Reasoning problems	Present	48	7
	Absent	18	7
		chi squared =1.82	NS
Memory problems	Present	63	11
	Absent	10	3
		chi squared =0.11	NS
Depression	Present	21	2
	Absent	45	12
		chi squared =0.98	NS
Anxiety	Present	23	2
	Absent	43	12
		chi squared =1.42	NS
Limb dyspraxia	Present	9	0
	Absent	64	15
		chi squared =0.94	NS
Sensory problems	Present	55	12
	Absent	16	7
		chi squared =0.95	NS

p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Some patients were unable to be assessed for reasoning, memory, depression, anxiety, limb dyspraxia or sensory problems due to speech and language difficulties i.e. dysphasia, dysarthria or articulatory dyspraxia.

Table 22

Comparison of treatment and no treatment groups on length of stay and amount of OT received

		Treatment groups (n=80)	No treatment group (n=20)
Length of stay (weeks)	Mean	9.23	9.00
	Standard deviation	4.15	4.33
	Range	1.8 - 23.0	2.2 - 15.4
		t=0.22 NS	ci (-1.84, 2.31)
OT attendences	Median	22.00	28.50
	Interquartile range	13.00 - 27.00	17.50 - 39.00
	Range	0 - 52	13 - 49
		M-W U=489.5 p<0.01	ci (-13.00, -2.00)
OT treatment time (half hour units)	Median	38.50	53.00
	Interquartile range	22.50 - 53.00	31.25 - 67.00
	Range	0 - 96	20 - 89
		M-W U=536.0 p<0.05	ci (-24.01, -2.00)

p = probability
NS = not significant, p > 0.05
ci = confidence interval

PAGE MISSING IN ORIGINAL

Table 23

Comparison of treatment and no treatment groups on perceptual total scores

		Treatment groups (n=80)	No treatment group (n=20)
RPAB			
Initial total score	Median	99.90	94.60
	Interquartile range	63.75 - 124.73	74.03 - 132.90
	Range	0.00 - 189.9	25.4 - 149.6
		M-W U = 783.5 NS	ci (-23.99, 17.70)
Final total score	Median	122.70	127.40
	Interquartile range	84.93 - 147.20	88.08 - 150.15
	Range	0.00 - 199.6	24.1 - 175.7
		M-W U = 779.0 NS	ci (-24.20, 18.90)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Table 24

Comparison of treatment and no treatment groups on functional total scores

		Treatment groups (n=80)	No treatment group (n=20)
BARTHEL ADL			
Initial total score	Median	9.00	8.00
	Interquartile range	7.00 -10.00	7.00 - 10.00
	Range	1 - 19	5 - 19
		M-W U = 758.5 NS	ci (-1.00, 2.00)
Final total score	Median	13.00	13.50
	Interquartile range	11.00 - 17.00	10.00 - 18.75
	Range	0 - 20	6 - 19
		M-W U = 727.0 NS	ci (-3.00, 1.00)
EDMANS ADL			
Initial total score	Median	29.00	25.50
	Interquartile range	22.00 - 34.00	20.25 - 31.50
	Range	8 - 62	12 - 59
		M-W U = 710.0 NS	ci (-3.00, 7.00)
Final total score	Median	44.00	45.00
	Interquartile range	35.25 - 57.75	37.00 - 67.00
	Range	0 - 77	22 - 76
		M-W U = 670.5 NS	ci (-13.00, 3.00)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

Table 25

Comparison of treatment and no treatment groups on gross function total scores

		Treatment groups (n=80)	No treatment group (n=20)
RMA GROSS FUNCTION			
Initial total score	Median	1.00	2.00
	Interquartile range	1.00 - 2.75	1.00 - 3.00
	Range	0 - 13	0 - 9
		M-W U = 648.0 NS	ci (-1.00, 0.00)
Final total score	Median	4.50	5.00
	Interquartile range	2.00 - 6.00	2.00 - 8.75
	Range	0 - 13	1 - 10
		M-W U = 731.0 NS	ci (-2.00, 1.00)

U = Mann-Whitney U test
p = probability
NS = not significant, $p > 0.05$
ci = confidence interval

These showed no significant difference between groups on either initial or final gross motor function scores.

6.6.7 Effect of amount of occupational therapy treatment received by treatment and no treatment groups

The results in table 22 showed that patients in the no treatment group received significantly more occupational therapy treatment than patients in the treatment groups. Therefore an analysis of covariance was calculated to adjust for the effect of the amount of occupational therapy treatment received by patients. An analysis of covariance is designed for use with parametric data, but there is no alternative available for use with non-parametric data. The results are shown in table 26. Analysis of these results showed that the amount of occupational therapy treatment received had a significant effect on ADL total scores ($p<0.05$), as assessed using either the Barthel ADL index or the Edmans ADL index. However, the amount of occupational therapy treatment received had no significant effect on the perceptual total score. The results indicated that the amount of occupational therapy treatment was not responsible for the lack of difference in perceptual total scores between patients in the no treatment and treatment groups. The results also indicated that the amount of occupational therapy treatment may be responsible for the lack of difference in ADL total scores between patients in the no treatment and treatment groups.

Table 26

Effect of amount of OT treatment received by no treatment group and treatment groups

Variable	degrees of freedom	f - statistic	significance
TOTAL2	1, 99	0.07	NS
ANOVA			
Covariate T6	1, 99	0.00	NS
ANCOVA	2, 99	0.04	NS
BTOTOT	1, 99	0.90	NS
ANOVA			
Covariate T6	1, 99	6.91	*
ANCOVA	2, 99	3.93	*
EDTOTOT	1, 99	1.70	NS
ANOVA			
Covariate T6	1, 99	5.78	*
ANCOVA	2, 99	3.78	*

ANOVA - analysis of variance
ANCOVA - analysis of covariance
TOTAL2 - final perceptual total score on RPAB
BTOTOT - final ADL total score on Barthel ADL index
EDTOTOT - final ADL total score on Edmans ADL index
T6 - amount of OT treatment time over 6 week trial period
NS - not significant, $p > 0.05$
p - probability
* - $p < 0.05$

6.6.8 Comparison of treatment and no treatment groups on individual RPAB subtests on both initial and final assessments

If a patient scored two standard deviations or more below the mean of the normal sample in the RPAB manual on individual RPAB subtests, a criterion score of 1 was given for that subtest.

Mann-Whitney U tests were calculated to compare the difference between treatment and no treatment groups on the proportion of patients in each group, scoring below their expected levels (criterion levels) on individual RPAB subtests, on the initial assessment. These showed there was no significant difference between groups on any of the RPAB subtests, with U values ranging from 601.5-790.5. Details are shown in table 27.

Comparison of the two groups on the individual RPAB subtests on the final assessment using Mann-Whitney U tests again showed no significant difference between groups on any of the RPAB subtests, with U values ranging from 582.5-786.0. Details are also shown in table 27.

Table 27

Comparison of treatment and no treatment groups on individual RPAB subtests on both initial and final assessments

	Initial assessment (n=100)		Final assessment (n=100)	
RPAB subtest	U	p	U	p
Picture Matching	644.5	NS	771.0	NS
Object Matching	752.0	NS	759.0	NS
Colour Matching	740.5	NS	718.0	NS
Size Recognition	760.0	NS	713.5	NS
Series	789.0	NS	765.5	NS
Animal Halves	790.5	NS	665.0	NS
Missing Article	785.5	NS	732.0	NS
Figure Ground	716.5	NS	786.0	NS
Sequencing Pictures	734.5	NS	783.0	NS
Body Image	778.5	NS	766.0	NS
R/L Copying Shapes	765.5	NS	699.0	NS
R/L Copying Words	747.5	NS	689.0	NS
3D copying	677.5	NS	769.0	NS
Cube Copying	601.5	NS	679.0	NS
Cancellation	781.0	NS	582.5	NS
Self Identification	692.5	NS	648.0	NS

U = Mann-Whitney U test p = probability NS = not significant, $p > 0.05$

6.6.9 Comparison of individual RPAB subtests between initial and final assessments for treatment and no treatment groups

The proportion of patients in the treatment and no treatment groups, scoring below their expected levels on individual RPAB subtests on initial and final assessments were compared using Wilcoxon Matched Pairs Signed Ranks tests. Details are shown in table 28.

The treatment group showed a significant improvement ($z=1.97-4.81$, $p<0.05-0.001$) between initial and final assessments on all subtests except Animal Halves ($z=1.32$, p = NS).

The no treatment group showed a significant improvement between initial and final assessments on Object Matching, Missing Article, Body Image, Right/Left Copying Shapes, 3D Copying, Cancellation and Self Identification ($z=2.02-2.68$, $p<0.05-0.01$), but no significant difference on any other subtests ($z=0.36-1.84$, p = NS),.

6.6.10 Comparison of perceptual and functional total scores between initial and final assessments for no treatment group

The perceptual and functional total scores were compared between initial and final assessments for the no treatment group (n=20). Wilcoxon Matched Pairs Signed Ranks tests were calculated between initial and final assessments for RPAB, Barthel ADL index, Edmans ADL index and gross motor function total scores. The RPAB total

Table 28

Comparison of individual RPAB subtests between initial and final assessments for treatment groups and no treatment group

	Treatment groups (n=80)		No treatment group (n=20)	
RPAB subtest	z	p	z	p
Picture Matching	2.82	**	0.37	NS
Object Matching	3.42	***	2.02	*
Colour Matching	3.27	**	1.69	NS
Size Recognition	2.52	*	0.36	NS
Series	3.25	**	1.84	NS
Animal Halves	1.32	NS	0.63	NS
Missing Article	1.97	*	2.02	*
Figure Ground	3.64	***	1.12	NS
Sequencing Pictures	3.26	**	1.51	NS
Body Image	4.23	***	2.13	*
R/L Copying Shapes	4.72	***	2.03	*
R/L Copying Words	4.81	***	1.79	NS
3D copying	2.12	*	2.50	*
Cube Copying	3.53	***	0.99	NS
Cancellation	3.31	***	2.68	**
Self Identification	2.55	*	2.20	*

z = Wilcoxon Matched Pairs Signed Ranks test
p = probability
NS = not significant, $p > 0.05$
* = $p < 0.05$
** = $p < 0.01$
*** = $p < 0.001$

scores showed a significant improvement over time (z=3.21, p<0.01) as did the Barthel ADL index total scores (z=3.76, p<0.001), Edmans ADL index (z=3.92, p<0.001) and gross motor function (z=3.52, p<0.001).

6.6.11 Comparison of changes in perceptual ability between treatment and no treatment groups

The number of patients whose criterion total score (i.e. the number of RPAB subtests in which the patient scored below their expected level) improved or did not improve over the six weeks was investigated.

This showed that 52 treatment group patients and 12 no treatment group patients (64%) improved whilst 28 treatment group patients and 8 no treatment group patients (36%) did not improve. There was no significant difference between treatment and no treatment groups as to how many improved or did not improve (chi-squared = 0.17, p = NS).

6.6.12 Relationship between perceptual total and functional total scores

To identify the relationship between perceptual and functional abilities, Spearman Rank Correlation Coefficients were calculated between the RPAB total scores and the Barthel ADL index and Edmans ADL index total scores on initial and final assessments for the no treatment group (n=20).

These indicated there was no significant relationship between perceptual and ADL abilities on either initial or final assessments. Details are shown in table 29.

As a result, the scores of each patient in the no treatment group, on perceptual total score and Barthel ADL index total score, on initial and final assessments, were plotted on scattergrams. Details are shown in figures 6 and 7.

These show there was little relationship between the perceptual and functional abilities for patients in this no treatment group.

Table 29

Correlation between perceptual and functional total scores for no treatment group

(n=20)

	rs	p
Initial assessment		
RPAB total score with Barthel ADL total score	0.24	NS
RPAB total score with Edmans ADL total score	0.21	NS
Final assessment		
RPAB total score with Barthel ADL total score	-0.03	NS
RPAB total score with Edmans ADL total score	-0.08	NS

rs = Spearman rank correlation coefficient
p = probability
NS = not significant, $p > 0.05$

Figure 6

Correlation between RPAB Total Score and Barthel Total Score on initial assessment

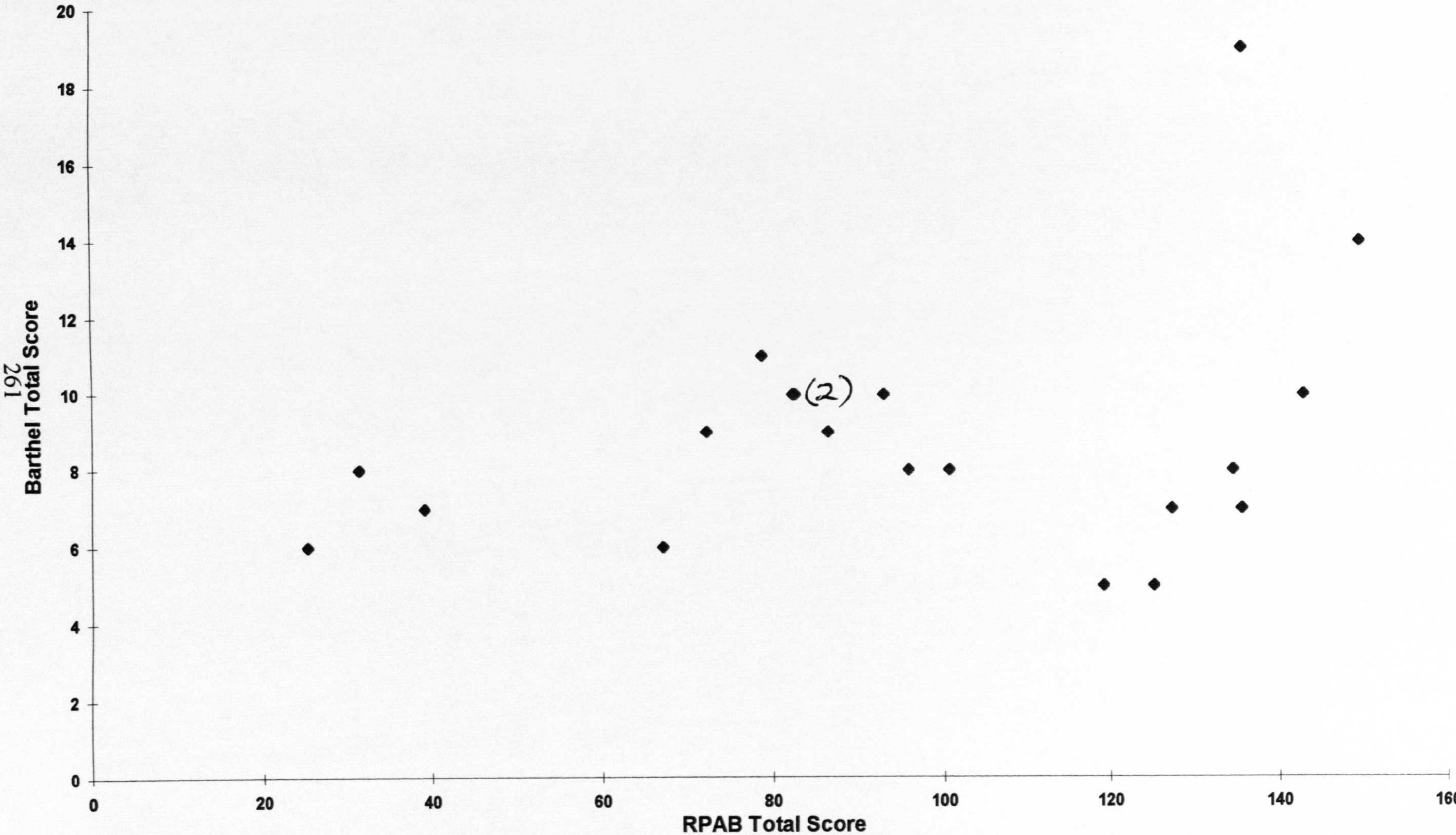
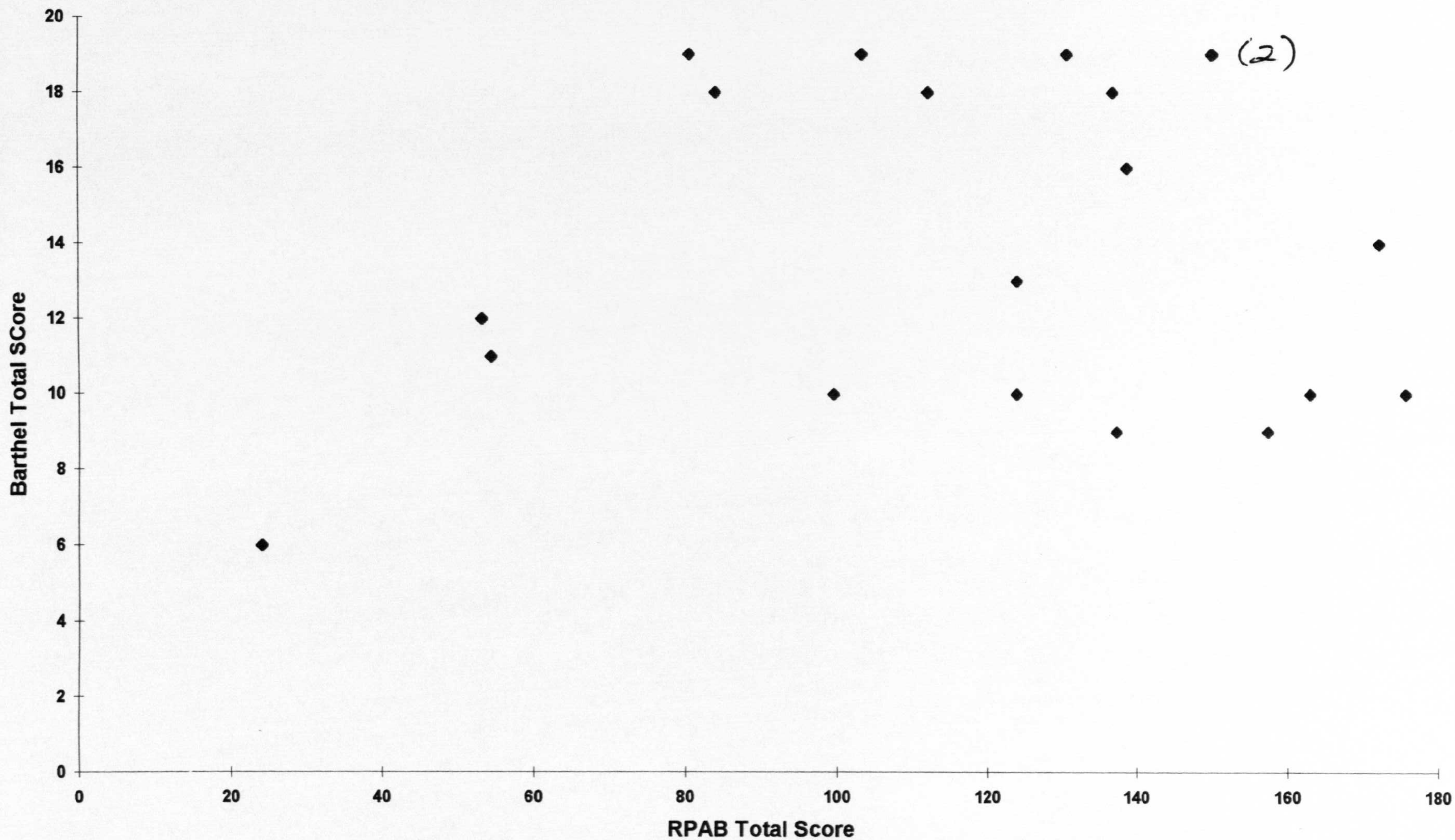


Figure 7

Correlation between RPAB Total Score and Barthel Total Score on final assessment



6.7 Discussion

One of the main limitations of the no treatment group study was that it was a comparison of retrospective information regarding the treatment groups (from the original study) and prospective information regarding the no treatment group. Reasons for and against the use of retrospective information are well reported by Drummond (1996). She explained that the one of the advantages for using retrospective information was that the information could be collected quickly as the information was already available. She suggested that retrospective information was likely to be unbiased as the data was not normally collected originally for the purposes of the later study. The disadvantages of using retrospective information included the fact that the information / records might be inaccurate or incomplete and the staff who completed the data initially may not still be available. If the original staff were available, difficulties could arise in expecting them to be able to remember the reasons for any missing data. It is also time consuming going through past records and these records may be lost or difficult to locate.

The advantage of using retrospective information in the no treatment group study, was that it was an inexpensive way to collect the information. The data for the treatment groups had already been collected in an unbiased way during the original study. There was no missing data from the treatment group study and the study methodology was the same for the treatment group study as for the no treatment group study. Also, the same staff collected the data for both studies. At the time, this was thought to be a reasonable strategy for comparing a no treatment group to the perceptual treatment groups in the original study.

The disadvantages of using retrospective information in the no treatment group study, were that changes had occurred in the environment and situation on the Nottingham Stroke Unit since the original study had been carried out. These changes included a change in policy regarding length of stay on the stroke unit, a change of physiotherapy staff and additional OT staff being employed causing differences in the amount of occupational therapy treatment received by patients. However, it should be noted that these changes were not anticipated at the time of planning this study. These changes will now be discussed in more detail.

In the time between the start of the treatment group study and the start of the no treatment group study, there was a gradual change in the National Health Service policy (NHS and Community Care Act, 1990; Health of the Nation white paper, 1992) regarding time patients spent in hospital. The change was towards discharging patients, who had been admitted to hospital, back into the community as soon as possible. This meant there was greater pressure on staff to reduce the length of stay and return patients to the community quicker, often before they had reached their best potential for recovery. The Nottingham Stroke Unit annual statistics (unpublished data) reflected this with a greater number of patients being treated on the stroke unit year by year and patients staying for shorter lengths of stay. For example, in 1992, 79 stroke patients were admitted to the Nottingham Stroke Unit with an average length of stay of 8.4 weeks on the Unit and in 1994, 97 stroke patients were admitted with an average length of stay of 6.7 weeks. The results were that by 1995, the stroke unit staff were generally applying a greater emphasis on a functional approach, rather than a neurodevelopmental approach, at an earlier stage than they had done in 1992 when the original study commenced.

The second major change between the time of the original study and the time that the no treatment group were studied, was a change of the Senior Physiotherapist. The new Senior Physiotherapist had completed her stroke rehabilitation training more recently than her predecessor. Although she used the same basic approach to stroke rehabilitation i.e. the Bobath approach (Bobath 1978), the more recent training included more functional aspects of stroke rehabilitation. During the no treatment group study, the Physiotherapists did not appear to be as strict in their administration of the Bobath approach as the previous Senior Physiotherapist and they appeared to adopt a more functional approach at an earlier stage with some patients. The result therefore, was a change of emphasis in the overall physiotherapy treatment on the stroke unit to a slightly more functional approach. This may have influenced the functional outcome of patients in the no treatment group study with these patients receiving more functional treatment during the six weeks of the trial.

The third major change between these two studies, was that a full-time OT assistant was employed on the Nottingham Stroke Unit when the no treatment group were being studied but not whilst the treatment groups were being studied. This OT assistant treated patients during activities such as washing and dressing, bathing and kitchenwork, often in group situations. She was able to spend most of her time in direct patient contact, enabling patients to be treated on a daily basis, whereas the qualified OTs had to spend some of their time in meetings (staff and patient orientated) and on other management duties. The effect of having this OT assistant was that the no treatment group received different amounts of OT attendences and OT treatment time than the treatment groups, with the no treatment group receiving more OT treatment. Therefore the functional improvement made by the no treatment group patients may be related to the amount of OT treatment they received or could possibly be due to the more daily treatment carried out by the OT assistant. This was shown to be true in the calculation of the analysis of covariance described in section 6.6.7, which demonstrated that the amount of OT received influenced the ADL total scores but not the perceptual total scores. These facts are supported by Drummond et al. (1996) who found that functional improvement was greater on the Nottingham Stroke Unit than on general medical wards and proposed that this was due to the OT policies and procedures on the stroke unit (as described in section 1.11).

Another possible change between the treatment and no treatment study was that the results from the treatment group study could have led to a general change in practice in the treatment of perceptual problems on the Nottingham Stroke Unit. For instance, staff of all disciplines may have made more use of the strategies that were used in the original study, within their own treatment.

A further limitation of this no treatment group study was that the patients were not randomised admissions to the Nottingham Stroke Unit, as the treatment groups had been. This was because the stroke unit evaluation study (Juby et al., 1996) had been completed by this time. Patients were therefore selected for admission to the stroke unit along similar lines to during the stroke unit evaluation study (as discussed in section 6.2) but there could have been a bias in the patient selection by the medical staff at this time. It may be that patients with more severe or more complex problems, requiring more specialist multi-disciplinary team intervention, were being referred and consequently admitted to the stroke unit. Due to the lack of randomisation to the stroke unit during the no treatment group study, there was no control as to whether a greater number of very severe or mild strokes were admitted to the stroke unit. Randomisation for the treatment group study prevented this from being a problem as there was a variety of all types of strokes admitted to both the stroke unit and general medical wards.

Generally, as has been shown, the no treatment group were not truly comparable to the original treatment group study population, due to the variances described on the Nottingham Stroke Unit in terms of changes in policies and staffing, and hence were not described as a control group.

There was no independent assessor for the no treatment group study which was another limitation when comparing the results with the treatment groups. This was due to practical reasons only as the original independent assessor had moved to work in a different department. However, as the inter-rater reliabilities between the ward OT and the independent assessor from the original treatment group study were high, it was not felt that this factor alone was responsible for the results. It is acknowledged though that bias could have affected these results. The assessor was aware of the objectives of this study and had completed the initial assessments also. However, she was unlikely to have remembered the initial assessment results and these results were not accessible again after completion. Also, if she was going to bias the results, then it would be likely to be in favour of intervention rather than showing no difference.

An unusual result in the study was that no significant correlation was found between perceptual and functional abilities for the no treatment group. The specific reason for this is unknown but it could be due to the sample size. The no treatment group appeared to be an atypical group of patients who showed evidence of perceptual problems on formal testing but these apparent problems did not affect the patients' functional abilities.

There may also have been insufficient numbers of patients to detect a difference between the treatment and no treatment groups, if a difference existed, as only 20 patients were included in the no treatment group.

The results from this second study showed that there was no significant difference between the treatment groups and the no treatment group on the amount of perceptual improvement that occurred over the six week trial period. This suggests that the improvement was not due to the effect of any specific perceptual treatment. The improvement could have been due to spontaneous recovery, as described in section 1.1.3. The patients were all early post stroke i.e. less than or equal to 14 weeks post stroke, which is the time when spontaneous recovery was most likely to occur. It could also be possible that spontaneous recovery was only partly responsible for the perceptual improvement, as suggested by Friedman and Leong (1992b), described in section 1.1.3. However, it would seem more likely that the improvement was due to the other effects of being treated on the Nottingham Stroke Unit, which supports the findings of Lincoln et al. (1997). This was also supported by Feigenson et al. (1977) who stated that it difficult to identify direct training effects from perceptual and cognitive retraining programmes from the indirect effects of co-ordinated patient care given by staff trained to recognise and treat perceptual and cognitive problems. Lincoln et al. (1985) and Hajek et al. (1993) similarly suggested that any benefits of perceptual training may be masked by the therapies received by patients on intensive rehabilitation / stroke units.

The Nottingham Stroke Unit philosophies, policies and procedures were all described in detail in section 1.11 but the pertinent factors which may affect outcome included-

- Having established philosophies, polices and procedures that were applied by all disciplines, 24 hours per day.
- Having blanket referral which allowed therapy to commence the moment the patient was admitted to the Stroke Unit.
- Having the multi-disciplinary team ward-based with all treatment being carried out on the ward and interdisciplinary working. All disciplines integrated and incorporated their knowledge and experience of each others' domains, within their own treatment. Members of the multidisciplinary were therefore readily accessible which facilitated improved communication and interaction between disciplines and facilitated multi-disciplinary treatment sessions.

- Nursing integration with the rehabilitation team. The improved nursing staff patient handling and education facilitated a different outlook on nursing care. Nurses were able to concentrate on rehabilitation and were more aware of the problems resulting from a stroke and the treatment of these problems.
- The availability of staff from disciplines such as the Speech and Language Therapist, Clinical Psychologist and Dietician.

However, these are perceived differences identified by the author from her own clinical experiences and have not been proven using research methodologies. There is little evidence to show whether the effectiveness of stroke units is due to the overall package of care or to individual components of care. It is most likely that the effectiveness is due to the overall package due to the large number of individual components which make up this package. It would be difficult to isolate any one or group of these components to identify their effectiveness. However, further investigation is still needed to try to identify which are the most important components that facilitate this effectiveness.

Overall, the lack of difference in improvement of perceptual and functional abilities between the treatment and no treatment groups was unexpected, particularly if these results were due to spontaneous recovery. Spontaneous recovery may have had more effect on perceptual recovery than was expected. If this is so, it may be more useful to only treat perceptual problems specifically, at a later stage after stroke. Alternatively, the correct perceptual stimulation throughout a 24 hour multi-disciplinary approach may have more influence on perceptual recovery that was initially envisaged and may account for the improvement seen in the no treatment group. If this is the case, it may be more useful to increase the training and knowledge of the recognition and awareness of perceptual problems and possible strategies for treatment, for all disciplines involved in treating stroke patients, on all wards. It may also be of more value to patients to reassess perceptual problems after discharge and treat any still evident on an out-patient basis. These areas all need further research and development.

6.8 Conclusions of the treatment groups and no treatment group study

The conclusions of the comparison of the treatment groups and no treatment group are as follows:

There was no significant difference between the treatment groups, including those following both the transfer of training or functional approach to perceptual treatment, and the no treatment group on patient characteristics or impairments.

Similarly, there was no significant difference between the treatment groups and the no treatment group on overall perceptual ability, overall functional ability, gross motor function ability or on scores on the individual RPAB subtests on the initial or final assessments.

There was a significant improvement on some individual RPAB subtests between the initial and final assessments, for patients in the treatment groups and the no treatment group. The particular RPAB subtests showing this improvement varied between the two groups, but this may have been an artefact of the small sample size..

There was a significant improvement between the initial and final assessments, for the no treatment group, on overall perceptual and overall functional abilities, including both activities of daily living and gross motor function.

There was no significant difference between the treatment groups and the no treatment group as to how many improved or did not improve on perceptual ability over time.

There was no significant correlation between the severity of perceptual and functional abilities on the initial or final assessments for the no treatment group.

CHAPTER SEVEN - GENERAL DISCUSSION

GENERAL DISCUSSION

There were some limitations of these two studies completed, all of which have been discussed in more detail in the appropriate discussion sections i.e. section 4 and section 6.7. These will now be summarised, along with the implications of the findings of the studies.

7.1 Numbers of patients

Firstly, there were probably insufficient numbers in each of the treatment groups, to reliably detect a difference between the treatment approaches, if one existed. The treatment groups study included 40 patients in each group and as discussed in section 4.1, 61 patients were actually required in each group. There were also therefore too few patients included in the no treatment group. A power calculation was not included for the no treatment study and the decision to include only 20 patients was made subjectively. As the no treatment group were not a satisfactory control group, the value of the results from this part of the study were of less relevance to the treatment group study. Future studies therefore should include a power calculation based on more accurate data, to identify the numbers of patients required to detect a difference if one exists and should include more patients than is thought necessary to allow for variations such as occurred in the treatment group study. The power calculation should identify the numbers of patients required for all groups, whether treatment groups or a control group, and these should be studies simultaneously rather than separately as in the studies described in this thesis.

7.2 Assessments

The assessments used in both studies to assess perceptual abilities may have been too global and not specific enough to detect small changes in perceptual ability. This was also suggested by Edmans and Lincoln (1989), Lincoln et al. (1989), Jesshope et al. (1991) and Donnelly et al (1998). One of the reasons for choosing the assessment used (i.e. the RPAB) to detect perceptual problems, was that it was commonly used in OT departments. The studies were intended to represent normal clinical practice in the UK but maybe more specific assessments need to be introduced to normal clinical practice rather than global assessments. For example future studies could use more specific standardised assessments such as the Behavioural Inattention Test (Wilson et al, 1987) or Balloons Test (Edgeworth et al., 1998) to assess unilateral neglect or the Visual Object and Space Perception Battery (Warrington and James, 1991) to assess spatial ability.

However, the assessments identified that some patients in the treatment groups did improve although some did not and yet the only significant differences between the treatment groups were:- side of stroke. handedness, hand used to complete the RPAB, dysphasia and limb dyspraxia. The patients who improved were more often right handed, left hemiplegic strokes without dysphasia or limb dyspraxia and used their dominant hand to complete the RPAB. More patients with right hemiplegia are likely to have dysphasia and limb dyspraxia, than left hemiplegic patients. It is important therefore when assessing patients for perceptual ability to consider the effects of dysphasia and limb dyspraxia. As discussed in section 4.2, it may be that patients with these impairments are unable to complete the perceptual tasks because of lack of understanding or due to praxis problems as suggested by Cramond et al. (1989) and Jesshope et al., (1991). If the results of the perceptual assessment only are considered, these patients may be classified as having perceptual problems when in fact they have dysphasia or limb dyspraxia. Further research is needed to identify the combined effects of these impairments on functional abilities and whether it is possible to assess them separately if they coexist.

Similarly, when analysing the results of the RPAB it is important to consider the effect of whether the patient used their dominant or non-dominant hand. The results in this study supported that of Cramond et al (1989) in that use of the dominant or non-dominant hand affects patients performance on the RPAB. This may be due to patients having poorer dexterity in their non-dominant hand resulting in them scoring below their expected levels on the RPAB because of lack of time. A further study is therefore needed to examine these affects in more detail. A cross-over design trial could be used with patients being assessed twice on the RPAB. Half the patients could complete their first RPAB assessment with the time restrictions as stated in the RPAB manual and having no time restrictions on their second RPAB assessment. The other half of the patients could complete their first RPAB assessment without time restrictions and their second RPAB assessment with time restrictions.

Another limitation of the treatment groups and no treatment group studies was that they did not include any assessment of upper limb function. This was because upper limb function was not expected to influence the impact of perceptual treatment. The effect of using the dominant or non-dominant hand when completing the RPAB has already been discussed in section 1.5.3 and section 4.2. However, the effect of using the dominant or non-dominant hand on ADL tasks was not investigated. As these current studies did not include any assessment of upper limb function, it was not known whether patients had regained any upper limb function after their stroke or not. It may be that if the patients' dominant upper limb is affected by the stroke, he / she may have more difficulties with functional tasks than patients whose non-dominant upper limb is affected.. If this was true, it would support the work of Cramond et al. (1989) regarding the effects of using the dominant or non-dominant hand when completing the RPAB. Patients may also find ADL tasks easier to complete if they have functional use in both upper limbs as the majority of ADL tasks are bilateral. Research is needed to investigate if there is any relationship between upper limb function and perceptual and / or functional abilities.

CT scans were not available for many patients in this study. Therefore it was not known if there was any correlation between amount of damage to different areas of the brain and the amount of improvement in perceptual and functional ability. This could be the basis for further research in the future.

7.3 Treatment

The treatment that was given in the treatment groups study was for multiple perceptual problems rather than specifically for one perceptual problem alone. This again had been done deliberately to represent normal clinical practice. However, the results support those of Edmans and Lincoln (1989, 1991). Towle et al. (1990) and Fanthome et al. (1995) who all produced negative results when treating multiple perceptual problems. Although the patients were treated for multiple perceptual problems, they were given treatment specific to the individual problems. However, a limitation of the treatment group study was that the effects of using either the transfer of training or functional approach on individual perceptual problems was not investigated. It may be that there was a difference between the transfer of training or functional approach on individual perceptual problems. As this had not been included in the original design of the study, it was not possible to investigate this retrospectively. Future studies should include randomised controlled trials to investigate the effects of using different treatment approaches with individual perceptual problems rather than multiple perceptual problems.

The treatment time given in the treatment groups study was also intended to represent the amount of treatment thought possible in a general clinical setting. A limitation was that this may not be sufficient to produce differences in perceptual improvement between the two treatment approaches, as was found in the Robertson et al. (1990) and Hajek et al. (1993) studies. During the treatment study, patients were treated for six weeks but maybe that time was not long enough to detect small differences between the two treatment approaches. Longer treatment intervals, i.e. longer than six weeks, may therefore be required to show any differences in improvements in perceptual ability. The treatment duration of six weeks was chosen as this length of time had been shown to be long enough to detect differences in previous studies

(Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985; Ladavas et al., 1994). Further randomised controlled trials are therefore required offering more intensive treatment over a similar period of time, or offering a similar amount of treatment over a longer period of time, to investigate the effect of the two treatment approaches, with individual perceptual problems, as described above.

Treatment following both approaches in the treatment study used similar strategies. As patients following either treatment approach showed improvement in perceptual abilities, this implies that it may be the use of these strategies that bring about the improvements rather than the actual treatment media. A future study could compare the treatment of perceptual problems using these strategies with no perceptual treatment.

Perceptual treatment was not found to be effective in this treatment study and yet previous studies had achieved more positive results (Robertson et al., 1988; Wagenaar et al., 1992; Robertson et al., 1992; Prada and Tallis, 1995; Diller et al, 1974; Weinberg et al., 1979 & 1982; Young et al., 1983; Gordon et al., 1985; Soderback and Normell, 1986; Ladavas et al., 1994; Webster et al, 1984; Gouvier et al., 1984). The implications are that the type of treatment regime used in these more positive studies could be responsible for this, as discussed in section 4.1, i.e. previous results implied that patients needed to be treated intensively for one perceptual problem alone and using specific perceptual assessments. The results from the current treatment study implied that this may be true as the current treatment did not comply with this type of treatment regime. Further randomised controlled trials are therefore still needed to identify if there is a difference between the transfer of training and functional approaches in treating perceptual problems, when a stricter treatment regime is followed.

7.4 Time post stroke

A major factor was that patients in both of these studies were all in-patients on the Nottingham Stroke Unit and only 11 to 99 days post stroke. At this stage patients were likely to be making some improvement spontaneously. Any spontaneous recovery may have masked any differences between the two treatment approaches and may have been responsible for the apparent improvement in the no treatment group. It is difficult to separate the effects of spontaneous recovery at this stage so it may be of value in future studies to consider treating patients later post stroke, when they are less likely to show such marked improvements in activities of daily living. Replicating this study with patients as out-patients, say for instance six months after stroke would eliminate most of the spontaneous recovery and also the effects of being on the Nottingham Stroke Unit. However, this would not answer the question of whether either of the two treatment approaches were more effective in treating perceptual problems early after stroke and further studies are still required to evaluate the effects of spontaneous recovery on perceptual abilities.

7.5 <u>Study location</u>

Another major factor was that the studies were carried out on a specialist stroke unit. The general effects of being on this stroke unit may have masked subtle differences in the improvement between the two treatment approaches as suggested by Feigenson et al. (1977), Lincoln et al. (1985), Hajek et al. (1993) and Lincoln et al. (1997). This may again have been responsible for the apparent improvement in the no treatment group, as discussed in section 6.7. Staff of all disciplines and grades on the Stroke Unit, had previously been taught about perceptual problems, their effects in everyday life for patients and strategies for treating such problems, consequently increasing their awareness of perceptual impairment. The results of the two studies suggested that this may have masked the effects, if any were present, of any additional perceptual treatment. This suggested increased perceptual awareness was not expected by the author when these treatment and no treatment studies were designed. Lincoln et al. (1997) also suggested that staff on the Nottingham Stroke Unit had a heightened perceptual awareness. The implications of this are that staff on all wards which treat stroke patients should be taught about perceptual problems, their identification and strategies for treating them. Staff of all disciplines could then incorporate perceptual treatment strategies into their own professional treatment. If further research studies proved this to be effective, this awareness could be cascaded to carers and volunteers also. Perceptual treatment is normally carried out on stroke units so evaluation is still needed on these units. The evaluation needs to take into account the effects of being on a specialist stroke unit, possibly by using a cross-over design study. An alternative would be to replicate this study on other wards where stroke patients have similar problems, but where the staff of all disciplines and grades have not been taught about perceptual problems, their implications and treatment strategies. Similarly, it may be of value to investigate the effect of gaining perceptual knowledge by comparing the improvement made by patients treated by staff with perceptual training and those treated by staff without perceptual training. This would therefore have to be completed on general wards rather than on the Stroke Unit.

7.6 Occupational Therapy

When comparing the treatment groups and no treatment groups, there was a significant difference in the number of occupational therapy attendances and amount of occupational therapy treatment time. The patients who improved had received more occupational therapy attendances and time. However, this could be that patients improved because they received more occupational therapy or it could be that those who did not improve had more severe problems, requiring more occupational therapy but did not receive it. It may be of value to study the effects of these comments in more depth e.g. starting with an audit of patients' occupational therapy requirements and comparing that with what they actually received. It would be very useful to clinicians to be able to identify in which patients perceptual improvement could be achieved, so they could allocate their available treatment time more effectively .

7.7 Cost evaluation

The treatment study showed no significant difference in the effects of treating perceptual problems using either the transfer of training or functional approaches. However, patients in this study did improve significantly between initial and final assessment on both perceptual and functional abilities. Patients in the no treatment group also improved significantly between initial and final assessment on both perceptual and functional abilities, suggesting that this improvement may not be due to the perceptual treatment following either of the two approaches used. The improvement may therefore have been due to spontaneous recovery or the 24 hour multi-disciplinary approach on the stroke unit. Perceptual treatment is time consuming and is therefore costly to the Health Service in terms of staff time. It is therefore important to identify what produces this improvement in perceptual and functional abilities, e.g. whether it is the perceptual treatment that is effective, whether it is spontaneous recovery or the effects of being on a unit where staff have a heightened awareness of perceptual problems and strategies to treat them. When this has been determined, a cost analysis would be needed. Considering the time shown to be required from the previous studies, discussed in section 1.9, that did show perceptual treatment to be effective, it would appear that each patient requires 40-60 minutes per day purely on perceptual training. This would be in addition to their other therapies including rehabilitation for such abilities as return of motor function and ADL. Therefore there would be cost implications to achieve this, as this is greater than that normally available to most stroke patients in hospital. If perceptual treatment is to be given it needs to be shown to be cost effective. It is also not known how long this treatment should continue for. Previous studies indicating the perceptual treatment is effective, treated patients for 4-7 weeks, which also would need to be included in a cost evaluation. The cost of staff time required to undertake full perceptual assessments could be reduced by using the shortened version B of the RPAB, as recommended by Matthey et al. (1993). This would give the occupational therapist the same amount of information about each patients' perceptual ability but would be less time consuming and also therefore less costly.

However, these costs need to be considered alongside the views and feelings of the patients and carers. The value to the patients and carers of perceptual problems being identified, being given an explanation of how these perceptual problems might affect their daily life and being offered treatment for these problems, cannot be costed in terms of money.

7.8 Control group

A final limitation of these two studies, was that a satisfactory control group were not investigated at the same time as the treatment groups were being studied, which caused difficulties in the comparison of perceptual treatment and no perceptual treatment effects.. At the time of designing the treatment group study, perceptual treatment was normally offered to patients on the Nottingham Stroke Unit. As there was no conclusive evidence as to whether perceptual treatment was effective or ineffective, it was therefore thought unethical to withdraw this type of treatment. A control group was not therefore studied alongside the treatment groups. When the results of the treatment group study showed no definite effect of perceptual treatment, a no treatment group was studied. Unfortunately there were various changes on the Nottingham Stroke Unit between these two studies, as discussed in section 6.7. This resulted in the no treatment group not really being comparable with the treatment groups. A repeat study would therefore need to be carried out on the Stroke Unit, in which either the transfer of training approach or functional approach is compared with controls, with random allocation to both groups.

Until there is further proven information on the value and effect of treating perceptual problems, it is important for clinicians to assess all stroke patients for perceptual ability and for other impairments such as dysphasia and limb dyspraxia. They should then explain any problems identified to the patient, the relatives and all staff concerned with that patient. Staff of all disciplines and grades should be taught about perceptual problems, their effect on everyday life for the patient and treatment strategies for these problems. This would help to achieve a 24 hour multi-disciplinary approach to perceptual awareness and treatment. The value of these latter three points would then all need further evaluation. Treatment of these perceptual problems should be related to functional ability as this is what is important to the patients. As it is still uncertain whether treating these problems can be effective, all patients should have perceptual treatment incorporated into their treatment programme and they should be part of a further randomised controlled study evaluating this treatment.

7.9 Nature of perceptual problems

These current studies have highlighted the complexity of the nature of perceptual problems, their assessment and their treatment. The assessment used in these studies to assess for perceptual problems (i.e. the RPAB) was chosen as it had similar categories to those described in the perceptual classification of Zoltan, Siev and Freishtat (Siev and Freishtat, 1976; Zoltan, Siev and Freishtat 1986) as described in section 1.3. However, as described in section 7.2, this assessment appeared to assess more global perceptual ability rather than specific perceptual problems as per the perceptual classification.

Another possibility is that maybe the classification used by Zoltan, Siev and Freishtat is not as clear cut as it sounds in their description and maybe there is more overlap of these problems than was first envisaged. If there is overlap of these perceptual problems, that makes diagnosis of the individual problems more difficult.

There are more assessments available now for OTs to use to assess individual perceptual problems as suggested in section 7.2, but this would be more time consuming to complete all these individual assessments. However, it may be more effective if OTs assessed and concentrated on treating individual perceptual problems following either the classifications by Benton (1984) or Zoltan, Siev and Freishtat (Siev and Freishtat, 1976; Zoltan, Siev and Freishtat 1986), rather than trying to treat all perceptual problems at once. This would result in the patients' treatment being more focused but this treatment again would then need evaluating in a randomised controlled trial.

The treatment group study found a significant correlation between perceptual ability and functional ability which supported the results of previous studies (Lorenze and Cancro, 1962; Tsai et al., 1982; Bernspang et al., 1982a; Andrews et al., 1980; Whiting et al., 1985; Edmans and Lincoln, 1990; Jesshope et al., 1991; Donnelly et al., 1998), and implied that the two abilities need to be considered together when planning patients treatment.

7.10 Rehabilitation theories

The expectation from the theories of the transfer of training and functional approaches, was that the patients following the transfer of training approach would improve more in perceptual abilities and that the patients following the functional approach would improve more in functional abilities. These two approaches, although both commonly used by OTs in the UK, had not been compared before in a randomised controlled trial. However the results did not show this clear cut difference in the treatment group study and patients in both groups, i.e. following either the transfer of training or functional approach, improved in both perceptual and functional abilities. As already discussed in section 4.3, this implied that maybe the treatment following these two approaches was ineffective with only 2.5 hours per week treatment, over a six week period. Alternatively, the improvement may have been related to spontaneous recovery or other aspects of treatment on the stroke unit.

The neurodevelopmental approach was generally used to improve physical impairments following stroke, by staff of all disciplines on the stroke unit, as discussed in section 4.3. This resulted in their being an overlap of treatment approaches being used with each patient, i.e. they either received a combination of neurodevelopmental and transfer of training approaches or a combination of neurodevelopmental and functional approaches. The neurodevelopmental approach encompasses many aspects of rehabilitation and requires evaluation of its effectiveness. Future studies could also ensure that treatment followed only one approach at a time, to enable the effectiveness of each approach to be evaluated separately

Patients following the transfer of training approach also received treatment for personal and instrumental ADL and all patients received physiotherapy following the neuroevelopmental approach. It was therefore difficult to eliminate the effect of other approaches. Future studies could use cross-over design trials to counteract this.

Many previous studies have investigated the effectiveness of the transfer of training approach (Robertson et al., 1988; Wagenaar et al., 1982; Robertson et al., 1992; Prada and Tallis, 1995; Edmans and Lincoln, 1989; Edmans and Lincoln, 1991; Towle et al., 1990; Fanthome et al., 1995; Diller et al., 1974; Weinberg et al., 1979; Weinberg et al., 1982; Young et al., 1983; Gordon et al., 1985; Soderback and Normell, 1986; Ladavas et al., 1994; Robertson et al., 1990; Taylor et al., 1971; Lincoln et al., 1985; Hajek et al., 1993) but there has been very little investigation of the functional approach except by Webster et al. (1984) and Gouvier et al. (1984). More evaluation of the effectiveness of the functional approach is therefore needed.

Overall, the results of the two perceptual treatment studies have shown no conclusive evidence that perceptual treatment, following either the transfer of training or functional approaches, was effective in the treatment of perceptual problems after stroke. Spontaneous recovery or the general effects of being on the stroke unit may have been responsible for the improvement in perceptual abilities that did occur.

REFERENCES

REFERENCES

Abreu B., Duval M., Gerber D., Wood W. Occupational performance and the functional approach. AOTA Self Study Series: Cognitive Rehabilitation. The American Occupational Therapy Association Inc., 1994.

Abreu B.C., Toglia J.P. Cognitive rehabilitation: a model for occupational therapy. AJOT, 1987; 41: 439-448.

Adams G.F., Hurwitz L.J. Mental barriers to recovery from strokes. the Lancet, 1963; September 14: 533-537.

Adams M.J. Thinking skills curricula: Their promise and progress. Educational Psychologist, 1989; 24: 25-77.

Adams S.A. A study to test the scalability and reliability of the Rivermead Motor Assessment with acute stroke patients and the scalability with non-acute stroke patients over the age of 65. MSc in Rehabilitation Studies Dissertation, Southampton University, 1992.

Affolter F. Perceptual processes as prerequisites for complex human behaviour. Int. Rehab. Med., 1981; 3: 3-9.

Affolter F.D. Perception, interaction and language; Interaction of daily living: the root of development. Springer-Verlag Co., Berlin, 1987.

Aho K., Harmsen P., Hatano S., Marquardsen J., Smirnov V.E., Strasser T. Cerebrovascular disease in the community: Results of a WHO collaborative study. Bulletin of the World Health Organisation, 1980; 58 (1): 113-130.

Albert M.A. A simple test of visual neglect. Neurology, 1973; 23: 658-664.

Anderson E., Choy E. Parietal lobe syndromes in hemiplegia, a program for treatment. American Journal of Occupational Therapy, 1970; 24: 13-18.

Andrews K., Brocklehurst J.C., Richards B., Laycock P.J. The prognostic value of picture drawings by stroke patients. Rheumatology and Rehabilitation, 1980; 19: 180-188.

Andrews K., Brocklehurst J.C., Richards B., Laycock P. J. The recovery of the severely disabled stroke patient. Rheumatology and Rehabilitation, 1982; 21: 225-230.

Ashburn A., Lynch M. Disadvantages of the early use of wheelchairs in the treatment of hemiplegia. Clin Rehab, 1988; 2: 327-331.

Ayres A.J. Sensory integration and learning disorders. Western Psychological Services, Los Angeles, 1980.

Basmajian J.V., Gowland C.A., Finlayson A.J., Hall A.L., Swanson L.R., Stratford P.W., Trotter J.E., Brandstater M.E. Stroke treatment: comparison of integrated behavioural-physical therapy vs traditional physical therapy programs. Arch. Phys. Med. Rehab., 1987; Vol. 68: 267-272.

Baum C.M. The evolution of the U.S. health care system. In eds. The OT manager. American OT Association Inc., Maryland, U.S.A., 1992; 3-25.

Beardsall L., Brayne C. Estimation of verbal intelligence in an elderly community: A prediction analysis using a shortened NART. Brit J Clin Psychology, 1990; 29: 83-90.

Benjamin J. The Northwick Park ADL Index. British Journal of Occupational Therapy, 1976; 39 (12): 301-306.

Benton A. Visuoperceptive, visuospatial and visuoconstructive disorders. In Heilman K.M., Valenstein E. Eds Clinical Neuropsychology, Oxford University Press, London, 1984; 151-181.

Benton A.L., Hamsher K.de S. Multilingual Aphasia Examination. Test manual, AJA Associates, Iowa City, Iowa, 1989.

Bernspang B., Bergstrom K., Eriksson S., Konradsson W.L., Fugl-Meyer A.R. The impact of visual perceptual dysfunctions on ADL performance in stroke with hemiplegia. Presented at 8th International Congress World Federation of Occupational Therapists. Hamburg, 1982a; June 13-18: 442-445.

Bernspang B., Lindberg M., Fugl-Meyer A.R. Incidence and prevalence of visual perceptual dysfunction in stroke victims. Proceedings of the 8th International Congress World Federation of OTs, Hamburg, 1982b; June 13-18: 543-547.

Bernspang B., Viitanen M., Eriksson S. Impairments of perceptual and motor function. Their influence on self-care ability 4-6 years after stroke. In: (eds) Bernspang B. Consequences of stroke. Doctoral Thesis, 1987, Umea, Sweden.

Bisiach E., Luzattia C. Unilateral neglect of representational space. Cortex, 1978; 14: 129-133.

Blower P. The advantages of the early use of wheelchairs in the treatment of hemiplegia. Clin Rehab, 1988; 2: 323-325.

Bobath B. Adult hemiplegia: evaluation and treatment. William Heinneman Medical Books Ltd., London, 1978.

Bourke G.J, Daly L.E., McGilvray J. Interpretation and uses of medical statistics. Blackwell Scientific Publications, London, 1985; 313-314.

Bowen A., McKenna K., Tallis R.C. Reasons for variability in the reported rate of occurrence of unilateral spatial neglect after stroke. Stroke, 1999; 30: 1196-1202.

Burt M. Perceptual deficits in hemiplegia. American Journal of Nursing, 1970; 70: 1026-1029.

Campbell D.C., Oxbury J.M. Recovery from unilateral visuospatial neglect? Cortex, 1976; 12: 303-312.

Cao Y., D'Olhaberriague L., Vikingstad E.M., Levine S.R., Welch K.M.A. Pilot study of functional MRI to assess cerebral activation of motor function after poststroke hemiparesis. Stroke, 1998; 29: 112-122.

Chollet F., DiPiero V., Wise R.J.S., Brooks D.J., Dolan R.J., Frackowiak R.S.J. The functional anatomy of motor recovery after stroke in humans: a study with positron emission tomography. Ann Neurology, 1991; 29: 63-71.

Christiansen C. Occupational Therapy: intervention for life performance. In: Christiansen C., Baum C. (eds) Occupational Therapy: overcoming human performance deficits. Slack Inc., New Jersey, 1991.

Collin C., Wade D.T., Davis S., Home V. The Barthel ADL Index: a reliability study. International Disability Studies, 1988; Vol. 10, No. 2: 61-63.

Cramer S.C., Nelles G., Benson R.R., Kaplan J.D., Parker R.A., Kwong K.K., Kennedy D.N., Finklestein S.P., Rosen B.R. A functional MRI study of subjects recovered from hemiparetic stroke. Stroke, 1997; 28: 2518-2527.

Cramond H.J., Clark M.S., Smith D.S. The effect of using the dominant or nondominant hand on performance of the Rivermead Perceptual Assessment Battery. Clinical Rehab, 1989; 3: 215-221.

Davis E.S., Radomski M.V. Domain-specific training to reinstate habit sequences. Occupational Therapy Practice, 1989; 1 (1):79-88.

De Gangi G.A., Royeen C.B. Current practice among neurodevelopmental treatment association members. AJOT, 1994; 48 (9): 803-809.

Delis D.C., Robertson L.C., Balliet R. The breakdown and rehabilitation of visuospatial dysfunction in brain injured patients. Int. Rehabil. Med, 1983; 5: 132-138.

Denes G., Semenza C., Stoppa E., Lis A. Unilateral spatial neglect and recovery from hemiplegia. Brain, 1982; 105: 543-552.

Dennis M., Langhorne P. So stroke units save lives: where do we go from here. BMJ, 1994; Vol. 309, 12 Nov: 1273-1277.

De Renzi E., Spinnler H. The influence of verbal and non-verbal defects on visual memory tasks. Cortex, 1966; 2: 322-335.

DeSouza L.H. The effects of sensation and motivation on regaining movement control following stroke. Physiotherapy, 1983; Vol. 69, No. 7: 238-240.

Dickstein R., Hocherman S., Pillar T., Shaham R. Stroke rehabilitation: three exercise therapy approaches. Physical Therapy. 1986; Vol. 66, No. 8: 1233-1238.

Diller L., Ben-Yishay Y., Gerstman L.J., Goodkin R., Gordon W.A., Weinberg J. Studies in cognition and rehabilitation in hemiplegia. Rehabilitation Monograph No. 50, Institute of Rehabilitation Medicine, New York University Medical Center, New York, 1974.

Diller L., Gordon W. Interventions for cognitive deficits in brain-injured adults. Journal Consult Clin Psychol, 1981; 49 (6): 822-834.

Diller L., Weinberg J. Hemi-inattention in rehabilitation: The evolution of a rational remediation program. Advances in Neurology, 1977; 18: 63-82.

Donnelly S.M., Hextell D., Matthey S. The Rivermead Perceptual Assessment Battery: its relationship to selected functional activities. BJOT, 1998; 61 (1): 27-32.

Drummond A. Research methods for therapists. Chapman and Hall, London, 1996.

Drummond A.E.R., Miller N., Colquohoun M., Logan P.C. The effects of a stroke unit on activities of daily living. Clinical Rehabil, 1996; 10: 12-22.

Eakin P. Problems with assessments of activities of daily living. British Journal of Occupational Therapy, 1989; 52 (2): 50-54.

Ebrahim S., Barer D., Nouri F. Affective illness after stroke. British Journal of Psychiatry, 1987; 151: 52-56.

Ebrahim S., Noun F.M., Barer D. Measuring disability after a stroke. Journal of Epidemiology and Community Health, 1985a; 39: 86-89.

Ebrahim S., Nouri F.M., Barer D. Cognitive impairment after stroke. Age & Ageing, 1985b; 14: 345-350.

Edgeworth J., Robertson I., McMillan T. The Balloons Test. Thames Valley Test Company, Bury St. Edmunds, 1998.

Edmans J.A., Lincoln N.B. The frequency of perceptual deficits after stroke. Clinical Rehabilitation, 1987; Vol.1, No.4: 273-281.

Edmans J.A., Lincoln N.B. The relation between perceptual deficits after stroke and independence in ADL. Bri J Occ Ther, 1990; April: 139-142.

Edmans J.A., Lincoln N.B. Treatment of visual perceptual deficits after stroke: four single case studies. Int Disabil. Studies, 1989; Vol.2: 25-33.

Edmans J.A., Lincoln N.B. Treatment of visual perceptual deficits after stroke: single case studies on four patients with right hemiplegia. Bri J Occ Ther, 1991; 54 (4): 139-144.

Edmans J.A., Towle D., Lincoln N.B. The recovery of perceptual problems after stroke and the impact on daily life. Clinical Rehab, 1991; 5: 301-309.

Edmans J.A., Webster J. The Edmans ADL index: validity and reliability. Disability and Rehabilitation, 1997; 19 (11): 465-476.

Ellis A.W., Young A.W. Human cognitive neuropsychology. Lawrence Erlbaum Associates, London, 1988.

Ernst E. A review of stroke rehabilitation and physiotherapy. Stroke, 1990; Vol. 21, No. 7: 1081-1085.

Fanthome Y., Lincoln N.B., Drummond A.E.R., Walker M.F., Edmans J.A. The treatment of visual neglect using the transfer of training approach. Bri J Occ Ther, 1995; 58 (1): 14-16.

Feeny D.M., Baron J.C. Diaschisis. Stroke, 1986; 17: 817-830.

Feigenson J.S., McCarthy M.L., Greenberg S.D., Feigenson W.D. Factors influencing outcome and length of stay in a Stroke Rehabilitation Unit. Stroke, 1977; Vol. 8 No 6: 657-663.

Fisher B., Yakura J. Movement analysis: a different perspective. Orthopaedic Physiotherapy Clinics of North America: The rehabilitation setting, 1993; 2 (1): 1-14.

Fleiss J.L. The measurement of inter-rater agreement. In: Statistical methods for rates and proportions. New York: John Wiley and Sons, 1981.

Folstein M.F., Folstein S.E., McHugh P.R. Mini-Mental State. A practical method for grading cognitive state of patients for the clinician. J Psychiatr Res, 1975: 12:189-194.

Foundas A.L., Macauley B.L., Rayner A.M., Maher L.M., Heilman K.M., Rothi L.J.G. Ecological implications of limb apraxia: evidence from mealtime behaviour. Journal of the International Neuropsychological Society, 1995; 1: 62-66.

Fowler F.G., Fowler H.W. The pocket Oxford Dictionary of current English. Oxford University Press, London, 1961.

Friedman P.J., Leong L. The Rivermead Perceptual Assessment Battery in acute stroke. British Journal of Occupational Therapy, 1992a; 55 (6): 233-237.

Friedman P.J., Leong L. Perceptual impairment after stroke: improvements during the first three months. Disability and Rehabilitation, 1992b; Vol. 14, No. 3: 136-139.

Furlan M., Marchal G., Viader F., Derlon J.M., Baron J.C. Spontaneous neurological recovery after stroke and the fate of ischaemic penumbra. Ann Neurology, 1996; 40: 216-226.

Gainotti G. Les manifestations de negligence et d'inattention pour l'hemispace. Cortex, 1968; 4: 64-91.

Gainotti G., D'Erme P., Monteleone D., Silveri M.C. Mechanisms of unilateral spatial neglect in relation to laterality of cerebral lesions. Brain, 1986; 109: 599-612.

Garraway W.M., Akhtar A.J., Hockey L., Prescott R.J. Management of acute stroke in the elderly - follow up of a controlled trial. BMJ, 1980a; Vol. 281, 27 Sept: 827-829.

Garraway W.M., Akhtar A.J., Prescott R.J., Hockey L. Management of acute stroke in the elderly: preliminary results of a controlled trial. BMJ, 1980b; 12 April: 1040-1043.

Gordon W.A., Hibbard M., Egelko S., Diller L., Shavir M., Lieberman A., Raquarsson K. Perceptual remediation in patients with right brain damage. A comprehensive program. Arch. Phys. Med. Rehabil, 1985; vol. 66, June: 353-359.

Gouvier W.D., Cottan G., Webster J.S., Beissel G.F., Wofford J.D. Behavioural interventions with stroke patients for improving wheelchair navigation. International Journal of Clinical Neuropsychology, 1984; Vol.VI, 3: 186-190.

Granger C.V., Albrecht G.L., Hamilton B.B. Outcome of comprehensive medical rehabilitation: measurement by PULSES profile and Barthel index. Archives of Physical Medicine and Rehabilitation, 1979; 60: 145-154.

Granger C.V., Hamilton B.B., Sherwin F.S. Guide for the use of the uniform data set for medical rehabilitation. Uniform Data System for Medical Rehabilitation Project Office, Buffalo General Hospital, New York 14203, USA, 1986.

Gresham G.E. Stroke outcome research. Stroke, 1986; Vol. 17, No. 3: 358-360.

Grieve J. Neuropsychology for occupational therapists. Blackwell Science, London, 1993: p14.

Hajek V.E., Kates M.H., Donnelly R., McGree S. The effect of visuo spatial training in patients with right hemisphere stroke. Canadian Journal of Rehabilitation, 1993; 6 (3); 175-186.

Halligan P.W., Marshall J.C., Wade D.T. Visuospatial neglect: underlying factors and test sensitivity. The Lancet, 1989; Oct 14: 908-911.

Health of the Nation white paper, London, 1992.

Hecaen H., Assal G. A comparison of constructive deficits following right and left hemispheric lesions. Neuropsychologia, 1970; 8: 289-303.

Hecaen H., Penfield W., Bertrand C., Malmo R. The syndrome of apractognosis due to lesions of the minor cerebral hemisphere. Arch Neurol Psychiat, 1956; 75: 400-434.

Heilmann K.M., Valenstein E. Clinical neuropsychology, Oxford University Press, New York. 1979.

Holbrook M., Skilbeck C.E. An activities index for use with stroke patients. Age and Ageing, 1983; 12: 166-170.

Hughlings Jackson J. 1876. Reprinted in J. Taylor (ed) Selected writings of John Hughlings Jackson, Hodder and Stoughton, London, 1932.

Hunt S.M., McKenna S.P., McEven J. The Nottingham Health Profile users manual. Rev. ed. Manchester, Galen Research and Consultancy, 1991.

Indredavik B., Bakke F., Solberg R., Rokseth R., Haheim L., Holme I. Benefit of a stroke unit: A randomised controlled trial. Stroke, 1991; Vol. 22, No.8: 1026-1031.

Indredavik B., Bakke F., Slordahl S.A., Rokseth R., Haheim L.L. Stroke unit treatment improves long-term quality of life, a randomised controlled trial. Stroke, 1998; Vol 29:895-899.

Indredavik B., Slordahl S.A., Bakke F., Rokseth R., Haheim L.L. Stroke unit treatment. Long term effects. Stroke, 1997; Vol. 28, No. 10: 1861-1866.

Itzkovich M., Elazar B., Averbuch S. Loewenstein Occupational Therapy Cognitive Assessment, Maddok Inc, Pequannock, NJ, USA, 1993.

Jarus T. Motor learning and occupational therapy: the organisation of practice. AJOT, 1994; 48 (9): 810-816.

Jesshope H.J., Clark M.S., Smith D.S.. The Rivermead Perceptual Assessment Battery: its application to stroke patients and relationship with function. Clinical Rehab, 1991; 5: 115-122.

Juby L.C., Lincoln N.B., Berman P. The effect of a stroke rehabilitation unit on functional and psychological outcome: A randomised controlled trial. Cerebrovascular Diseases, 1996; 6: 106-110.

Kalra L, Dale P, Crome P. Improving stroke rehabilitation. Stroke, 1993; Vol. 24, No 10: 1462-1467.

Katz S., Ford A.B., Moskowitz R.W., Jackson B.A., Jaffe M.W. Studies of illness in the aged. The index of ADL: a standardised measure of biological and psychological function. Journal of American Medical Association, 1963; 185: 914-919.

Kertesz A., Ferro J.M. Lesion size and location in ideomotor apraxia. Brain, 1984; 107: 921-933.

Kings Fund Consensus Conference. Treatment of stroke. BMJ, 1988; 297: 128.

Kinsbourne M. Hemineglect and hemisphere rivalry. In: (eds) Weinstein E.A. and Friedland R.P. Advances in neurology, Raven Press, New York, 1977.

Kinsella G., Ford B. Acute recovery patterns in stroke patients. Med. Journal of Australia, 1980; Dec.13: 663-666.

Kinsella G., Ford B. Hemi inattention and the recovery patterns of stroke patients. Int. Rehabil. Med, 1985; 7: 102-106.

Kotila M., Nieni M.L., Laaksonen R. Four year prognosis of stroke patients with visuospatial inattention. Scand J Rehab Med, 1986; 18: 177-179.

Kotila M., Waltimo O., Niemi M.L., Laaksonen R., Lempinen M. The profile of recovery from stroke and factors influencing outcome. Stroke, 1984; Vol. 15 No 6: 1039-1044.

Kwakkel G., Wagenaar R.C., Twisk J.W.R., Lankhorst G.J., Koetsier J.C. Intensity of leg and arm training after primary middle cerebral artery stroke: a randomised trial. The Lancet, 1999; Vol. 354, July 17: 191-196.

Ladavas E., Menghini G., Umilka C. A rehabilitation study of hemispatial neglect. Cognitive Neuropsychology, 1994; 11 (1); 75-95.

Laidler P. Stroke rehabilitation structure and strategy. Chapman and Hall, London, 1994: p49.

Langhorne P. The stroke unit story. Stroke Matters, 1997; Ed. 1 No.2, July.

Langhorne P., Dennis M. Stroke Units: an evidence based approach. BMJ Books, London, 1998.

Langhorne P., Williams B. O., Gilchrist W., Howie K. Do stroke units save lives? The Lancet, 1993; Vol. 342 Aug 14: 395-398.

Lawson I.R. Visual-spatial neglect in lesions of the right cerebral hemisphere: a study in recovery. Neurology, 1962; 12: 23-33.

Lee R.G., Van Donkelaar P. Mechanisms underlying functional recovery following stroke. Can J. Neurol. Sci., 1995; 22: 257-263.

Levine D.N., Warach J.D., Benowitz L., Calvanio R. Left spatial neglect: Effects of lesion size and premorbid brain atrophy on severity and recovery following right cerebral infarction. Neurology, 1986; 36: 362-366.

Lezak M.D. Neuropsychological assessment. Oxford University Press, Oxford, 1995.

Lincoln N.B., Edmans J.A. A re-validation of the Rivermead ADL scale for elderly patients with stroke. Age and Ageing, 1990; 19: 19-24.

Lincoln N.B. The assessment and treatment of disorders of visual perception. Reviews in Clinical Gerontology, 1995; 5: 77-82.

Lincoln N.B. The recognition and treatment of visual perceptual disorders. Top Geriatric Rehabil, 1991; 7 (1): 25-34.

Lincoln N.B., Blackburn M. Ellis S., Jackson J., Edmans J.A., Nouri F.M., Walker M.F., Haworth H. An investigation of factors affecting progress of patients on a stroke unit. Journal of Neurology, Neurosurgery and Psychiatry, 1989; 52: 493-496.

Lincoln N.B., Clarke D. The performance of normal elderly people on the RPAB. Bri J Occ Ther, 1987; May: 156-157.

Lincoln N.B., Crow J.L., Jackson J.M., Waters G.R., Adams S.A., Hodgson P. The unreliability of sensory assessments. Clin Rehab, 1991; 5: 272-282.

Lincoln N.B., Edmans J.A. A shortened version of the RPAB? Clinical Rehabilitation, 1989; 3: 199-204.

Lincoln N.B., Leadbitter D. Assessment of motor function in stroke patients. Physiotherapy, 1979; Vol. 65, No. 2: 48-51.

Lincoln N.B., Whiting S. Cockburn J., Bhavnani G. An evaluation of perceptual retraining. Int. Rehabil. Med, 1985; 7: 99-101.

Lincoln N.B., Drummond A.E.R., Berman P. Perceptual impairment and its impact on rehabilitation outcome. Disability and Rehabilitation, 1997; 19 (6): 231-234.

Logigian M.K., Samuels M.A., Falconer J., Zagar R. Clinical exercise trial for stroke patients. Arch. Phys. Med. Rehab., 1983; Vol. 64, August: 364-367.

Lord J., Hall K. Neuromuscular reeducation versus traditional programs for stroke rehabilitation. Arch. Phys. Med. Rehab., 1986; Vol.67, February: 88-91.

Lorenze E.J, Canco R. Dysfunction in visual perception with hemiplegia: its relation to activities of daily living. Arch. Phys Med & Rehab, 1962; Oct: 514-517.

McCarthy R.A., Warrington E.K. Cognitive neuropsychology - a clinical introduction. Academic Press Inc., London, 1990.

Mahoney F.I., Barthel D.W. Functional evaluation: The Barthel Index. Maryland State Medical Journal, 1965; Feb: 61-63.

Matthey S., Donnelly S.M., Hextell D. The clinical usefulness of the Rivermead Perceptual Assessment Battery: statistical considerations. Bri J Occ Ther, 1993; 56(10): 365-370.

Miller E. Recovery and management of neuropsychological impairments. John Wiley and Sons, Chichester, 1984.

Miller N. Symposium on measurement: the assessment of limb dyspraxia. Clinical Rehabilitation, 1988; 2: 177-181.

Motomura N., Yamadori A., Mori E., Ogura J., Sakai T., Sawada T. Unilateral spatial neglect due to haemorrhage in the thalamic region. Acta Neurol Scand, 1986; 74: 190-194.

Neistadt M.E. A critical analysis of occupational therapy approaches for perceptual deficits in adults with brain injury. AJOT, 1990; 44 (4): 299-305.

Nelson H.E. The National Adult Reading Test (NART): Test manual, NFER - Nelson, Windsor, 1982.

Netz J., Lammers T., Homberg V. Reorganisation of motor output in the non-affected hemisphere after stroke. Brain, 1997; 120: 1579-1586.

NHS and Community Care Act, HMSO, London, 1990.

Nouri F.M., Lincoln N.B. An extended ADL scale for stroke patients. Clinical Rehabilitation, 1987; 1: 301-305.

Nudo R.J., Wise B.M., Fuentes S.I., Milleken G.W. Neural substrates for the effects of rehabilitation training on motor recovery after ischaemic infarct. Science, 1996; 272: 1791-1794.

Nunnally J.C. Psychometric theory. McGraw-Hill, London, 1967: 226.

Ottenbacher K.J., Jannell S. The results of clinical trials in stroke rehabilitation research. Arch Neurol, 1993; Vol. 50, Jan: 37-44.

Oxbury J.M., Campbell D.C., Oxbury S.M. Unilateral spatial neglect and impairments of spatial analysis and visual perception. Brain, 1974; 97, 551-564.

Pigott R., Brickett F. Visual neglect. American Journal of Nursing, 1966; 66: 101-105.

Prada G., Tallis R. Treatment of the neglect syndrome in stroke patients using a contingency electrical stimulator. Clinical Rehabilitation, 1995; 9: 304-313.

Riddoch M.J., Humphreys G.W. Cognitive neuropsychology and cognitive rehabilitation. Lawrence Erlbaum Associates, Hove, 1994, p137.

Robertson I.H,, Gray J.M., McKenzie S. Microcomputer based cognitive rehabilitation of visual neglect: three multiple-baseline single case studies. Brain Injury, 1988; 2: 151-163.

Robertson I.H., Gray J.M., Pentland B., Waite L.J. Microcomputer-based rehabilitation for unilateral left visual neglect: A randomized controlled trial. Arch Phys Med Rehabil, 1990; 71: 663-668.

Robertson I.H., North N.T., Geggie C. Spatiomotor cueing in unilateral left neglect: Three case studies of its therapeutic effects. Journal of Neurology, Neurosurgery and Psychiatry, 1992; 55: 799-805.

Robinson R.G., Kubos K., Starr L.B., Price T.R. A two year longitudinal study of post-stroke mood disorders: Findings during the initial evaluation. Stroke, 1983; 14: 736-741.

Robinson R.G., Starr L.B., Price T.R. A two year longitudinal study of mood disorders following stroke: prevalence and duration at six months follow up. British Journal of Psychiatry, 1984; 144: 256-262.

Rossi P.W., Kheyfets S., Reding M.J. Fresnel prisms improve visual perception in stroke patients with homonymous hemianopia or unilateral visual neglect. Neurology, 1990; 40: Oct, 1597-1599.

Sanguet J., Benton A.J., Hecaen H. Disturbances of the body scheme in relation to language impairment and hemispheric locus of lesion. J Neurol Neurosurg Psychiat, 1971; 34: 496-501.

Schoening H.A., Anderegg L., Bergstrom D., Fonda M., Steinke N., Ulrich P. Numerical scoring of self care status of patients. Archives of Physical Medicine and Rehabilitation, 1965; 46: 689-697.

Shallice T., Evans M.E. The involvement of the frontal lobes in cognitive estimation. Cortex, 1978; 14: 294-303.

Sheikh K., Smith D.S., Meade T.W., Goldenberg E., Brennan P.J., Kinsella G. Repeatability and validity of a modified ADL index of chronic disability. International Rehabilitation Medicine, 1979; Vol. 1, No 2: 51-58.

Shinar D., Gross C.R., Bronstein K.S. et al. Reliability of the ADL scale and its use in telephone interview. Archives of Physical Medicine and Rehabilitation, 1987; 68: 723-728.

Siev E., Freishtat B. Perceptual dysfunction in the adult stroke patient. Slack Inc., New Jersey, 1976.

Siegel S., Castellan N.J. Nonparametric statistics for the behavioural sciences. McGraw Hill Inc., 1988.

Sinyor D., Amato P., Kaloupek D.G., Becker R., Goldenberg M., Coopersmith H. Post-stroke depression: relationships to functional impairment, copying strategies and rehabilitation outcome. Stroke, 1986; Vol. 17 No 6: 1102-1107.

Skilbeck C.E., Wade D.T., Langton-Hewer R., Wood V.A. Recovery after stroke. Journal of Neurology, Neurosurgery and Psychiatry, 1983; 46: 5-8.

Smith L. Communicative activities of dysphasic adults: a survey. British Journal of Disorders of Communication, 1985; 20: 31-44.

Smith M.E. The Edinburgh Stroke rehabilitation study. British Journal of Occupational Therapy, 1979; 42 (6): 139-142.

Smith M.E., Garraway W.M., Smith D.L., Akhtar A.J. Therapy impact of functional outcome in a controlled trial of stroke rehabilitation. Arch. Phys. Med Rehabil, 1982; Vol 63, Jan: 21-24.

Söderback I., Normell L.A. Intellectual function training in adults with acquired brain damage. Evaluation. Scand. J. Rehab. Med, 1986; 18: 147-153.

Spencer C., Clark M., Smith D.S. A modification of the Northwick Park ADL Index (the Australian ADL Index). British Journal of Occupational Therapy, 1986; 49 (11): 350-353.

Steinberg B.A., Augustine J.R. Behavioural, anatomical and physiological aspects of recovery of motor function following stroke. Brain research reviews, 1997; 25: 125-132.

Stevens R.S., Ambler N.R., Warren M.D. A randomized controlled trial of a stroke rehabilitation ward. Age and Ageing, 1984; 13: 65-75.

Streiner D.L., Norman G.R. Health Measurement Scales, a practical guide to their development and use. Oxford Medical Publications 1995.

Stroke Units Trialists Collaboration. Collaborative systematic review of the randomised trials of organised in-patient (stroke unit) care after stroke. BMJ, 1997; Vol.314, 1151-1159.

Sufrin E.M. The physical rehabilitation of the brain injured elderly. In (eds) Edelstein B.A., Couture E.T. Behavioural assessment and rehabilitation of the traumatically brain damaged, Plenum, New York, 1984; 191-221.

Sunderland A., Wade D.T., Langton-Hewer R. The natural history of visual neglect after stroke. Int. Disabil. Studies, 1987; 9: 55-59.

Sundet K., Finset A., Reinvang I. Neuropsychological predictors in stroke rehabilitation. Journal of Clinical and Experimental Neuropsychology, 1988; 10: 363-379.

Taylor M.M. Controlled evaluation of percept-concept-motor training therapy after stroke resulting in left hemiplegia. Research grant RD-2215-M, sponsored by Rehabilitation Institute, Detroit, Sept, 1969.

Taylor M.M., Schaeffer J.N., Blumenthal F.S., Grisell J.L. Perceptual training in patients with left hemiplegia. Arch. Phys. Med. Rehabil, 1971; April: 163-169.

Testani-Dufour L., Marano Morrison C.A. Brain attack: correlative anatomy. Journal of Neuroscience Nursing, 1997; Vol. 29, No. 4: 213-223.

Thurlborn K.R., Carpenter P.A., Just M.A. Plasticity of language-related brain function during recovery from stroke. Stroke, 1999; 30: 749-754.

Toglia J.P. A dynamic interactional approach to cognitive rehabilitation. In: Katz N. (ed). Cognitive rehabilitation: models for intervention in occupational therapy. Andover Medical Publications, Boston, 1992.

Toglia J.P. Generalisation of treatment: a multicontext approach to cognitive perceptual impairment in adults with brain injury. AJOT, 1991; 45 (6): 505-516.

Towle D., Edmans J.A., Lincoln N.B. An evaluation of a group treatment programme for stroke patients with perceptual deficits. Int. J. Rehab Research, 1990; 13: 328-335.

Traversa R., Cicinelli P., Bassi A., Rossini P.M., Bernardi G. Mapping of motor cortical reorganisation after stroke. Stroke, 1997; 28: 110-117.

Trombly C. Anticipating the future: assessment of occupational function. AJOT, 1993; 47 (3): 253-257.

Tsai L.J., Howe T.H., Lieu I.N. Visuospatial deficits in stroke patients and their relationship to dressing performance. J Formosan Med Assoc, 1983; 82: 353-359.

Turton A. Mechanisms for recovery of hand and arm function after stroke: a review of evidence from studies using non-invasive techniques. British Journal of Occupational Therapy, 1998; 61 (8): 359-364.

Tyerman R., Tyerman A., Howard P., Hadfield C. Chessington Occupational Therapy Neurological Assessment Battery. Nottingham Rehab, Nottingham, 1986.

Van Ravensberg C.D., Tyldesley D.A., Rozendal R.H., Whiting H.T.A. Visual perception in hemiplegic patients. Arch Phys. Med. Rehab, 1984; vol. 65, June: 304-309.

Wade D.T. Measurement in neurological rehabilitation. New York: Oxford University Press, 1992; 72.

Wade D.T., Langton-Hewer R. Functional abilities after stroke: measurement, natural history and prognosis. J Neurol Neurosurg Psychiatry, 1987; 50: 177-182.

Wade D.T., Legh-Smith J., Hewer R.L. Social activities after stroke. International Rehabilitation Medicine, 1985; 7(4): 176-181.

Wade D.T., Skilbeck C., Langton-Hewer R. Selected cognitive losses after stroke. Int Disabil Studies, 1989; Vol. 2: 34-39.

Wagenaar R.C., Van Wieringen P.C.W., Netelenbos J.B., Meijer O.G., Kuik D.J. The transfer of scanning training effects in visual inattention after stroke: five single-case studies. Disability and Rehabilitation, 1992; 14 (1): 51-60.

Walker M.F., Lincoln N.B. Factors influencing dressing performance after stroke. J Neurol, Neurosurg and Psychiat, 1991; 54: 699-701.

Warrington E., James M. The Visual Object and Space Perception Battery. Thames Valley Test Company, Bury St. Edmunds, 1991.

Webster J.S. Jones S., Blanton P., Gross R.., Beissell G.F., Wofford J.D. Visual scanning training with stroke patients. Behaviour Therapy, 1984; 15: 129-143.

Wechsler D. The Wechsler Adult Intelligence Scale manual. The Psychological Corporation, New York, 1955.

Wechsler D. Wechsler Memory Scale Revised. Test manual, The Psychological Corporation, San Antonio, TX, 1987.

Weiller C., Chollet F., Friston K.J., Wise R.J.S., Frackowiak R.S.J. Functional reorganisation of the brain in recovery from striatocapsular infarction in man. Ann. Neurology, 1992; 32: 463-472.

Weiller C., Ramsay S.C., Wise R.J.S., Friston K.J., Frackowiak R.S.J. Individual patterns of functional reorganisation in the human cerebral cortex after capsular infarction. Ann. Neurology, 1993; 33: 181-189.

Weiller C. Recovery from motor stroke: human positron emission tomography studies. Cerebrovascular Disorders, 1995; 5: 282-291.

Weinberg J., Diller L., Gordan W.A., Gerstman L.J., Lieberman A., Lakin P., Hodges G., Ezrachi D. Training sensory awareness and spatial organisation in people with right brain damage. Arch. Phys. Med. Rehabil, 1979; Vol. 60, Nov: 491-496.

Weinberg J., Piasetsky E., Diller L., Gordan W.A. Treating perceptual organisation deficits in non neglecting RBD stroke patients. Journal of Clinical Neuropsychology, 1982; Vol.4, No.1: 59-75.

Weinstein E.A., Friedland R.P. Hemi-inattention and hemisphere specialisation: introduction and historical review. Advances in Neurology, 1977; 18: 1-31.

Whiting S., Lincoln N.B., Bhavnani G., Cockburn J. The Rivermead Perceptual Assessment Battery, NFER - Nelson, Windsor, 1985.

Whiting S.E., Lincoln N.B. An ADL assessment for stroke patients. British Journal of Occupational Therapy, 1980; 43 (2): 44-46.

Willanger R., Danielson U.T., Ankerhus J. Visual neglect in right sided apoplectic lesions. Acta Neurol Scandinav, 1981; 64: 327-336.

Wilson B.A., Cockburn J., Halligan P. The Behavioural Inattention Test. Thames Valley Test Company, Bury St. Edmunds, 1987.

Wolf S.L., Lecraw D.E., Barton L.A., Jann B.B. Forced use of hemiparetic upper extremities to reverse the effect of learned nonuse among chronic stroke and head-injured patients. Exper Neurology, 1989: 104: 125-132.

World Health Organisation. International classification of Impairments, Disabilities and Handicaps (ICIDH). Manual of classification, Geneva: WHO, 1980.

York C.D., Cermak S.A. Visual perception and praxia in adults after stroke. American Journal of Occupational Therapy, 1995; Vol. 49, No. 6: 543-550.

Young G.C., Collins D., Hren M. Effect of pairing scanning training with block design training in the remediation of perceptual problems in left hemiplegics. Journal of Clinical Neuropsychology, 1983; Vol.5, No.3: 201-212.

Zigmond A.S., Snaith R.P. The hospital anxiety and depression scale. Acta Psychiatr Scand, 1983; 67: 361-370.

Zoltan B. Vision, perception and cognition - a manual for the evaluation and treatment of the neurologically impaired adult. Slack Inc., New Jersey, 1996.

Zoltan B., Siev E., Freishtat B. The adult stroke patient: A manual for evaluation and treatment of perceptual and cognitive dysfunction. Slack Inc., New Jersey, 1986.

APPENDICES

APPENDIX 1

The validity and reliability testing of the Edmans ADL index

Introduction

The Edmans ADL index was designed and developed as described in section 1.7. Any new assessment then needs to be standardised by testing for its validity and reliability, if the results obtained are to be meaningful in comparing performance between patients and within individual patients over a short period of time, i.e. the assessment must be identical for each individual patient on each occasion.

Validity is determining whether a new measure is measuring what was intended. There are three main types of validity (Eakin, 1989; Streiner and Norman, 1995):-

a) Content
b) Criterion - concurrent or predictive
c) Construct - convergent or discriminant

a) Content validity - refers to the content of the assessment, i.e. does the measure have enough items selected to cover the domain of "activities of daily living" and does it include all the relevant aspects of this domain.

b) Criterion validity - this refers to an outside criterion or "gold standard", which has been widely used and accepted, with which the new measure should be correlated. Criterion validity can be divided into two types - concurrent or predictive

Concurrent criterion validity - is the correlation of a new measure and criterion measure, both given at the same time.

Predictive criterion validity - is when the criterion measure is not available until some time in the future, when the correlation can be made.

c) Construct validity - a construct can be thought of as a mini theory to explain the relationship among various behaviours or attitudes. In this study, the hypothetical construct is "activities of daily living", which is not a clearly measurable physical attribute and there is no accepted definition of what constitutes "activities of daily living". Construct validity can be divided into two types - convergent or discriminant.

Convergent construct validity - sees how closely the new measure is related to other variables and other measures of the same construct, to which it should be related.

Discriminant construct validity - is when the construct should correlate with related variables but not with dissimilar, unrelated variables.

As there is no recognised "gold standard" activities of daily living assessment to measure against, the content and convergent construct validity only were considered at this time.

Sensitivity is the ability of a measure to detect genuine changes in the patients' ability (Eakin, 1989). However, the more sensitive a test is to small changes in a patients' behaviour, the less reliable it becomes.

Reliability is determining whether the new measure is measuring something in a reproducible fashion. There are two main types of reliability (Eakin, 1989; Streiner and Norman, 1995):-

a) Internal consistency

b) Stability - inter-rater, intra-rater or test-retest

a) Internal consistency - refers to the level of correlation of the scores between all items of the measure, based on a single administration of the measure. Measures of internal consistency represent the average of the correlations among all the items in the measure, but do not take into account variations from day to day or between observers.

b) Stability - refers to the reproducibility of the measure in three ways - inter-rater, intra-rater or test-retest.

Inter-rater reliability - refers to the agreement of scoring between observers, which is not due to chance agreement.

Intra-rater reliability - refers to the agreement between observations made by the same rater on two different occasions.

Test-retest reliability - refers to the agreement between observations made on two occasions separated by some interval of time.

The inter-rater and test-retest reliability only were considered at this time.

Method used to establish the validity and reliability of the Edmans ADL index

Once the design of the Edmans ADL index was complete, the index was tested to ensure that it was valid and reliable.

Validity

Content validity was established by comparing the content of the Edmans ADL index with that of other published ADL assessments.

The Edmans ADL index was compared with the Barthel ADL index, as the Barthel ADL index is the most widely known and well used ADL assessment. However, there is no real "gold standard" available in terms of ADL assessments. If there was, there would be no need to develop another ADL assessment.

To assess the construct validity and sensitivity, 60 patients admitted consecutively to the Nottingham Stroke Unit were assessed by the Stroke Unit Occupational Therapists, on the Barthel ADL index and the Edmans ADL index. These indices were completed on admission to, and discharge from, the Stroke Unit, by the Occupational Therapist who was treating the patient, i.e. the same Occupational Therapist assessed each individual patient on admission and discharge. This was to ensure that any increase in score was due to an improvement rather than an inter-rater variation.

Criteria for admission to the Nottingham Stroke Unit at this time, were as follows:-

- no current medical problems requiring active intervention.
- no definite discharge date by four weeks post stroke.
- able to be transferred by maximum of two nurses.
- able to manage half hourly sessions of therapy at a time, without undue fatigue.
- able to do at least two of the following:- drink from a cup, eat independently, wash own face.
- able to toilet themselves independently prior to stroke.

Reliability

The Edmans ADL index was tested for inter-rater and test-retest reliability in the following ways:-

To assess the inter-rater reliability, another 20 patients who were in-patients on the Nottingham Stroke Unit, were assessed on the Edmans ADL. index. The patients were at varying stages of the rehabilitation and were assessed during treatment, independently and simultaneously, by two Occupational Therapists.

To assess the test-retest reliability, a further 20 patients who were one year post stroke were assessed on the Edmans ADL index by telephone interview to their partner / carer, by one Occupational Therapist, on two separate occasions, one month apart. The activities were observed by the partner / carer of the patient and the partner / carer was asked to describe the amount and type of assistance given to the patient for each item on the ADL index. The Occupational Therapist then scored. the ADL index according to the information given by the partner / carer. The patients were not interviewed themselves.

The patients were selected from 29 patients discharged consecutively from Nottingham Stroke Unit, one year prior to this study. Nine patients were excluded from the study for the following reasons:- three were in Rest Homes, one had recently suffered another stroke and was receiving full nursing care, one had moved away from the area, one did not speak or understand English, two were unable to be traced, and one died during the year since discharge.

One year post stroke was chosen as by then little change in ADL ability would be expected over a one month interval. The time interval of one month was chosen for practical reasons only. The telephone interview method was chosen as Shinar et al. (1987) showed this to be a valid method to assess patients on the Barthel ADL index and also for practical reasons.

Results of the validity and reliability testing of the Edmans ADL index

The Edmans ADL index is standardised because details of the level of assistance required, i.e. exactly what help the patient requires, are specified and written on the assessment form. It is therefore identical for each patient.

Validity

a) Content validity

A comparison of the activities included in the Edmans ADL index and other published ADL assessments was made by listing the subtests of each ADL assessment. These are shown in table 30. The activities in the table are listed according to the main headings in each assessment.

This shows that the Edmans ADL index, (assessment 1) includes activities that represent each of the sub-sections of indoor activities, excluding "toilet use". This section was excluded as it was felt that "toilet use" was a combination of being able to wash and dress the lower half, stand up and transfer. Overall therefore, the Edmans ADL index represents "activities of daily living" for indoor activities only.

Table 30 Comparison of activities included in ADL assessments

ADL activities	ADL assessments												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Bowels		*		*			*						
Bladder		*		*			*						
Continence						*			*	*	*		
Grooming		*		*					*	*	*		
Clean teeth	*							*		*	*		
Comb hair	*							*					
Make up / shave	*							*					
Hygiene					*								
Washing self										*	*		
Wash face / hands	*		*				*	*					
Wash trunk	*						*						
Wash lower half	*						*						
Overall wash								*					
Bathing / shower	*	*		*		*			*	*	*		
Wash in bath								*					
Get in / out bath			*	*				*					
Dressing		*	*		*	*		*	*	*	*		
Dress upper trunk	*			*			*						
Dress lower trunk	*			*			*						
Dress feet	*						*						
Undressing			*					*					
Feeding		*			*	*	*		*	*	*		*
Drinking	*		*					*					
Eating	*		*	*				*					
Swallowing	*												
Sit	*						*						
Stand	*						*						
Transfers	*	*		*		*							
Bed to chair			*	*				*	*	*	*		
On / off floor	*							*	*	*	*		
Toilet use		*	*	*		*	*	*	*	*	*		
Mobility / walking	*	*		*	*		*						
Indoor mobility			*					*	*	*	*		
Outdoor mobility								*	*	*	*		*
Uneven ground													*
Wheelchair				*			*						
Stairs	*	*		*			*						*
Ascending stairs									*	*	*		
Descending stairs									*	*	*		
Bed					*								
Into bed	*												
Out of bed	*												
Move in bed	*						*						
Rise and sit in bed							*						

ADL activities	ADL assessments 1	2	3	4	5	6	7	8	9	10	11	12	13
Control of environment					*								
Using taps									*	*	*		
Prepare tea									*	*	*		
Boiling water										*			
Make hot drink	*		*					*			*		*
Prepare snack	*							*					*
Prepare meal / cook	*				*			*	*				
Washing up													*
Drink to room													*
Light cleaning	*							*					*
Heavy cleaning	*							*					*
Bedmaking								*					
Wash small clothing	*							*					*
Wash full wash	*												*
Hang out washing								*					
Ironing	*							*					
Cope with money								*					*
In / out car								*					*
Cross road								*					*
Self to shops								*					
Public transport								*					*
Carry shopping								*					*
Go out socially													*
Read papers / books													*
Write letters													*
Use telephone													*
Manage garden													*
Drive car													*
Last 3 months:													
Prepare main meals												*	
Washing up												*	
Washing clothes												*	
Light housework												*	
Heavy housework												*	
Local shopping												*	
Social outings												*	
Walk outdoors												*	
Pursue hobby												*	
Drive car / use bus												*	
Last 6 months:													
Outings / car rides												*	
Gardening												*	
House/car maintenance												*	
Reading books												*	
Gainful work												*	
Associated problems	*												*

Key to assessments in table 30

1 - Edmans ADL index
2 - Barthel ADL index (1,2)
3 - Nottingham 10 point ADL scale (3)
4 - Functional Independence Measure (FIM) (4)
5 - Edinburgh stroke study (5)
6 - Katz ADL index (7)
7 - Kenny self-care assessment scale (8)
8 - Rivermead ADL assessment (9,10)
9 - Northwick Park ADL index (11)
10 - Australian ADL index (12)
11 - Sheikh et al, modified ADL index (13)
12 - Frenchay activities index (14,15)
13 - Extended ADL scale (16)

b) Convergent construct Validity

The 60 patients assessed by Occupational Therapists on the Barthel and Edmans ADL indices had a mean age of 68.92 years, ranging from 27 to 88 years with a standard deviation of 11.22 years. There were 36 male patients and 24 female patients, 38 had a left hemiplegic stroke and 22 had a right hemiplegic stroke.

i) Correlation between Barthel and Edmans total scores

Spearman rank correlation coefficients were calculated between the Barthel ADL index total score and the Edmans ADL index total score, on admission to and discharge from the Stroke Unit (n=60). These indicated a highly significant correlation between Barthel ADL index and Edmans ADL index total scores on admission and at discharge (Admission, rho = 0.93, $p<0.001$; discharge, rho = 0.94, $p<0.001$). This showed that the Barthel and Edmans ADL indices were measuring the same thing in terms of content and convergent construct validity.

However, the Barthel ADL index has a ceiling limit whereas the Edmans ADL index has a greater number of activities. To demonstrate this, the scores for each patient on Barthel ADL index total score and Edmans ADL index total score, on admission and discharge assessments, were plotted on scattergrams. Details are shown in figures 8 and 9.

Figure 8

Correlation between Barthel and Edmans ADL indices total scores on admission

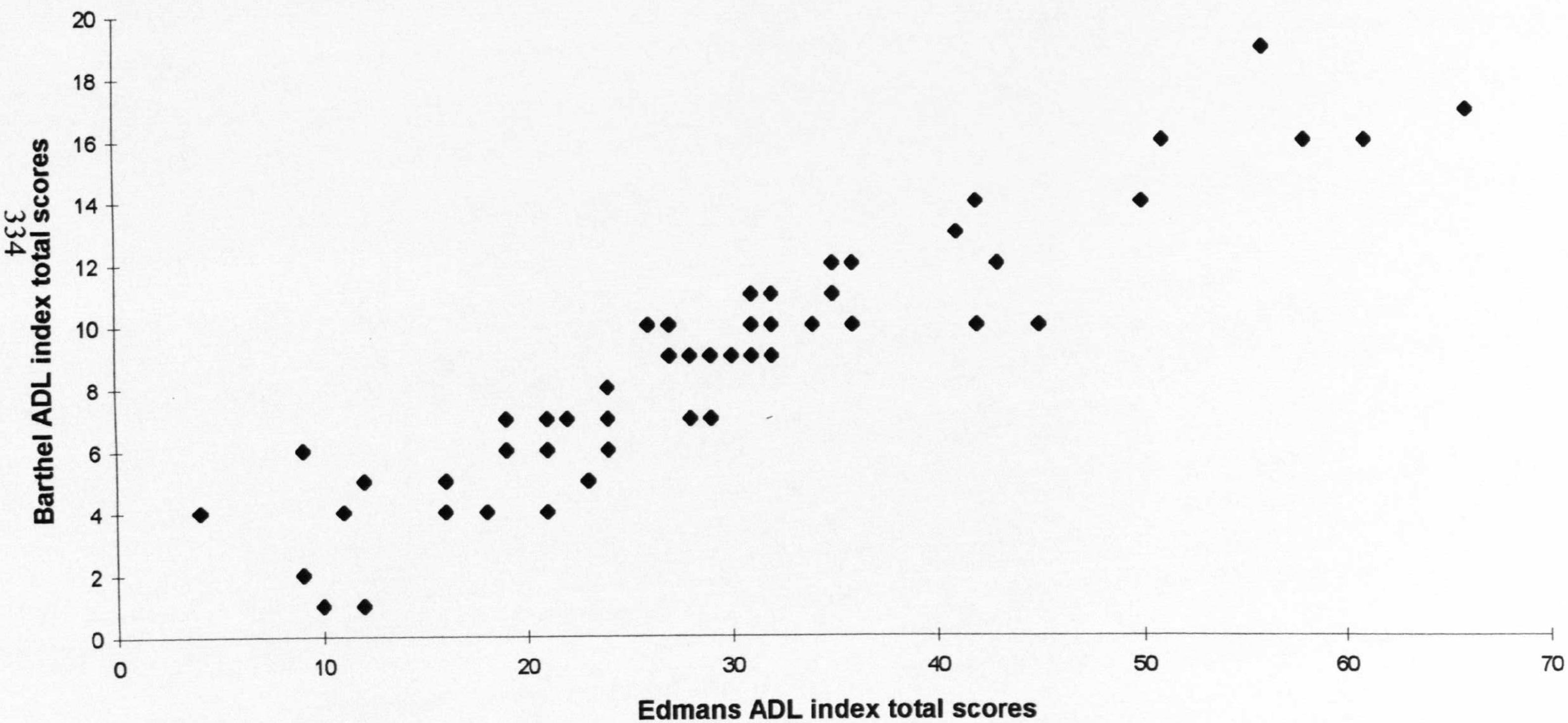
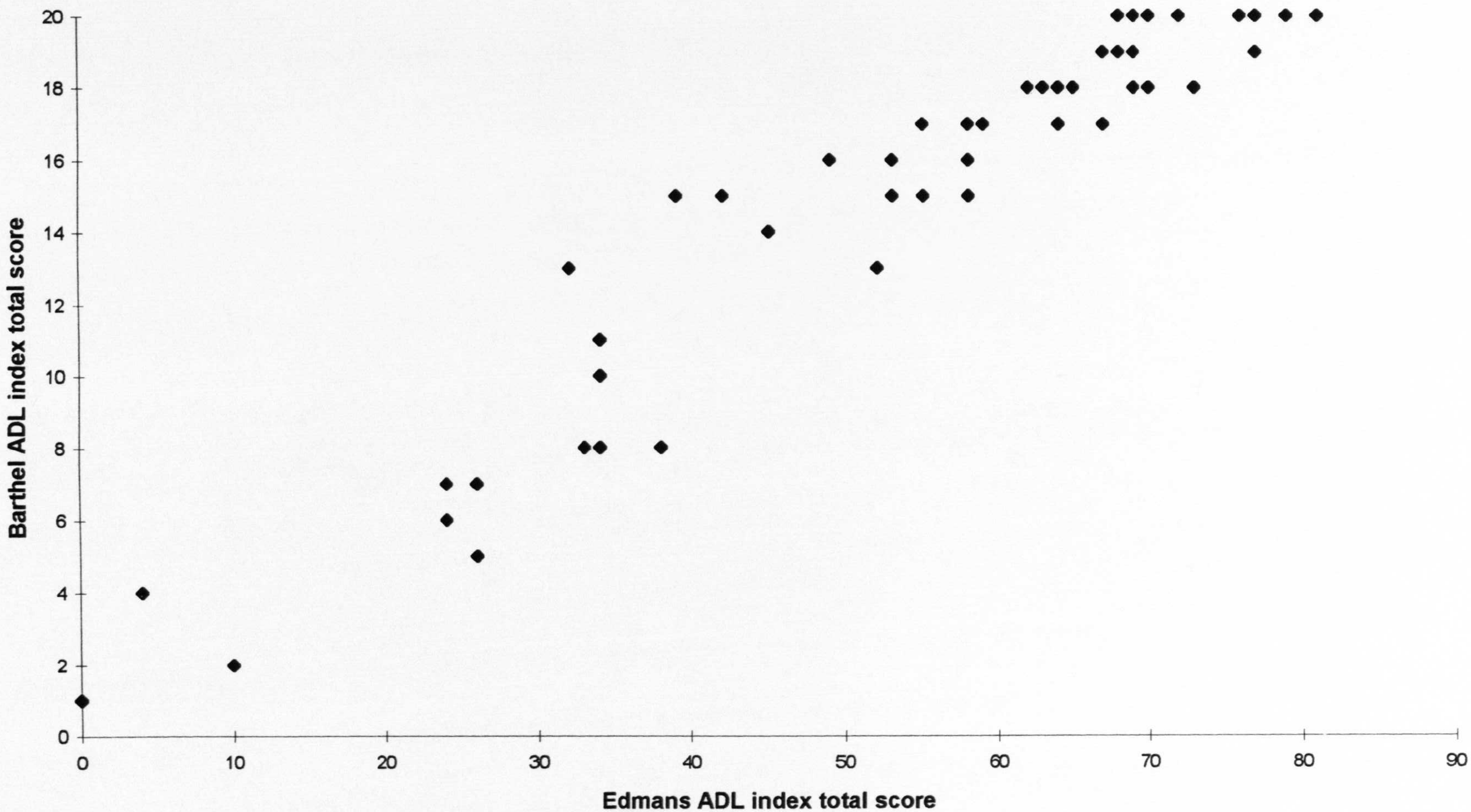


Figure 9

Correlation between Barthel and Edmans ADL indices total scores on discharge



ii) Association between Barthel and Edmans individual activities scores

The level of association between Barthel and Edmans ADL indices on individual activities was found by using chi-squared tests. Results are shown in table 31. These show a strong association between Barthel and Edmans ADL indices on all the activities listed.

Association was not calculated between some activities as they did not match sufficiently, i.e. Barthel "feeding" and Edmans "swallow" and "drink", and Barthel "transfer" and Edmans "sit".

c) Sensitivity to change over time

Wilcoxon matched pairs signed ranks tests were calculated between the admission and discharge sub-sections of the Barthel ADL index and the sub-section total scores of the Edmans ADL index (n=60). Results are shown in table 32.

These show a significant change from admission to discharge for all sub-sections of the Barthel ADL index and sub-section total scores of the Edmans ADL index, except "bowels" on the Barthel ADL index. These results indicate that the Barthel ADL index and Edmans ADL index are sensitive enough to detect changes in ability.

Table 31

Association between Barthel and Edmans ADL indices on individual activities

Activity		Admission		Discharge	
Barthel	Edmans	X	p	X	p
Groom	Hair	23.27	***	17.30	***
Groom	Teeth	31.80	***	31.30	***
Groom	Shave / make up	42.33	***	41.40	***
Feed	Eat	26.52	***	41.40	***
Transfer	Stand	43.37	***	37.46	***
Transfer	Transfer	50.69	***	55.18	***
Mobility	Walk	40.79	***	47.98	***
Dress *	Dress top	15.16	***	34.06	***
Dress	Dress lower	44.90	***	40.27	***
Dress	Dress shoes	27.72	***	33.50	***
Stairs	Stairs	n / c	n / c	51.07	***
Bath	Bath	n / c	n / c	42.27	***

X = Chi-squared tests

p = probability

*** = $p < 0.001$

* = Barthel "dressing" includes standing up but Edmans "dress top" does not

n / c = not calculable due to insufficient variation of distribution of scores

Table 32

Sensitivity of Barthel and Edmans ADL indices to change over time

Barthel sub-sections	z	p
Bowels	0.91	NS
Bladder	2.00	*
Groom	2.67	**
Toilet	5.91	***
Feeding	3.07	**
Transfer	5.84	***
Mobility	5.91	***
Dress	5.91	***
Stairs	5.65	***
Bath	3.52	***
Edmans sub-sections		
Washing	6.47	***
Grooming	2.96	**
Dressing	5.91	***
Meal times	3.34	***
Basic mobility	5.89	***
Advanced mobility	5.97	***
Bed mobility	5.84	***
Kitchen activities	5.58	***
Housework activities	4.01	***

z = Wilcoxon Matched Pairs Signed Ranks Tests

p = probability

** = $p < 0.01$

*** = $p < 0.001$

NS = not significant

The median change and interquartile ranges were calculated for the sub-sections of the Barthel ADL index and the sub-section total scores of the Edmans ADL index. These results are shown in table 33.

Reliability

a) Inter-rater reliability

The 20 patients assessed on the Edmans ADL index by two Occupational Therapists at the same time, had a mean age of 73.20 years, ranging from 46 to 87 years with a standard deviation of 9.23 years. There were 11 male patients and 9 female patients, 15 had a left hemiplegic stroke and 5 had a right hemiplegic stroke.

i) Agreement between observers on individual activities of the Edmans ADL index

The level of agreement between observers on individual activities of the Edmans ADL index was found by using a weighted Kappa coefficient of agreement, with a weighting of 1. Results are shown in table 34. Using the classification by Fleiss (1981), there was excellent agreement on 21/27 (78%) activities, good agreement on 5/27 (18%) activities and fair agreement on 1/27 (4%) activity.

Table 33

Median and interquartile ranges of sub- sections of Barthel and Edmans ADL indices

		Percentiles		
	Median	25	50	75
Barthel sub-sections				
Bowels	0.00	0.00	0.00	0.00
Bladder	0.00	0.00	0.00	0.00
Groom	0.00	0.00	0.00	0.00
Toilet	1.00	1.00	1.00	1.00
Feeding	0.00	0.00	0.00	0.00
Transfer	1.00	0.25	1.00	2.00
Mobility	2.00	1.00	2.00	3.00
Dress	1.00	1.00	1.00	1.00
Stairs	1.00	0.00	1.00	1.00
Bath	0.00	0.00	0.00	1.00
Edmans sub-sections				
Washing	3.00	2.00	3.00	4.00
Grooming	0.00	0.00	0.00	0.75
Dressing	4.00	1.00	4.00	6.00
Meal times	0.00	0.00	0.00	2.00
Basic mobility	3.50	0.25	3.50	5.00
Advanced mobility	5.00	1.00	5.00	8.00
Bed mobility	4.00	0.25	4.00	6.00
Kitchen activities	5.00	0.00	5.00	7.75
Housework activities	0.00	0.00	0.00	1.75

Table 34

Agreement between observers on individual activities of Edmans ADL index

Activity	Kappa coefficient	Level of agreement
Wash - top	0.90	excellent
Wash - lower	0.89	excellent
Wash - bath	0.90	excellent
Groom - hair	1.00	excellent
Groom - teeth	0.67	good
Groom - shave / make up	0.34	fair
Dress - top	1.00	excellent
Dress - lower	1.00	excellent
Dress - shoes	1.00	excellent
Feed - swallow	0.65	good
Feed - drink	0.64	good
Feed - eat	0.65	good
Mobility - sit	0.78	excellent
Mobility - stand	1.00	excellent
Mobility - transfer	1.00	excellent
Mobility - walk	1.00	excellent
Mobility - stairs	0.84	excellent
Mobility - floor	0.71	good
Bed - in	0.89	excellent
Bed - move	1.00	excellent
Bed - out	0.89	excellent
Kitchen - drink	0.80	excellent
Kitchen - snack	1.00	excellent
Kitchen - meal	1.00	excellent
Housework - clean	1.00	excellent
Housework - laundry	1.00	excellent
Housework - iron	1.00	excellent

b) Test-retest reliability

The 20 patients one year post stroke, who were assessed on the Edmans ADL index by telephone interview on two separate occasions one month apart, had a mean age of 68.95 years, ranging from 36 to 88 years with a standard deviation of 11.10 years. There were 12 male patients and 8 female patients, 14 had a left hemiplegic stroke and 6 had a right hemiplegic stroke.

i) Agreement over time on individual activities of the Edmans ADL index

The level of agreement over time on individual activities of the Edmans ADL index was found by using a weighted Kappa coefficient of agreement, with a weighting of 1. Results are shown in table 35. Using the classification by Fleiss (1981), there was excellent agreement on 17/27 (63%) activities, good agreement on 6/27 (22%) activities and fair agreement on 3/27 (11%) activities. Agreement could not be calculated for one activity (mobility - sit) (4%) as there was insufficient variation in the distribution of the scores.

Strengths and limitations of the Edmans ADL index

As explained in section 1.7, some of the existing standardised ADL assessments do not include a wide range of activities. Therefore, these assessments do not permit a fully comprehensive assessment of a person's ability to live independently at home.

Table 35

Agreement over time on individual activities of Edmans ADL index

Activity	Kappa coefficient	Level of agreement
Wash - top	0.64	good
Wash - lower	0.86	excellent
Wash - bath	0.88	excellent
Groom - hair	1.00	excellent
Groom - teeth	0.64	good
Groom - shave / make up	0.64	good
Dress - top	1.00	excellent
Dress - lower	0.75	excellent
Dress - shoes	0.86	excellent
Feed - swallow	1.00	excellent
Feed - drink	1.00	excellent
Feed - eat	0.86	excellent
Mobility - sit	n / c	n / c
Mobility - stand	1.00	excellent
Mobility - transfer	1.00	excellent
Mobility - walk	1.00	excellent
Mobility - stairs	0.54	fair
Mobility - floor	0.69	good
Bed - in	1.00	excellent
Bed - move	0.77	excellent
Bed - out	1.00	excellent
Kitchen - drink	1.00	excellent
Kitchen - snack	0.74	good
Kitchen - meal	0.92	excellent
Housework - clean	0.73	good
Housework - laundry	0.57	fair
Housework - iron	0.49	fair

n / c = not calculable due to insufficient variation of distribution of scores

Similarly, some assessments do not reflect the degree of dependence, because of the scoring procedure. These assessments, therefore, are unsuitable to monitor minor changes over time, to demonstrate a patients' progress or to detect changes in ability.

The Edmans ADL index, however, meets the requirements originally set, in that it includes the activities necessary to enable a person to live independently at home and includes the degree of dependence for each activity. It can be used to monitor progress, has evidence of validity and has so far only been used with stroke patients on the Nottingham Stroke Unit.

The activities in the Edmans ADL index were chosen as being representative of all the sub-sections in table 29, which are involved with indoor activities, whereas most of the indexes previously listed, omit one or more of the sub-sections.

"Toilet use", as a separate assessment activity, was intentionally excluded in the Edmans ADL index as it was felt that the ability to use the toilet was covered by a combination of being able to wash and dress the lower half, stand and transfer. It is debatable whether "toilet use" should be included as a separate assessment activity and is an area which could be considered for further investigation. "Continence", whether urinary or faecal, was also excluded as ADL assessments generally measure disabilities and continence is an impairment (Wade, 1992). "Continence" was therefore included in the list of associated problems instead. The Edmans ADL index has only 4 levels of scoring, which is little improvement on sensitivity, compared to many other ADL indices available. However, it has a greater range of activities, which together with the 4 scoring levels, makes it more useful in clinical practice.

The Edmans ADL index also has an additional sheet with a list of associated problems which may affect the patients' performance in ADL, such as language, perception, sensation, dyspraxia, reasoning, memory, depression, anxiety, urinary and faecal incontinence. The validity and reliability of this list have not yet been tested. Assessments for these problems were routinely carried out on the Nottingham Stroke Unit, by different disciplines, mainly using standardised procedures, i.e. Speech and Language Therapist assessed language and comprehension; Occupational Therapist assessed perception; Physiotherapist assessed sensation; Psychologist assessed dyspraxia, reasoning, memory, depression and anxiety; and nurses assessed urinary and faecal continence. This information was then collated by the Occupational Therapist and included with the Edmans ADL index form. Finally, it has a summary of scores sheet which could be included in the patients' medical notes.

It fulfils the requirements suggested by Eakin (1989), i.e. the assessment is representative, relevant and sensible, measuring what it is intended to measure and achieving its required purpose. It is valid and is sensitive enough to detect minor effects of treatment or change over time. Finally, the results of the ADL index are meaningful to others, can be communicated to others and is simple to use.

The Edmans ADL index is a summed index in that each sub-section has a total score of ability / disability. However, these scores are only summed for ease of displaying the results on a summary of scores sheet intended for use in the patient's medical notes. It is intended that only the scores for individual activities be used in clinical practice. This is because each activity has not been weighted according to the level of importance of each activity, which would be needed to achieve an accurate account when the scores are added together.

There was generally a strong association between the Barthel and Edmans ADL indices on individual activities, except for Barthel "dress" - Edmans "dress top". It should be noted however, that Barthel "dress" includes standing up but Edmans "dress top" does not and therefore these do not match accurately. The association for the stairs and bathing activities could not be calculated as there was insufficient variation in the distribution of the scores.

Problems were encountered when calculating test-retest reliability and these may have accounted for some of the differences in the scores on the two assessments. Some patients had conditions other than their stroke which were causing some physical deterioration. These included the following:-

- one patient was waiting for a total hip replacement and the condition of her hip was causing a deterioration in her mobility.
- one patient had painful knees due to arthritis, causing a deterioration in her mobility.

- one patient had a bad fall and another had a fit / blackout between the two assessments, causing physical deterioration.
- another patient had an eye operation between the two assessments which may have affected her ADL ability.

Generally there was good agreement over time on individual activities of the Edmans ADL. index, except for four activities, three of which had fair agreement only. Agreement over time could not be calculated for one activity, "mobility - sit", as there was insufficient variation in the distribution of the scores.

Obviously there are some limitations to the work completed so far on this ADL index. Firstly, the Edmans ADL index has only been used with patients on a Stroke Unit, where the admission criteria were as mentioned in the method section. This may affect the use of this index with stroke patients in different settings, e.g. in-patients on acute medical or health care of the elderly wards in hospital, patients in the community not admitted to hospital, or out-patients. Occasional difficulties could arise in scoring "dress lower" on the Edmans ADL. index as on the Nottingham Stroke Unit, patients are taught to stand to pull up clothes and other Units may teach patients to pull up clothes whilst lying on the bed. Although it is unlikely that the results would differ significantly, further work needs to be carried out, using this index in these other areas.

Secondly, although the results indicated that the Edmans ADL index is sensitive enough to detect changes in ability, a randomised control trial would be needed to identify if it is sensitive enough to detect the effects of treatment.

Thirdly, the inter-rater reliability was only calculated on the results of two Occupational Therapists, who were used to working together and used the same approach to treatment. For more flexibility, the inter-rater reliability needs assessing for other Occupational Therapists, e.g. those who have not been trained to work on the Nottingham Stroke Unit, those who work in different departments, with different populations, different hospitals or in different parts of the country. Similarly the inter-rater reliability need assessing between other disciplines, e.g. nurses and Physiotherapists, to ensure the reliability is maintained when the index is completed by other disciplines.

Finally, the test-retest reliability was assessed at one year post stroke. The time post stroke was chosen as little change in ADL ability would be expected after a year and over a one month interval. However, the reliability over longer intervals of time and at different times post stroke needs to be assessed in future studies. Similarly, the test-retest reliability needs further assessment, using direct observation of patients as the partner / carer may have answered the questions according to their expectations of the answers required.

Overall these results have shown that the Edmans ADL index has content and construct validity, is sensitive to change over time, is reliable for use with in-patient stroke patients and has inter-rater and test-retest reliability.

APPENDIX 2

Ethical approval letter

City Hospital

Medical Administration Dept.,
Hucknall Road,
Nottingham
NG5 1PB
Telephone
0602 691169
Ext: 45678
FAX: (0602) 627788
" Internal: 46788

Our Ref EC92/5
Your Ref:
Please ask for Dr. J.P. Curran

28th January 1992

Miss J.A. Edmans,
Senior Occuptional Therapist,
Stroke Unit,
Sherwood Wing

Dear Miss Edmans,

Comparison of the transfer of training and functional approaches in the treatment of perceptual problems in stroke patients

Thank you for your protocol which was considered at our recent meeting.

The Committee could see no ethical objection to your study. However, it was felt that although some patients may not be able to give written consent, there is no reason why verbal consent, after a simple explanation, should not be sought. On the understanding that you agree to our suggestion, approval is given to this study.

Yours sincerely,

JOHN P. CURRAN
Honorary Secretary
City Hospital Ethics Committee

Nottingham Health Authority SN651 M20

APPENDIX 3

Obtaining consent to participation in the study

If perceptual problems were identified on the RPAB, an explanation was given to each patient about what these problems were and how they might affect the patient in everyday life.

It was explained to the patient that a research project was being carried out, investigating the treatment of these problems. Explanation was given that there were two main approaches currently used by Occupational Therapists and that the research was to identify which approach was most effective in treating perceptual problems, as this was not known at that time.

The patient was asked if they were willing to participate and that it would involve being treated by an additional Occupational Therapist for some of their treatment, over the following six weeks, followed by a repeat assessment on the RPAB.

APPENDIX 4

Speech And Language Therapy Assessment

AUDITORY COMPREHENSION This should be based only on auditory input and exclude use made of situational understanding and additional help given by non-verbal cues.	
0	Unable to select common nouns from objects / pictures at a single word level.
1	Able to select common nouns and some verbs from objects / pictures at single word level - correct responses approximately 75%.
2	Following simple commands, short phrases or simple sentences containing two information carrying words - correct responses 75%.
3	Greater consistency than (2) at two information carrying word level and approximately 50% accuracy at 3-4 information word level.
4	Following sentences of 3-4 information carrying words, 75% accuracy and more complex sentences but may have specific semantic or syntactic difficulties. Following more abstract material and using reasoning skills and coping strategies but comprehension problems will still be apparent to Speech and Language Therapists although probably less so to family etc.
5	No obvious problems - can follow complex sentences, instructions, abstract material and improved reasoning skills. May only have specific minimal problems.

EXPRESSIVE LANGUAGE This rating should be based only on spoken output. Reference to non-verbal communication has been specifically excluded.	
0	No meaningful expressive language.
1	Some limited social speech e.g. hello, thanks, all right and very occasional appropriate naming.
2	More social speech and appropriate single word naming up to 50% of attempts.
3	Using short phrases and simple sentences. Conversation about familiar topics possible with significant help from listener.
4	Some obvious problems but without significantly limiting ideas expressed or form of expression.
5	Very minimal discernible expressive problems e.g. occasional word finding difficulties, loss of fluency etc.
Please add a brief comment about the presence, prevalence and severity of any of the following, if appropriate: perseveration, jargon, recurrent utterance, paraphrasic errors, limited syntactic structures, word finding difficulties, repetition (echoing back the speakers' utterance.	

ARTICULATORY DYSPRAXIA Only information on articulatory dyspraxia is required but comments on the presence of limb apraxia would be useful. Rate as "U" if impossible to judge at any stage.	
0	Unable to produce words / phonate. Obvious struggle.
1	Only able to produce limited range of phonemes and no recognisable words other than spontaneous automatic speech.
2	Able to produce some target words but still significant articulatory difficulty.
3	Able to produce phrases and short sentences with occasional phonemic errors, but much greater difficulty with polysyllabic words, clusters etc.
4	Occasional phonemic errors and / or "stiff" articulation.
5	No obvious problem or very minimal discernible articulatory dyspraxia.

READING COMPREHENSION	
0	Unable to match word to word.
1	Able to match some words to everyday objects or verbs.
2	Able to carry out simple written commands or complete simple sentences.
3	Able to understand short complex written commands or complete sentences.
4	Attempting complex paragraph type material but accuracy not more than 50%.
5	Able to understand complex paragraphs. Only discernible problem may be slower reading rate the pre-stroke.

DYSARTHRIA Based on intelligibility in general conversation in a quiet room. Percentage of words that are intelligible.	
0	Completely unintelligible or anarthric.
1	Occasional word only is intelligible.
2	Speech severely distorted but some words and phrases are intelligible - 25% of output. Frequent need for repetition, which may not be successful.
3	Speech is distorted but about 50% is intelligible. Often necessary to repeat.
4	Speech is intelligible at least 75%. there may be some articulation problems and / or some abnormality in respect of rate, volume, voice etc. which does not significantly influence intelligibility. Occasionally needs to repeat.
5	No obvious problems - occasional minimal loss of intelligibility on specific words or minimal problems with volume, rate etc.

APPENDIX 5

Inter-rater reliability of the RPAB between ward and research Occupational Therapists

Introduction

Inter-rater reliability is the agreement of scoring between observers, which is not due to chance agreement. This is needed in order to determine whether the results are reliable when an assessment is administered by different people. The RPAB manual provides information on the inter-rater reliability of the RPAB but only on the basis of three observers scoring the RPAB results from assessments on just six patients. These were six male stroke patients, aged between 21 and 70 years, with a wide range of perceptual problems. In clinical practice however, there is much debate over the subjective nature of the scoring of some of the RPAB subtests e.g. Right Left Copying Shapes, Right Left Copying Words, 3D Copying and Cube Copying. Some clinicians appear to score these subtests differently, with varying scores according to the accuracy of the shape and position etc.

In view of the fact that the initial RPAB assessments were carried out by either of two OTs, the ward OT or the research OT, the limitation of the original RPAB inter-rater reliability and the subjective nature of some of the RPAB subtests, it was decided to check the inter-rater reliability between the two OTs involved in this study.

Method

To test the inter-rater reliability between the ward Occupational Therapist and the research Occupational Therapist, 20 patients who were in-patients on the Nottingham Stroke Unit were assessed on the RPAB. The patients were randomly selected to include patients who were at varying stages of their rehabilitation. They were assessed independently and simultaneously by the ward Occupational Therapist and the research Occupational Therapist.

Results

The 20 patients assessed on the RPAB had a mean age of 68.85 years, ranging from 46 to 84 years, with a standard deviation of 9.30 years. There were 13 male patients and 7 female patients, 15 had a left hemiplegic stroke and 5 had a right hemiplegic stroke.

The level of agreement between observers on individual subtests of the RPAB was found by using a weighted Kappa coefficient of agreement, with a weighting of 1. A Kappa coefficient requires a sample of at least three times the number of categories in the subtest. This statistic was therefore only suitable for some subtests of the RPAB i.e. Picture Matching, Object Matching, Size Recognition, Series, Animal Halves, Missing Article, Figure Ground and Sequencing Pictures. Results are shown in table 36. Using the classification by Fleiss (1981), there was excellent agreement on all subtests (k=0.86-1.00).

Table 36

Agreement between ward and research Occupational Therapists on individual subtests of the RPAB

RPAB subtest	Kappa coefficient	Level of agreement
Picture Matching	1.00	excellent
Object Matching	1.00	excellent
Size Recognition	1.00	excellent
Series	1.00	excellent
Animal Halves	1.00	excellent
Missing Article	1.00	excellent
Figure Ground	1.00	excellent
Sequencing Pictures	0.86	excellent

Spearman rank correlation coefficients were calculated for the remaining RPAB subtests i.e. Colour Matching, Body Image, Right Left Copying Shapes, Right Left Copying Words, 3D Copying, Cube Copying, Cancellation and Self Identification. Results are shown in table 37. These showed a highly significant correlation between observers (rho = 0.96-1.00, p<0.001).

Discussion and conclusion

There was good inter-rater reliability between the ward Occupational Therapist and the research Occupational Therapist. This indicates that there was no difference in outcome, of the assessment of the patients abilities using the RPAB, according to the which OT carried out the RPAB assessment.. These results therefore support the results in the RPAB manual (Whiting et al., 1985) in that the RPAB measures perceptual ability in a reproducible fashion.

Table 37

Correlation between ward and research Occupational Therapists on individual subtests of the RPAB

RPAB subtest	rho	p
Colour Matching	1.00	***
Body Image	0.99	***
Right Left Copying Shapes	0.97	***
Right Left Copying Words	1.00	***
3D Copying	1.00	***
Cube Copying	1.00	***
Cancellation	1.00	***
Self Identification	0.96	***

rho = Spearman rank correlation coefficient

p = probability

*** = $p < 0.001$

APPENDIX 6

Inter-rater reliability of the RPAB between the ward Occupational Therapist and the independent assessor

Introduction

The limitation of the original RPAB inter-rater reliability and the subjective nature of some of the RPAB subtests were described in appendix 5. As a result, it was decided to also check the inter-rater reliability between the ward OT and the independent assessor involved in this study.

Method

To test the inter-rater reliability between the ward Occupational Therapist and the independent assessor, 20 patients who were in-patients on the Nottingham Stroke Unit were assessed on the RPAB. The patients were randomly selected to include patients who were at varying stages of their rehabilitation. They were assessed independently and simultaneously by the ward Occupational Therapist and the independent assessor.

Results

The 20 patients assessed on the RPAB had a mean age of 68.3 years, ranging from 45 to 86 years, with a standard deviation of 11.33 years. There were 10 male patients and 10 female patients, 13 had a left hemiplegic stroke and 7 had a right hemiplegic stroke.

The level of agreement between observers on individual subtests of the RPAB was found by using a weighted Kappa coefficient of agreement, with a weighting of 1. A Kappa coefficient requires a sample of at least three times the number of categories in the subtest. This statistic was therefore only suitable for some subtests of the RPAB i.e. Picture Matching, Object Matching, Size Recognition, Series, Animal Halves, Missing Article, Figure Ground and Sequencing Pictures. Results are shown in table 38. Using the classification by Fleiss (1981), there was excellent agreement on all subtests ($k=0.85-1.00$).

Spearman rank correlation coefficients were calculated for the remaining RPAB subtests i.e. Colour Matching, Body Image, Right Left Copying Shapes, Right Left Copying Words, 3D Copying, Cube Copying, Cancellation and Self Identification. Results are shown in table 39. These showed a highly significant correlation between observers ($rho = 0.84-1.00$, $p<0.001$).

Table 38

Agreement between ward Occupational Therapist and independent assessor on individual subtests of the RPAB

RPAB subtest	Kappa coefficient	Level of agreement
Picture Matching	0.85	excellent
Object Matching	1.00	excellent
Size Recognition	0.86	excellent
Series	1.00	excellent
Animal Halves	1.00	excellent
Missing Article	1.00	excellent
Figure Ground	0.93	excellent
Sequencing Pictures	0.93	excellent

Table 39

Correlation between ward Occupational Therapist and independent assessor on individual subtests of the RPAB

RPAB subtest	rho	p
Colour Matching	1.00	***
Body Image	0.97	***
Right Left Copying Shapes	0.92	***
Right Left Copying Words	0.98	***
3D Copying	0.94	***
Cube Copying	0.99	***
Cancellation	1.00	***
Self Identification	0.84	***

rho = Spearman rank correlation coefficient

p = probability

*** = $p < 0.001$

Discussion and conclusion

There was good inter-rater reliability between the ward Occupational Therapist and the independent assessor on all RPAB subtests except for Self Identification. The correlation for this subtest was 0.84, which is lower than that suggested by Nunnally (1967), who recommended that a minimum reliability of 0.90 should be considered as acceptable. Investigation using a scattergraph showed that the ward OT scored slightly higher than the independent assessor on this subtest. As the independent assessor was therefore stricter on the scoring for this subtest, the improvement in the patients' scores may be greater in reality than was shown in the scores. The good inter-rater reliability on the other subtests indicated that any variation in the patients abilities, as assessed on the RPAB, from the initial RPAB assessment to the final RPAB assessment, was due to an actual variation in the patients abilities and not due to a difference in scoring between the OT carrying out the initial RPAB assessment and the independent assessor carrying out the final RPAB assessment. These results also supported the results in the RPAB manual (Whiting et al., 1985) in that the RPAB measured perceptual ability in a reproducible fashion.