

**A SOMATOSENSORY TEST:**

**A PILOT STUDY**

by

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for the degree of Master of Science  
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**DEDICATION**

To all the children in my life, past, present  
and future - in particular to my sons,  
Francois and David.

I, AGNITA LOMBARD, hereby declare that the work on which this thesis is based is my original work (except where acknowledgments indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other University.

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ABSTRACT

The most commonly used tests for the evaluation of perceptual motor function of children in South Africa are the Southern California Sensory Integration Tests (Ayres, 1972) and Southern California Postrotary Nystagmus Test (Ayres, 1975).

These particular tests were revised, changed and restandardized in 1989. For various reasons the new form, Sensory Integration and Praxis Tests (Ayres, 1989), is not feasible for use in South Africa.

It has thus become imperative to develop tests in South Africa that can replace these tests. The South African Institute of Sensory Integration appointed working committees in various sectors of the country to develop a test for the South African population. The candidate decided to develop a Somatosensory Test which could be used as part of a South African test of sensory integration.

A test was designed and constructed, based on the model used by Ayres in the Southern California Sensory Integration Tests. This test comprises five subtests, i.e. Non-vestibular Proprioception (in the first phase of the study this subtest was named Kinesthesia), Finger Recognition, Form Recognition, Two Point Discrimination and Tactile Stimuli Placement tests.

This proposed test was used in the field by seven voluntary field workers. They each recruited a sample of convenience and administered the proposed test to 58 children. A self-administered questionnaire was completed for each test administered completed to evaluate the mechanics of the test. The data obtained from the questionnaires were statistically analysed and from this the candidate could draw conclusions about changes necessary for the test.

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Suggested changes were implemented. These included shortening the test, changing verbal instructions, adapting some parts of test items, reorganising the score sheet and changing the instruction manual accordingly.

A pilot study was conducted to determine validity and reliability of the proposed test. A representative sample (n = 114) was recruited from the Sub A population in the Durbanville and Kraaifontein area of the Northern suburbs of the Cape Town Metropolitan Area.

A comparative study was done to validate the proposed test, using the Southern California Sensory Integration Tests as a gold standard. The Two Point Discrimination test was excluded from this validation study as there is no corresponding test of the SCSIT. Results were compared and levels of sensitivity and specificity were established. In general higher levels of specificity than sensitivity were obtained. The Form Recognition test had the highest sensitivity level (60%) and in the case of the Finger Recognition test statistically significant differences were obtained between means ( $p = 0.006$ ).

Thirty children from the group of 114 were tested by two testers to establish the reliability coefficient. The Form Recognition test had the highest coefficient (0.83).

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LIST OF ABBREVIATIONS AND TERMS USED

SAISI: South African Institute of Sensory Integration. This institute comprises occupational therapists who use the theory of Sensory Integration in practice. It offers courses in theory, test administration/interpretation and treatment.

S.I.: Sensory Integration.

SCSIT: Southern California Sensory Integration Tests.

SCPNT: Southern California Postrotary Nystagmus Test.

SIPIT: Sensory Integration and Praxis Tests.

KIN: Kinesthesia Test.

MFP: Manual Form Perception Test.

FI: Finger Identification Test.

GRA: Graphesthesia Test.

LTS: Localization of Tactile Stimuli Test.

DTS: Double Tactile Stimuli Perception Test.

PROP: Non-vestibular Proprioception Test.

FR: Finger Recognition Test.

FORM: Form Recognition Test.

TPD: Two Point Discrimination Test.

TSP: Tactile Stimuli Placement Test.

Tactile Defensiveness:

It is the tendency to react negatively and emotionally to non-noxious tactile stimuli. It is thought to be a result of a lack of higher-level inhibition of sensory stimuli. There is a typical fight or flight reaction to tactile stimuli that are usually well tolerated by other individuals. This condition often contributes to attention deficits and hyperactivity. Social and emotional adjustments can also be affected. These reactions are usually seen whilst assessing tactile functions, but the sensory history is also a valuable source of information (see TIE, Touch Inventory for Elementary School-Aged Children by Charlotte Brasic Royeen, 1990).

Postural background movements:

These are the appropriate adjustments that are made to the posture whilst executing a task. When these are poorly developed the movements often appear exaggerated, awkward and inappropriate. They can be associated with low postural tone, deficient equilibrium reactions and poor tonic proximal stability. There is no formal evaluation method, but can easily be observed during the execution of tasks.

Adaptive Response:

An adaptive response is a purposeful, goal directed response to a sensory experience. The greatest sensory-motor organization occurs during an adaptive response to sensation. This is a response in which the person deals with his body and environment in a creative or useful way.

Adaptive Behaviour:

The term adaptive response is limited as it implies an automatic response to sensory intake. The term adaptive behaviour is broader and allows the individual to choose freely amongst several effective strategies.

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## CHAPTER I

### INTRODUCTION

In paediatric occupational therapy, many of the clients are children with developmental delays. These delays include motor incoordination, perceptual deficits, perceptual-motor deficits and attention deficits. Because of these developmental delays the children are unable to thrive and often unable to master their environment, affecting their function in all spheres of life, i.e. work/play, self care, social and emotional.

Development is multi-dimensional and treatment should thus be many faceted. Occupational therapists have an holistic approach to the treatment of a client, promoting function in all the areas of life. This is achieved through the use of meaningful activity, in the case of a child, usually play. The child's day is made up of various activities of which play comprises a great part. To the child, play is an important life task and through play the therapist facilitates the child's mastery of his environment (Bundy, in Fisher et al, 1991). Play thus becomes a powerful treatment tool.

"Play is important to pediatric occupational therapists as an indicator of children's development, as a behaviour in its own right, and as the medium most commonly used in treatment." (Bundy, 1989, p.85)

Occupational therapists use play as a vehicle for development. Bundy (in Fisher et al, 1991, p.59) proposes the following working definition of play:

"Play is a transaction between an individual and the environment that is intrinsically motivated, internally controlled, and free of the many constraints of objective reality."

Many therapists working in the field of developmental delays are

using the A.Jean Ayres model of evaluation and treatment (Fisher et al, 1991). According to this theory the therapist provides the individual with opportunities for enhanced sensory intake, demanding an adaptive response whilst providing the "just right challenge" (Bundy in Fisher et al, 1991, p.55). Therapy is also thought to be most successful when the activities are intrinsically motivated, involve the individual actively, are controlled by the individual and provide a safe environment for the child to explore because the constraints of objective reality is controlled by the therapist. In the light of the similarities between play and Sensory Integration, Bundy (Ibid, p.61) suggests that if Sensory Integration is carried out successfully, it becomes a "special subset of play transactions in which all activities include enhanced sensory stimulation".

## 1. HISTORICAL OVERVIEW

Sensory Integration Therapy (S.I.T.) has gained popularity over the past few decades as an occupational therapy approach in pediatrics. Sensory integration addresses maturation of neural systems subserving the acquisition of specific skills rather than the teaching of specific skills (splinter skills). Ayres' claims of promoting function have been substantiated by other authors such as De Quiros and Schragar (1978), Knickerbocker (1980) and Cermack and Henderson (1989).

Sensory Integration is defined by Ayres (1979, p.184) as:

"Treatment involving sensory stimulation and adaptive responses to it, according to the child's needs ... The goal of therapy is to improve the way the brain processes and organizes sensations."

If the clinician is to address the problems of processing and organization of sensation, he/she needs to establish exactly which of the neural systems are implicated. For this reason Ayres developed evaluation tools as standardized tests, the Southern

California Sensory Integration Tests (Ayres, 1972) and the Southern California Postrotary Nystagmus Test (Ayres, 1975). For the purposes of this text these test will be referred to as SCSIT and SCPNT respectively.

These tests were developed in the United States of America and standardized on the American population, providing normative data for that population. They became available in South Africa towards the end of the 1970's when the first South African occupational therapists were trained in Sensory Integration theory, test administration and therapy. There are however no norms available for the South African population. The lack of appropriate norms is obviously not the ideal situation, but these test nevertheless provided therapist with the much needed means of identifying the group of the population who needs their services. Results that are compared to norms also serve as diagnostic guidelines because they enable identification of the neural systems that are implicated.

Ayres and co-workers started revising these tests in the early 1980's (Fisher, et al, 1991) and they have since been discontinued in their present form. Of the original SCSIT, four subtests were omitted, five underwent major revisions, seven underwent minor or no revisions and four completely new tests were added. The SCPNT was also incorporated into the battery, instead of being an independent test. This new/revised test battery was published in 1989 and named the Sensory Integration and Praxis Tests (Ayres, 1989), referred to in this text as the SIPIT.

The Sensory Integration and Praxis Tests (SIPIT) are impractical for use in South Africa. The computerized scoring is done in the USA. The time lapse between testing and interpretation and the resultant high cost to the test user is impractical. The lack of normative data for the South African population remains.

The need for a South African test for sensory integration has thus become imperative. The South African Institute of Sensory Integration appointed several working committees to develop the

various components of such a test. A test for the evaluation of somatosensory perception, which forms an integral part of sensory integration, is one component which needs to be developed.

The somatosensory system (tactile and proprioceptive) assumes an important, albeit subserving role in the development of sensory motor function. Both these systems that comprise the somatosensory system derive information from the environment by means of mechanoreceptors, in the the skin, joints and muscle fibres. This information is interpreted by the central nervous system and integrated in order to form the basis of motor performance (Bairstow and Laslow, 1981, Hoare and Larkin, 1991, Harris, et al, 1984)

Ayres linked tactile functions closely to general neural development and early childhood behaviour (Ayres, 1972). In later works she hypothesized that poor tactile perception contributes to somatodyspraxia, a specific disorder in motor planning (Royeen and Shelley in Fisher, et al, 1991). The function of the proprioceptors is critical to the process by which reflexes, automatic equilibrium responses and planned movement occur (Ayres, 1972).

If the clinician is able to identify discrepancies in the function of these neural systems, he/she will be able to intervene therapeutically at the level where dysfunction originates. The information enables the clinician to identify the child in need of intervention and also serves as guidelines for therapy.

## **2. AIMS OF THE STUDY**

The purpose of developing a South African version of a Sensory Integration Test would be to make an assessment tool available to South African occupational therapists that are easily obtainable, cost effective, can render immediate results and is standardized on the South African population. Tests which assess somatosensory perception can complement other tests, eg. tests of motor function and other perceptual abilities, for a comprehensive

assessment of Sensory Integration. The candidate will set out to design, develop and analyse test items that can be used to assess somatosensory perception.

### 3. OBJECTIVES OF THE STUDY

The objectives of this study are:

- to design and construct an age appropriate assessment tool for the assessment of somatosensory perception
- to evaluate the tool in order to select the most appropriate test components, the most suitable mechanical procedures and the most effective protocol
- to conduct a pilot study on a representative sample to determine the reliability and validity of the evaluated tool.

### 4. METHOD

The candidate will choose procedures for a proposed test of somatosensory perception. She will draw from existing tests and procedures that are generally accepted as valid measures of somatosensory perception in the field of clinical neurology. The following factors will be taken into account in designing and constructing test items:

- availability and cost of materials
- general appeal of procedures to the child
- economical use of time in administration of test items
- possibility of reproducing tests items for future standardization

Once the test is designed and constructed it will be evaluated by means of field work done by experienced testers. These testers will administer the test to a number of children to enable them

to give an opinion on the test mechanics. A questionnaire will be compiled for completion with the test. The responses will be statistically analysed and these results will be used in selecting the most appropriate items, eliminating any problems with the mechanics of the test, refining instructions and reducing the number of items if necessary. A detailed account of methods and materials is given in chapter III.

The test will be altered as indicated by the above findings. A further study will be conducted to determine validity and reliability. Detailed methodology is described in chapter III.

The candidate will select a representative sample of children from one designated geographical area. The somatosensory subtests of the SCSIT as well as the proposed test will be administered to all the children in the sample. A comparison will be made of the results to gauge validity using the SCSIT test as the gold standard.

The sample will be drawn from the northern suburbs of the Cape metropolitan area, particularly Durbanville and Kraaifontein. This geographical area is inhabited by white, "coloured" and black citizens. Most of the white population is represented by higher income and middle income groups. The "coloured" community is generally of the lower income group. This information was obtained from the Department of Urban studies, Cape Town City Council, according to 1991 Census. At the time of the study it was not possible to include the black community in the study as security within the black residential areas was not sufficient for field work to be conducted there safely.

The data analysis will compare scores obtained on the corresponding subtests of the SCSIT and the proposed test in order to determine validity.

A smaller sample will be randomly selected from the above sample and tested by a co-worker, using the proposed test. The scores obtained here will be compared to scores obtained by the candidate in order to establish reliability.

## 5. LIMITATIONS

Funds and time were limiting factors in both stages of the study.

In the first part of the study, funds restricted the candidate to making use of voluntary field workers. These workers had limited time to spend on the field work as they all had other work commitments. Limited funds restricted the candidate to construction of only one test kit. Therefore only one worker could conduct the field work at any one time. This resulted in protracting the field work and thus limiting the number of field studies that could be done within the restraints of time.

The limitation of the number of field studies done, could have resulted in possibly not selecting the most valuable items to include in the test. Some valuable items may also have been discarded.

The reliability and validity studies can only be considered as a pilot study for the reasons given below:

--- The numbers for determining the normal values are not be sufficient

--- The same data are used in assessing the validity and reliability

The security situation at the time of the study in black residential areas did not allow for field work to be conducted. The black population was therefore not included in the research, making the sample less representative of the population.

## 6. ANATOMY AND PHYSIOLOGY OF THE SOMATOSENSORY SYSTEM

For a review of the relevant anatomy and physiology of the somatsensory system the reader is referred to Appendix 7.

CHAPTER II  
REVIEW OF LITERATURE

In this chapter the relevant literature pertaining to sensory integration, test development and questionnaire design is reviewed.

1. THEORETICAL BACKGROUND OF SENSORY INTEGRATION

1.1 WHAT IS SENSORY INTEGRATION?

Since Dr. Ayres defined sensory integration as being "the ability to organize sensory information for use" (Ayres, 1972a), the theory has developed and expanded greatly through her own efforts as well as the work of other researchers in the field (Clark, et al, 1989, Fisher, et al 1991, Royeen, 1989, Bundy, 1989, Kinnealey, 1989). In 1989 Ayres stated:

"(s)ensory integration is the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment. The spatial and temporal aspects of inputs from different sensory modalities are interpreted, associated, and unified. Sensory integration is information processing ... The brain must select, enhance, inhibit, compare, and associate the sensory information in a flexible, constantly changing pattern; in other words, the brain must integrate it." (Ayres, 1989, p.11)

Ayres spent 35 years of her life developing this theory, the therapeutic application of it and the necessary evaluation tools.

There are two basic principles of occupational therapy that can be realized through implementation of sensory integration techniques, especially in the paediatric field. Occupational therapists view play as an essential occupation of childhood (see Bundy, p2). It is therefore the primary treatment medium and is utilized to promote sensory integration.

The second principle of relevance, is that participation in meaningful activity enhances both mind and brain-body, because mind and brain-body are interrelated (Kielhofner and Fisher in Fisher et al, 1991). Activity that promotes the development and growth of one will also promote the development and growth of the other. In sensory integration, treatment is aimed at eliciting adaptive responses/behaviour (see 1.3.2.4. p.22) and therefore enables participation in meaningful activity.

Ayres died in December 1988. During her life she had influenced therapists in providing them with the theory of sensory integration. Not only did it open doors to therapist using these techniques with their paediatric clients, but also stimulated much research in this area which included studies relating neo-natal intervention, adult neurology and psychiatry. (Anderson, 1986, Barnard, 1983, Edelman, 1982, Korner, 1983, Field, 1985, Pelletier, 1985, Iwasaki and Holme, 1989, Ross and Burdick, 1981 and Hamada and Van Schroeder, 1988, Weber, 1984, Yekutiel et al 1994).

"For optimum brain function in man, it is necessary for it both to receive and to integrate for use a constant stream of stimuli, especially from the body. Without both elements, man's ability to cope with the world diminishes." (Ayres, 1972, p.20)

In sensory integrative dysfunction, the stimuli are available but there is inadequate processing of these stimuli (Ayres, 1972a). The brain's task of filtering, organizing and integrating is diminished. Ayres cites Sherrington (1906, 1955) as one of the first neurophysiologists to stress the importance of central nervous system mechanisms for sensory integration (Ayres, 1972a).

It is necessary for an individual to take in sensory information from the movement of their bodies and the environment, and to process this information by integration within the central nervous system. Only then can the individual use the information to plan and organize behaviour. (Fisher and Bundy in Fisher et al, 1991)

The important sensory systems which form the theoretical base of sensory integration are the vestibular, proprioceptive, tactile, auditory and visual systems. The vestibular, proprioceptive and tactile systems are seen to be precursors to the development of the auditory and visual systems. Auditory and visual systems are regarded as the end products of vestibular, proprioceptive and tactile systems. (Kimball in Kramer et al 1993)

In treatment of sensory integrative disorders the therapist strives to enable the client to acquire the "end products". The therapist is concerned with the integrity and integration of these underlying sensory systems that are responsible for development of these "end products". The "end products" are reflected in visual and auditory perceptual ability. These end products are a direct result of the adaptive response that the therapist sought to elicit through therapy. (Ibid)

Whilst developing the theory of sensory integration Ayres described a number of sensory deficits and realized that they needed to be clinically identifiable. The development of the SCSIT was the natural result of her train of thought. In this test which was developed and refined over many years she was able to classify factors that formed clusters of diagnostic syndromes. These clusters were described, changed and added to through ongoing research (factor analytic studies, see table 2.1). The therapists who kept up to date with Ayres' development in thinking were able to expand their therapeutic expertise because they were provided with scientifically based guidelines for therapeutic intervention.

These tests (SCSIT) were marketed in USA and widely distributed to many countries. The need existed for the latest research to be reflected in the assessment tools used to evaluate clients and this led to the revision of the SCSIT, which was replaced by the SIPIT.

## 1.2 GROWTH AND EXPANSION OF SENSORY INTEGRATION THEORY

Following the first publication of "Sensory Integration and Learning Disorders" in 1972, much research ensued on the validity of the theory, the assessment tools, and the efficacy of treatment procedures.

Although Ayres was not an educationist, her work had educational implications. Ayres claimed academic progress through enhanced sensory integration (Ayres 1972b). Her work was based on a variety of neurological disorders in children which she described as sensory integrative deficits. She found positive correlations between sensory integration deficits and learning disabilities and proposed intervention strategies based on these findings. For this she was both supported and extensively criticized (Polatajko, 1983, 1985, 1991 et al, 1992 et al, Humphries et al, 1990, Wilson et al, 1992, Cummins, 1991, Brown et al 1983, Densem et al, 1889, Knicker, 1980, Morrison and Sublett, 1983, Fisher et al, 1986, Su & Yerxa, 1984, Thibault et al, 1994).

### 1.2.1 Research relating to the Southern California Postrotary Nystagmus Test

The studies by Polatajko (Polatajko, 1983, 1985) focussed essentially on the use of the Southern California Postrotary Nystagmus Test. The test is criticized for its validity as a measure of vestibular function as well as its predictive validity in identifying subjects with learning disabilities. Her 1983 study compared the performance on the Postrotary Nystagmus test of 20 learning disabled subjects to that of 20 normal subjects. No significant differences at the 5% level could be demonstrated. In 1985 (N=80) similar findings were made (Ibid). In both these studies Polatajko based "vestibular dysfunction" on discreet vestibular nystagmus, ignoring integration of vestibular input with other sensory stimuli (Wiss, 1989, Wilson, 1992a).

Wilson (1992b) examined the reliability of the SCPNT with children with motor coordination problems (N=69). She found a

significantly higher intra-tester than inter-tester reliability.  
( $p < .001$ )

Polatajko's work was substantiated by Brown and co-workers (Brown et al 1983). Both Brown and Polatajko's studies were done with relatively older (8 to 12 yrs) children and consisted of heterogeneous groups of learning disabled subjects. Neither of the researchers distinguished between learning disabled subjects diagnosed as having sensory integrative disorders and those without. Ayres recognized that not all learning disabled subjects have sensory integrative disorders (Fisher in Fisher et al, 1991). The study by Brown purposefully excluded subjects with possible sensory integrative disorders, i.e. subjects with poor balance, poor sequencing, poor tactile perception, hyperactivity and poor imitation of postures. The candidate views this as a misrepresentation of the total population of learning disabled children. It should also be kept in mind that not all learning disabled or all subjects with sensory integrative disorders, have vestibular based diagnoses. (Fisher in Fisher et al, 1991). Polatajko failed to assess the effect of such diffuse vestibular processes (Wiss, 1989).

Penberthy (1985) studied 23 learning disabled and 23 normal children by comparing their vestibular responses to rotation using an electronystagmograph. In this study the learning disabled group consisted of subjects with identified vestibular based sensory integrative disorders (As identified by a single therapist). She could find no significant differences between the groups ( $p = .05$ ) and suggests abandoning the use of the Southern California Postrotary Nystagmus test. This study was done on a relatively small group ( $N=46$ ) and the sensory integrative status of the control group as assessed, was not reported on.

In support of the Ayres theory, Morrison and Sublett (1983) found that a group of learning disabled children ( $n=87$ ) had significantly ( $p < .05$ ) depressed scores on the Postrotary Nystagmus test and that there was greater variability in their scores than those of normal children. Fisher et al (1986)

produced similar results in their study of adult subjects with vestibular impairment ( $p = .05$ ). They suggested that the diagnosis of a vestibular based dysfunction is valid, but that this diagnosis should only be based on a meaningful cluster of symptoms, rather than a single test score.

Shumway-Cook et al, (1987) examined the Vestibulo-ocular reflex and performance on moving platform posturography of motor-impaired, learning disabled children. They found a poor correlation between motor-impairment and the vestibulo-ocular reflex (73% of learning disabled children demonstrated normal vestibular function within the 95% confidence level). A high correlation was obtained between motor-impairment and abnormal performance on the moving platform posturography (80% of learning disabled children demonstrated deficits on the moving platform posturography). They suggest that the observed motor-impairments seen in learning disabled children may "reflect a central abnormality of sensory interaction resulting in an inability to coordinate normal vestibular signals with orientation inputs from vision and somatosensory systems for postural orientation". This view is in line with Ayres' thinking that single test scores are not as valuable in evaluation as a cluster of symptoms.

### 1.2.2 Research on the efficacy of Sensory Integrative Therapy

In 1991 Polatajko and co-workers (Polatajko et al, 1992) reviewed the status of sensory integration by examining 7 studies that used sensory integration treatment with samples of learning disabled children. They failed to find statistical evidence that sensory integration treatment improved academic performance. They did however concede that a Type II error may have occurred because of the small sample sizes. They also pointed out that treatment delivered in the research setting only vaguely resembled that of the clinical setting and for this reason may not have been as effective or representative of sensory integration. The sensitivity of the measure used to evaluate change is also questioned as observers of a child often report gains that can

not be illustrated by formal measures. In addition the significant gains made by individuals are often not reflected in group studies. Although suggestions of further more rigorous research were made, these researchers (Polatajko et al, 1992) still gave little support for sensory integration as an effective intervention for academic problems of children.

Humphries et al, (1990) were able to demonstrate significant ( $p = .05$ ) gains in motor function as a result of sensory integration therapy, but no academic gains. In a study by Polatajko et al, (1991) the researchers could find no significant differences between effects of sensory integrative therapy and perceptual motor training. They did however concede that in the case of mathematics, the  $p$  values were very close to significance ( $p = .054$  at 6 mths and  $p = .058$  at 9 mths). They speculated that had a one-tailed test been done, results obtained for sensory integration could have been significantly better than those for perceptual motor training. This was however not investigated and may indicate bias on the part of the researcher in not exploring the possibility.

Densem et al, (1989) examined the efficacy of sensory integrative therapy on 57 children referred for perceptual motor difficulties and learning disabilities. Effects of sensory integrative therapy and physical education programmes were compared. The researchers were unable to demonstrate differences in the outcomes of these interventions except reading abilities of children who were already reading at the time of intervention ( $p < .01$ ). In this respect the group who received sensory integrative therapy showed significant gains above those who only followed a programme of physical education. A heterogeneous group of learning disabled children was studied and only 78% of the children had an average or above average intelligence. This is not in accordance with the accepted definition of Learning Disabilities. The diagnosis of Specific Learning Disability (SLD) requires the demonstration of academic underachievement relative to cognitive potential (Shapiro et al, 1984). Other variables were also uncontrolled in the study by Densem and co-workers, eg. behavioural problems,

attention deficits and speech and language problems.

Wilson (Wilson et al, 1992a) compared sensory integration treatment with equal amounts of tutoring (N=29) and could not demonstrate any significant differences in the gains the children made. Two years later a follow-up study was done with the same group of children and it was found that the group of children who had received sensory integrative therapy had more sustained gross motor gains ( $p < .05$ ). On measures of reading skills, fine motor skills, visual motor skills and behavioural factors no significant differences were found.

### 1.2.3 Other related research

Between 1965 and 1987 Ayres published eight papers on multivariate analyses that support the theory of sensory integration. Based on Ayres' interpretations of these analyses the theory of sensory integration evolved and new insights were gained. The factors emerging from these studies were not identical and the labels used by Ayres changed over time. Certain similarities could however be seen and suggest several different but relatively consistent patterns of dysfunction. Although these studies indicated that domains of dysfunction could be identified, Ayres realized that these were not discreet typologies and in any one child more than one pattern could be demonstrated.

As Ayres was exploring new ideas her research methodology changed from one study to another. Her studies never replicated previous ones and sample sizes were consistently small. Fisher and Murray (Fisher et al, 1991) recognise these weaknesses in Ayres' research and realize that confirmatory rather than exploratory factor-analytic techniques would have been more valuable in confirming the existence of the constructs. In reappraising these studies, Cummins (1991) also found this lack of consistency between Ayres' factor labels and composition. He maintains that for this reason no core group of variables could be seen that allowed reliable identification of these factors. On these

grounds he concluded that there could be no validity attributed to the diagnostic procedures or remedial programmes derived from these multivariate studies.

Despite the criticism of sensory integration, the use of the SCPNT as evaluation tool and vestibular stimulation as an intervention strategy, more positive responses have been directed at the other sensory elements of sensory integration, i.e. tactile and kinesthetic processing.

In a study of 475 subjects ranging from 5 years to adulthood Baird and Laszlo (1981) demonstrated a positive correlation between kinesthetic sensitivity and fine and gross motor function ( $p < .01$ ). Hoare and Larkin (1991) found that clumsy children performed significantly more poorly on three out of seven tasks of kinesthetic awareness ( $p < .001$ ).

Haron and Henderson (1985) found developmentally dyspraxic boys performed inferiorly on tasks of active and passive touch. Kinnealey (1989) could demonstrate significant ( $p < .001$ ) differences in tactile scores of learning disabled and normal children ( $N=60$ ). This researcher compared tactile functions of learning disabled and normal children. The tactile portions of the SCSIT as well as Luria-Nebraska Neuropsychological Battery, (Children's Revision) were used. Kinnealey found that both these tests were able to correctly classify 90% of the children as either learning disabled or normal. Individual tests of both these batteries were shown to be less reliable than when the tests were given together.

In a study of 182 children with known or suspected sensory integrative dysfunction, Ayres and co-workers (Ayres et al, 1987) could demonstrate strong associations between praxis, tactile processing, visual perception and sentence repetition.

Somatosensory processing abilities of very low-birth weight infants were examined at school age by Demaio-Feldman (DeMaio-Feldman, 1993). These children scored significantly

differently on all measures of somatosensory processing (SCSIT) compared with a standard group ( $p < .0001$ ). These findings have implications for neonatal occupational therapy. The researcher also makes a case for the development of measures of somatosensory perception at younger ages so that intervention can be made more timeously.

Jennings found a positive correlation between haptic manipulative skills and form reproduction in 47 kindergarten children (Jennings, 1974). She suggests that observation of the child's method of haptic manipulation can be developed into an appropriate evaluation method for use in the clinical setting of occupational therapy. Lochner (1985) demonstrated gains in impulse modification and attention deficits by means of haptic training. Stereotypic behaviour could be reduced in severe multiply disabled adult persons ( $N=36$ ) through sensory treatment (Iwasaki and Holm, 1989).

Bauer (1977) found that hyperactive boys display more tactile sensitive behaviours than boys that are not classified as such. Molteno and Cumpsty described the phenomenon of tactile aversion as seen in infants and cautions against the misdiagnosis of this condition. Royeen investigated this construct extensively with her work culminating in the development of the Touch Inventory for Elementary School-Aged Children (Royeen, 1987 and 1990). The construct of tactile defensiveness is well documented by Royeen (Royeen, 1985). Dunn documented the performance of typical children on a sensory profile in order to ascertain which items of this profile can be used to identify children who have problems in this area.

#### 1.2.4 Summary

There are still many differing opinions on the validity of sensory integration theory as well as the efficacy of intervention strategies. In 1982 Ottenbacher (Ottenbacher, 1982) examined 49 studies on the efficacy of sensory integration therapy. He attempted to clarify this controversy. He found that

in 75% of these studies, the subjects were not receiving sensory integrative therapy but rather some elements of sensory stimulation that could be rigorously controlled within the research situation. Research into the efficacy of sensory integration treatment has been difficult because scientific research requires that variables be controlled. This leads to the use of a small number of strictly controlled activities that do not accurately represent the construct of sensory integration (Ottenbacher in Fisher et al, 1991). Although this approach has methodological advantages for research, it no longer represents sensory integration. Under these research conditions the integrative gestalt is lost as the treatment construct is more than the sum of its sensory parts.

Ottenbacher also points to other difficulties in efficacy studies. The heterogeneity of learning disabled children creates problems with sample comparability which in turn complicates the interpretation of research results. To be able to generalize findings it is necessary to select random samples. This random sampling results in considerable amounts of between subject variance and reduces the probability of detecting a statistically significant effect of treatment when studying groups. Ottenbacher acknowledges the urgent need for scientific consensus and urges clinicians to collectively cooperate and collaborate. He suggests that studying the relationship between variables over time may be a more effective research method. For generalization of research and development of empirical consensus, replication of research is necessary.

Occupational therapy is a holistic treatment approach that promotes function in all spheres of human function. It is therefore not surprising that many therapists adopt an eclectic approach. Eclecticism may be very valuable in the clinical setting but makes research of variables difficult.

From the foregoing review of literature the following are apparent:

- (i) Ayres' work stimulated a vast amount of research among many different professionals. Some of these supported the theory and practice of sensory integration whilst others abandoned the theory and treatment strategies.
- (ii) A great deal of criticism has been directed at the importance Ayres attached to vestibular deficits and their influence on academic performance. Many of these researchers did not differentiate between learning disabled children that have vestibular disorders and those that do not have vestibular disorder.
- (iii) The Southern California Postrotary Nystagmus test is criticized for its lack of strict control of other variables such as a light. It is felt that it cannot be a measure of vestibular function as it does not measure discreet function. In describing vestibular dysfunction, Ayres was appreciative of all the other factors that complemented vestibular function.
- (iv) Efficacy studies that could not find support for sensory integration treatment strategies tended to be reductionistic. Mostly the studies were designed around strictly controlled sensory stimulation procedures that could be well controlled in the research setting. These procedures often did not represent sensory integration as a treatment strategy.
- (v) Efficacy studies centered mostly around academic performance and many of the other functional gains that can be made by sensory integration have been ignored, eg. daily living tasks, social function, self esteem, attention control, etc.
- (vi) Sensory Integration is a multifaceted intervention approach which is difficult to reduce to components.

### 1.3 POSTULATES OF SENSORY INTEGRATION AND THE UNDERLYING ASSUMPTIONS

#### 1.3.1 Postulates of Sensory Integration

There are three major postulates of sensory integration (Ayres, 1989, Fisher in Fisher et al 1991).

**One:** The human organism receives information from its environment as well as movement of the body, processes and integrates this information within the central nervous system in order to use the information in planning and organizing behaviour.

**Two:** Deficits of the above process of sensory integration will result in deficits in conceptual and motor learning.

**Three:** If enhanced sensory experiences are provided within the context of meaningful activity and if they elicit adaptive behaviour, improved sensory integration will result and this will enhance learning.

#### 1.3.2 Assumptions underlying the postulates of Sensory Integration

**1.3.2.1 Neural Plasticity:** The theory of sensory integration implies that changes can be effected in brain function by means of intervention. This assumes that the brain has the capacity to change, i.e. plasticity. In earlier works Ayres (Ayres, 1972a) stressed that this plasticity decreases with age and optimum gains could be made if intervention was done between ages 3 and 7 years of age. Fisher (in Fisher et al, 1991) points out that this plasticity is not lost after that age and in fact persists into adulthood or even later. She also questions the assumption that younger children make greater gains than older clients.

- 1.3.2.2 **Developmental Sequence:** More complex behaviours develop as a result of previously acquired less complex behaviours that have occurred before. Sensory integration occurs in a developmental sequence, just as in normal development. Sensory integrative intervention is aimed at recapitulating normal neuromotor development if at certain developmental stages immaturity occurs in an individual. This is achieved by providing therapeutic sensory and motor experiences that also follow this developmental sequence. (Short-DeGraff, 1988).
- 1.3.2.3 **Nervous System Hierarchy:** The brain is comprised of systems that are hierarchically organized. Higher level neural function is dependent on the integrity of lower level function. This concept of hierarchical function of the brain was Ayres' way of communicating difficult ideas to her followers (Fisher in Fisher et al 1991), but detracted from Ayres' holistic systems view of the brain. Fisher proposes that more emphasis should be placed on this systems view of the nervous system, whereby the higher levels of function are dependent on lower level function, but in turn this higher level function controls the lower level function. Thus the systems interact and cortical as well as subcortical structures contribute to sensory integration.
- 1.3.2.4 **Adaptive behaviour:** This means being able to meet the ever changing challenges of the environment. Central to the theory of sensory integration are the theories that eliciting an adaptive behaviour enhances sensory integration and that the ability to produce adaptive behaviour reflects sensory integration (Fisher in Fisher et al, 1991). The implication is that if intervention can elicit an adaptive response, sensory integration will be enhanced. The therapist is assured of the goals of sensory integration being met when an adaptive response is successfully elicited. Through adaptive behaviours the person experiences how it feels. The person is able to

attempt more complex adaptive behaviours only if he recognises that the previous movements were successful. The therapist grades therapy by providing the "just right" challenge. Fisher (Ibid) speculates that "actual performance of increasingly complex movements indicates that new neuronal models have developed" (p.17).

1.3.2.5 **Inner Drive:** Individuals have an inner drive to develop sensory integration through actively participating in meaningful activities. In treatment these would be represented by sensorimotor activities. This inner drive is linked to motivation, self-direction and self-actualization. The child with sensory integrative dysfunction often lacks this inner drive. If therapeutic intervention is successful the child will experience satisfaction through mastery of the environment which will enhance the inner drive. (Fisher in Fisher et al, 1991). This circular process provides the feedback that strengthens the inner drive to seek out more growth promoting experiences.

#### 1.4 DEVELOPMENT OF EVALUATION TOOLS OF SENSORY INTEGRATION

From the theory Ayres proceeded to develop evaluation tools that could identify dysfunction in the various systems that are responsible for sensory integrative disorders.

Ayres first published the Ayres Space Test in 1962. To this she added the Southern California Motor Accuracy Test (1964), Southern California Figure Ground Visual Perception Test (1966), Southern California Kinesthesia and Tactile Perception Test (1966) and the Southern California Perceptual Motor Tests (1968). The Position in Space and Design Copying Tests (1972) were included in the full Southern California Sensory Integration Tests, first published in 1972. The Southern California Postrotary Nystagmus Test, designed for the evaluation of the vestibular system, was published in 1975. In the 1980 edition of the Southern California Sensory Integration Tests the manual was

updated and the Motor Accuracy Test revised with new procedures and new normative data.

The Southern California Sensory Integration Tests had many limitations. Amongst these were inadequate standardization procedures, poor reliability on the majority of tests and inadequate validity studies (King-Thomas & Hacker, 1987). Despite these major weaknesses, it provided the clinician with information regarding the child's responses to sensory input and his ability to make adaptive responses. This was useful in setting treatment goals.

In the late 1980's Ayres substantially revised the whole test battery. Some of the original tests of the Southern California Sensory Integration Tests were omitted, some received major revisions, others received minor or no revisions and four new tests were added to the battery. The Postrotary Nystagmus Test was included as part of the new battery called the Southern California Sensory Integration and Praxis Test (1989). It consists of 17 subtests that measure four overlapping domains, i.e. tactile processing, vestibular-proprioceptive processing, visual perception and practic ability.

## 2. TESTS AND TESTING

### 2.1 HISTORICAL BACKGROUND OF TEST DEVELOPMENT

Modern day testing was generated by Darwin's theory of evolution (Anastasi, 1976). His concept of the "survival of the fittest" generated interest in measuring individual differences.

In the early nineteenth century there was a movement towards more humane treatment of the mentally retarded and insane. It therefore became necessary to classify the different degrees of retardation. Remnants of this early work can be found in present day tests, i.e. the Seguin Form Board (Anastasi, 1976).

The early experimental psychologists were concerned with

uniformities rather than differences in behaviour as this would enable them to classify individuals. The importance of rigorous control of conditions under which observations were made, was recognized. This was the forerunner of present day standardization procedures in testing.

Galton is regarded as a pioneer in the field of test development (Anastasi, 1976; Campbell, 1989). He believed that tests of sensory discrimination could serve as a means of gauging a person's intellect. Galton recognized the importance of standardized testing as well as developing correlation methods with which to analyse data. He was the first to develop statistical methods for the analysis of data on individual differences. These were later refined by Karl Pearson.

Many others were influenced by these pioneering works of Galton, such as Cattell, Jastrow, Kraepelin, Ebbinghaus, Ferrari and Binet (Anastasi, 1976). They followed these trends of standardizing procedures for measures that determined individual differences.

In 1904 Binet was appointed by the French government to study procedures for the education of retarded children. He and Simon prepared the first Binet-Simon scale for measurement of intelligence which appeared in 1905 (Anastasi, 1976). The concept of norms for different ages, calculation of mental ages and eventually the search for factors of intelligence developed from this early work. Binet's test attracted world wide attention and was adapted and translated into different languages. In 1916 an important adaptation was made by Terman of the Stanford University. This became known as the Stanford-Binet test of Intelligence (Anastasi, 1976).

Later standardized testing developed further to include its application in personnel selection, school admissions, psychiatric and other medical diagnostic tasks. These standardized test have at times been criticized for labeling individuals and the lack of cultural validity for some population groups (Campbell, 1989). It is however still the best way of

sorting, classifying diagnosing and measuring function and progress.

Great interest has been shown in isolating factors that contribute to motor development, motor learning and skilled motor performance. Stott Moyes and Henderson published their Test of Motor Impairment in 1972 (Stott et al revised, 1984). This test served as one of the first references for clinicians in the field of motor development. Krus, Bruininks and Robertson (Campbell, 1989) identified nine different aspects of gross and fine motor development and these have since become important factors in evaluating motor performance of children with developmental disabilities.

Sensorimotor systems present a more complex measurement problem. This requires the isolation of factors that impact on motor performance in the various types of dysfunction of the central nervous system.

Research into sensorimotor performance has mostly centered around the study of children with cerebral palsy. In the 1950's and 1960's the tests that appeared were mostly based on the developmental scales of Gesell (Gesell and Ilg, 1946). These tests were aimed at quantifying motor performance in order to produce developmental quotients or motor ages (Campbell, 1989). It was recognized that it is important to assess and document motor development in quantitative ways in order to measure progress in handicapped children.

The Halstead-Reitan Neuropsychological Battery was developed for the assessment of brain injured adults with the purpose of localizing the area of insult (Gilandas et al, 1984). Many of the common clinical procedures of neurological evaluation were implemented in this battery. Later Reitan validated two batteries for children.

In the 1970's the development of assessment tools for evaluating mild neurological dysfunction in children saw the light. The

Southern California Sensory Integration Test by Ayres was published in 1972 although different, separate parts had been published earlier. To this battery she added the Southern California Postrotary Nystagmus Test in 1975. Both these test were revised and replaced by the Sensory Integration and Praxis Tests in 1989 (Ayres, 1989).

In 1978 the Bruininks-Osseretsky Test of Motor Proficiency was published (Bruininks, 1978). The Miller Assessment of Preschoolers of 1982 could identify mild to moderate developmental delays in kindergarten children. The Movement Assessment of Infants by Chandler, Andrews & Swanson was published in 1980, but this test was limited to neurological assessment of infants. Miller also developed the Miller Infant and Toddler Test (Miller, 1989) and the Miller Infant & Toddler Screening for Everybaby (Miller, 1990). These two test were only viewed by the candidate as pilot editions because validation studies were still underway. However, they appear to be more comprehensive evaluation tools as they do not only address the neurological status of the infant and toddler. Assessments of daily living skills, emotional/social and cognitive development are included.

The Developmental Test of Visuo-Motor Integration by Beery and Buktinica was first published in 1982 and updated in 1989. This test became popular amongst occupational therapists because of its easy administration and expedient results. It did however not assess abilities beyond pencil and paper activities. The De Gangi-Berk Test of Sensory Integration appeared in 1983 and was aimed at the preschool child. This test however has no components of visual perception or tactile /proprioceptive or vestibular processing and usually has to be used in conjunction with other tests for a comprehensive evaluation.

## 2.2 THE NECESSITY FOR FORMAL TESTING IN OCCUPATIONAL THERAPY

Before the 1970's the pediatric occupational therapist did not have measurement tools available when evaluating the development of clients. Apart from the descriptive, qualitative scales

developed by Gesell and Ilg (Gesell and Ilg, 1946), the therapist had to depend largely upon their own clinical judgement. Even when using the Gesell scales, the therapist had to largely depend on his/her own subjective comparison of client performance to the scales.

Clinical judgements may vary because of the many uncontrolled variables within the clinical setting, i.e. sensory acuity of the clinician, differences in application of diagnostic criteria to clinical evidence, bias in expectation and error of omission or commission in gathering the evidence. Lack of uniform clinical settings may also contribute to variation of evaluation outcomes. The use of norm-referenced or standardized tests would address many of these shortcomings.

The advantages of standardized test are their objectivity, quantification of scores which contribute to communication among professionals and the relative cost effectiveness once the initial cost of development has been accounted for. The testing tool is however just as good as the user of it. The clinician is equally important to the testing as the tool itself (Campbell, 1989).

The unreliability of the clinician's observational skills have long been recognized (Campbell, 1989). Although clinicians in the area of neurodevelopment have contributed significantly to developing the theory and teaching therapeutic skills, they did not develop scientific measuring tools that could quantify behaviour and that were scientifically based.

The lack of appropriate tools has often led occupational therapists to use ill suited tests from other disciplines such as psychology or tests that were not reliable measuring instruments (Campbell, 1989). The latter may be in the form of checklists that get passed from one therapist to another and may not be understood by any other professional outside of the particular setting where it was compiled. The validity and reliability of these tests are often questionable.

Therapists have come to realise that if the validity of their measurement tools is questioned, their therapeutic intervention may also be (Campbell, 1989). If occupational therapists are to occupy their rightful place amongst other accredited professionals, clinical evaluations and practices would have to be scientifically validated.

### **3. STANDARDIZED NORM-REFERENCED TESTS**

Standardization implies a uniformity of procedures of administration and scoring of a test (King-Thomas & Hacker, 1987). The examiner attempts to keep testing conditions, item administration and scoring procedures consistent with guidelines set out by the test developer. Only through this consistency can the examiner make meaningful comparisons of results with those of the sample population on which the test was originally standardized.

"Norm-referenced tests provide scores that can be compared with a standardized comparable population." (King-Thomas & Hacker, 1987). By making these comparisons it can be ascertained whether there are differences in performance between the individual and that of the standardized group. This information is usually used for diagnostic purposes and making other decisions such as whether therapeutic intervention is desirable, what intervention would be appropriate, placement of the client, etc.

### **4. PILOT STUDIES AND THE DEVELOPMENT EDITION**

Gwyer (1989) suggested the following guidelines for developing tests.

The development edition of a test affords the researcher the opportunity of collecting vital information about the designed testing tool.

Pilot studies precede the Development Edition. These are much smaller studies and focus more narrowly on test items and

procedures. It can be seen as a try-out phase. This phase is a critical learning exercise for the refinement of ideas, items and procedures.

This try-out phase allows the developer flexibility in trying out the items on a small group without having to adhere to formal selection criteria. Various methods of administration and scoring can be experimented with. Appropriateness of materials and general content of items can be field tested and this data can then be used in refining the items.

The researcher will gather data from examiners and test subjects. Hereby the best possible test items and administration procedures can be selected for the final form of the test. This investigation can be done by observation, interview and/or questionnaire. From this the developer can glean valuable objective information about the mechanics of the test and necessary modifications can be made.

In the pilot study it is possible to examine preliminary reliability and validity of the test. An initial analysis of inter-rater and intra-rater reliability can be done by using the data from examiners and test subjects. Information regarding content validity can also be gathered at this stage which will give the developer an idea of the relationship between the test items and the domains being tested. Provisional data regarding the intended population, and appropriate sample sizes, amongst others can also be collected in this phase.

Depending on the outcomes of the pilot study, a decision can then be made as to whether further pilot studies are needed or whether the test can be regarded as a Development Edition.

## **5. RELIABILITY**

Reliability refers to the consistency or reproducibility of results. A reliable instrument yields the same results time and

again provided the subject has not changed (King-Thomas & Hacker, 1987).

In reliability studies the instrument is correlated with itself. A correlation coefficient is computed for reliability. King-Thomas and Hacker (1987) suggest that for diagnostic purposes a reliability coefficient of .90 or above is needed whereas for screening purposes a coefficient of .80 is acceptable.

For the purpose of this study only inter-rater reliability will be considered although for future development of the instrument, other forms of reliability need to be investigated such as intra-rater reliability and internal consistency.

Inter-rater reliability refers to the correlation of scores obtained by different examiners of the same subject, using the same instrument. In this instance two testers would test the same subject on different occasions under the same circumstances. Care need to be exercised to eliminate the effect of learning or immediate effect of testing and maturation. Timing would be of the essence here. Enough time should be allowed between tests so that the child does not remember the tasks or that the short term effects of tasks alter the child's response, i.e. the stimulation afforded during testing may effect immediate short term changes. It is also necessary that the second testing takes place before the subject's natural maturation has an effect.

## 6. VALIDITY

Validity refers to the extent to which tool measures what it claims to do. It refers to the "appropriateness, meaningfulness and usefulness made from the test scores" (Gwyer, 1989). Information is gathered that supports or refutes the test for the stated purposes. This is an ongoing process and one that can not be obtained from one study only. It is initially investigated as the test is developed and confirmed through subsequent use (Dunn, 1989).

For the purposes of this study only criterion-related validity will be considered although other measures of validity will have to be considered in future research, i.e. construct validity, face validity and content validity.

Concurrent validity is obtained by correlating two or more measures given to the same subject at approximately the same time, e.g. comparing tests results on two test purporting to measure the same variables. In the case of new test development, the new test is compared to one with known validity, the gold standard.

## **7. QUESTIONNAIRE DESIGN**

In the preliminary, try-out, stage of the study, the designed tool will be field tested by occupational therapists using it with children. A self-administered questionnaire will be used to collect data each time the test is administered. The works of Oppenheim (1973), and Polit and Hungler (1978) were consulted regarding this type of questionnaire design.

The self administered questionnaire has many advantages. It ensures a high response rate, accurate sampling and a minimum of interviewer bias (Oppenheim, 1973). It produces standardized responses that enable the researcher to compare responses (Polit & Hungler, 1978).

The content of questions will be determined by the goals and objectives of the study. It has to be reviewed very carefully to prevent it becoming too lengthy or complex whilst still ensuring the necessary coverage.

Once the variables to be investigated have been established, the form of question has to be decided on, i.e. open-ended or closed questions. Open-ended questions leave the respondent a wide choice of answers, are easy to construct, but more difficult to analyse. They also do not have a guaranteed response as the respondent may choose to elaborate or not. Closed questions

provide fixed alternatives from which the respondent must choose, they are more difficult to construct, easier to administer and analyse, less time consuming to answer and have a greater probability of eliciting a response. Combinations of these two types of question are recommended to offset the strengths and weaknesses of both.

Attention should be given to the sequence of questions in order for it to have a logical flow.

Wording of questions must take the following into consideration:

- The questions must be clear, concise and unambiguous;
- Responders must be able to reply, i.e. they must know the answers;
- The questions must be free of bias;
- Sensitive matters should be carefully worded to ensure a willingness on the part of the respondent to answer.

The layout and design needs careful attention to ensure a high response rate. Good visual spacing, visual markers and different colours of paper where appropriate can make the questionnaire easier to complete.

The means of data processing should also be taken into account, i.e. if a mainframe computer is used the questionnaire will need coding columns

Introductions and instructions should be clear and precise to ensure uniform completion of the questionnaires.

**CHAPTER THREE****METHODOLOGY**

This chapter describes the procedures followed in the two stages of the study. In the first section (1 to 7) a description is given of the design of the test instrument, the implementation of the field work in the try-out phase and analysis of the results. In the second section (8) the procedures followed during the investigation of validity and reliability are described.

**1. TEST DESIGN**

A test was designed to evaluate somatosensory perception in children. The areas that were covered were tactile perception and nonvestibular proprioception.

The long term intention is to develop a test that will eventually replace the existing tests for somatosensory perception of the Southern California Sensory Integration Tests (SCSIT). This test will be based on the clinical procedures used in the SCSIT.

The changes and alterations to test procedures of the SCSIT are from the candidate's own experience as well as informal communication with colleagues. To the knowledge of the candidate there is no research on the mechanical procedures of the SCSIT. The lack of this type of research may reflect on the rigorous training in the use of these tests. Once a tester has completed his/her training, procedures that are difficult to execute, no longer pose a problem. The candidate has, where possible, endeavoured to eliminate unnecessary difficult procedures. In other cases attention was given to the accuracy of measurements and allowing for remeasurement after the test has been completed.

The somatosensory perception test of the SCSIT comprises six tests, i.e. Kinesthesia, Manual Form Perception, Finger Identification, Graphesthesia, Localization of Tactile Stimuli and Double Tactile Stimuli Perception.

**1.1 KINESTHESIA OF THE SCSIT**

This test is intended to measure the capacity to perceive joint position and movement. The testee is required to replicate a

movement experienced passively. The finger of the testee is moved passively from a starting point to a designated point on a chart and returned to the starting point. The testee is then required to move the finger actively to the same point. This whole procedure is carried out whilst vision is occluded.

Fisher (1991) questions the validity of this test for proprioception as by definition, proprioception is the conscious awareness of active and not passive movement. She also reports on the low test-retest reliability and the low loading of this test in factor analytic studies. Ayres, cited by Fisher in Fisher et al (1991), said:

"I suspect that the reason Kinesthesia of the SIPIT does not show a stronger loading is that it is not really a good test. I don't know how to make it better, though. It is too dependent upon the ability to focus attention on tactile-kinesthetic input. Standing and Walking Balance is a better measure of proprioception but it also reflects vestibular processing." (1991, p. 99)

It was decided however for the development of the candidate's test to include a test resembling the Kinesthesia (SCSIT), but to emphasize that it is non-vestibular proprioception.

With the Kinesthesia test (SCSIT) some testees tended to move the finger once it had landed on the intended spot, thus making measurement inaccurate. It was also found that in testees with poor postural background movements, it was difficult to move the finger to the required spot and the limb recoiled immediately when not held by tester.

In designing the "Kinesthesia Test", attempts were made to eliminate these problems. A carriage was provided for the testee's hand to rest upon to enable the tester to maintain the testee's limb in the required position, without giving extra tactile or proprioceptive input (see plate 1, p35).

In the Kinesthesia test (SCSIT), the testee's vision is occluded by a hand held shield which allows the tester only one hand for administration. This problem was overcome by providing a free standing screen on a goose neck which could be positioned in front of the testee's face without the tester holding it. This allowed the tester the use of both hands (see plate 2, p35).



Plate 1: Adapted "mouse" for Kinesthesia test.



Plate 2: Adapted screen to occlude vision for use with all subtests.

In the Kinesthesia test (SCSIT), the tester is required to move the testee's finger to a given point on a chart. Often this exact point could not be reached in one smooth movement due to resistance in the testee's limb, thus making the point of reference on the chart an inaccurate point to measure from. This problem was overcome by providing a disposable protocol sheet for this test (see appendix 3). When the tester does not reach the exact spot indicated on the chart, a mark is made which is then used as a reference point.

The Kinesthesia test (SCSIT) does not provide a trial for learning purposes. In the experience of the candidate it was found that children often did not grasp what was expected of them and this led to some resistance of the limbs when moved passively. It was thought necessary to provide trial items where vision is not occluded.

Having to measure the distance between the reference point on chart and the point of placement of the testee's finger immediately, does not allow the tester to check the measurement at a later stage. This often leads to inaccurate measurement and possibly allowing the testee to become bored and distracted whilst the tester is measuring. This problem was overcome by the provision of the disposable protocol sheet. The tester can make a mark when the testee reaches the point that he/she chooses and measurement can be carried out later when general scoring is done.

The manual of the Kinesthesia test (SCSIT) does not indicate the time it should take for the movement of the finger on each item. The candidate included timing on the items in order to make the administration more uniform.

- The proposed "Kinesthesia test"

A disused computer mouse was chosen as a carriage for the testee's hand as this has a roller ball mechanism which provides for a smooth movement. This was adapted by adding ears to

resemble a real mouse. The electronic components of the mouse were removed (see plate 1, p35).

A typist's document holder was used for occlusion of the testee's vision. A white shield was attached to this to enlarge the area (see plate 2, p35).

A protocol sheet was designed with premarked lines of varying lengths in horizontal, vertical and diagonal planes. Each line is marked with points A and B on either end of the line. Point A is the starting point and point B is the point that the testee's limb is moved to. A column for the testee's details as well as scoring column appear on this side of the protocol sheet (see appendix 3).

A detailed instruction manual was compiled (see appendix 1). The Kinesthesia Test has a section on general operating instructions pertaining to the test room, placement of equipment, seating of tester and testee, timing of items and manipulation of the mouse. Specific instructions are given as to the administration of items with the verbal instructions given either in bold print for English and underlined for Afrikaans.

Scoring is done after completion of all tests items. The distance between point B and the mark made to indicate the tester's position is measured. In cases where the tester had to make an additional mark outside point B, the measurement is taken from this point. These distances are recorded in the scoring column for both left and right sides and each subtracted from 50, giving left and right raw scores. A total raw score is calculated by adding the measurement obtained from left and right and subtracting this from 100.

## 1.2 FINGER IDENTIFICATION TEST OF THE SCSIT

The identification of fingers touched has long been a recognised test included in the evaluation of individuals with neurological dysfunction. In this test, the testee is required to identify the

finger that is touched by the tester whilst vision is occluded. The candidate regarded this as a valuable test to include as it is widely recognised as being able to assess the spatial and temporal appreciation of tactile stimuli (Ayres, 1972b).

In the Finger Identification test of the SCSIT, the tester touches the testee's fingers with her/his own for 12 of the items and with an eraser for 4 items whilst vision is occluded. The testee is each time required to indicate the appropriate finger/fingers.

In the experience of the candidate it was found that the temperature of the tester's fingers would vary from day to day depending on the weather conditions. The length of individual tester's nails also varies which detracts from the standardised administration procedure. To overcome both these problems, rubber thimbles (turned inside out) were used. The thimbles are warmed to body temperature prior to testing by placing in a garment pocket of the tester.

- The proposed Finger Recognition Test

A selection of 18 items was made, each indicating the different positions where stimuli should be applied. The items consist of single as well as double stimuli and four single items for the lateral surfaces of fingers were included.

The tester is required to touch the designated location with the finger that is covered with a rubber thimble that has been turned inside out. These thimbles are warmed to body temperature prior to testing (see plate 3, p39).

A placement mat was designed to be taped to the table to indicate to the testee the position of the hands, i.e. spreading of fingers (see plate 4, p39).

Vision is occluded in the same way as in the previous tests. General instructions are the same for this test as for previous

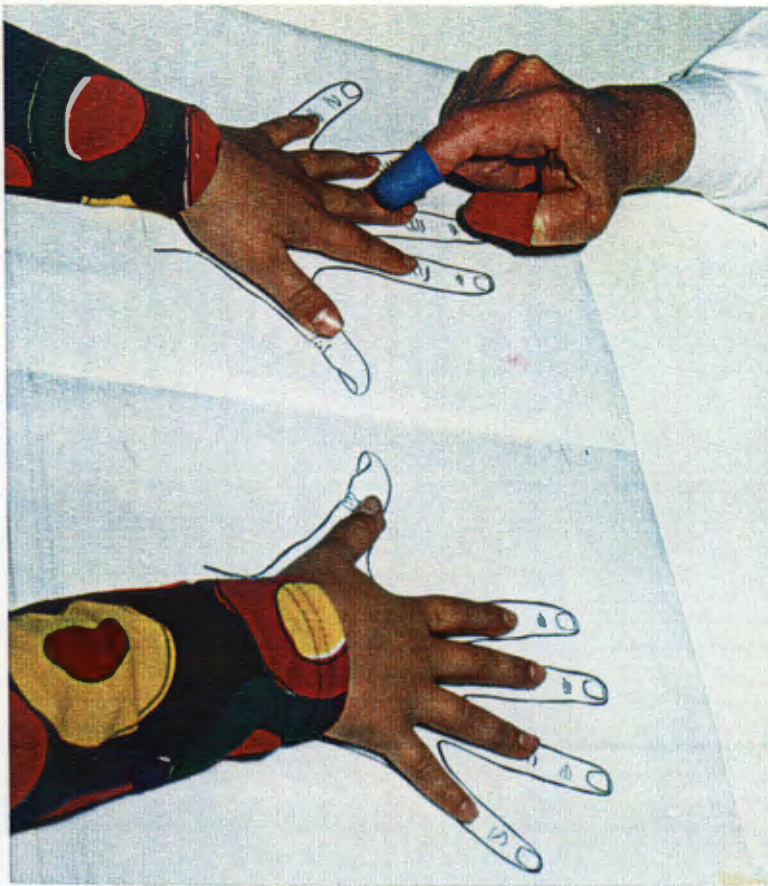


Plate 3: Use of rubber thimbles and placement mat for Finger Recognition test.

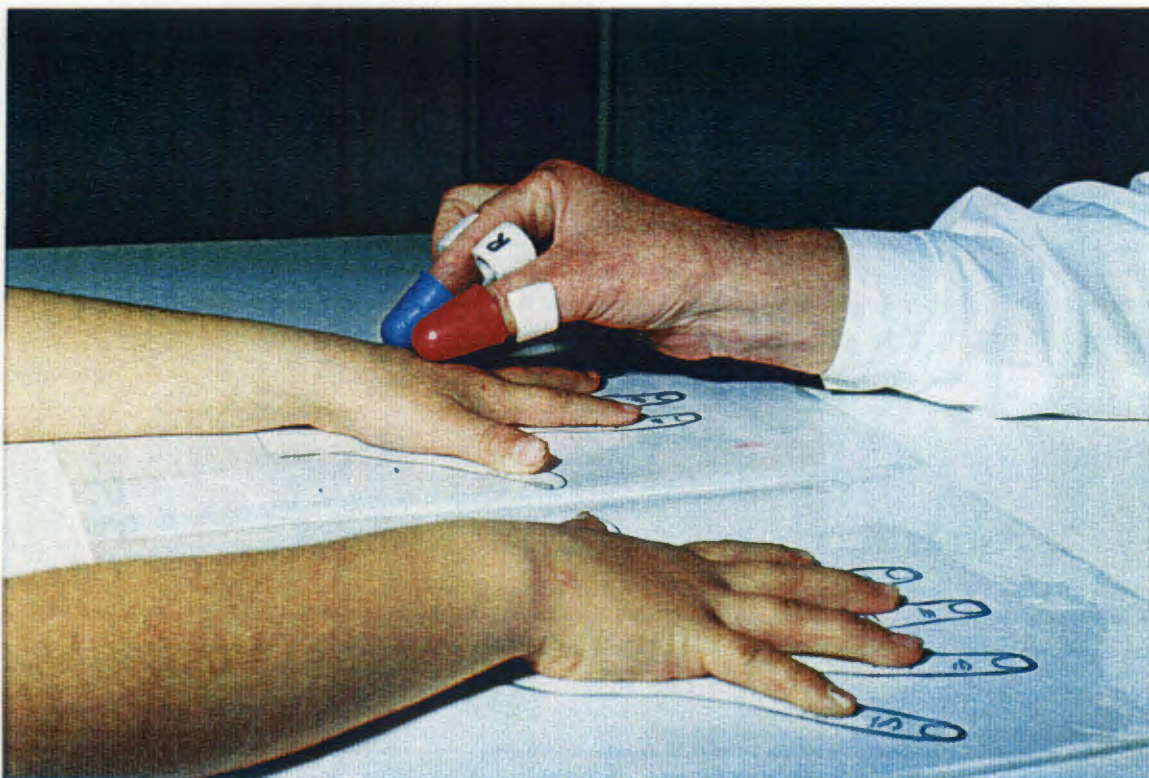


Plate 4: Use of rubber thimbles, finger splint and placement mat in Two Point Discrimination test.

test (see manual, appendix 1). Operating instructions include a description of apparatus, general instructions pertaining to placement of the mat and the use of the thimbles. Specific instructions of the administration procedures follow, giving the verbal instructions in bold print for English and underlined for Afrikaans.

A score of 2 is given for a correct response. If a child should choose a wrong finger and immediately changes his mind and then indicates the correct one, a score of 1 is given. The reason for this is that children often can identify the correct finger once the extra tactile stimulus of the wrong response is registered. This child's tactile ability lies somewhere between the correct and incorrect.

### 1.3 MANUAL FORM PERCEPTION TEST OF THE SCSIT

This test is a test of intersensory integration and is based on the classical testing of stereognosis. It involves visually identifying the 2-dimensional counterpart of a geometric form held in the hand whilst vision of the form is occluded.

The candidate proposes that Manual Form Perception test of the SCSIT evaluates the integration of sensory systems at a higher cognitive level than the somatosensory level and could lead to confusion as to the level at which the deficit has occurred.

In the candidate's experience it has been observed that poor figure ground perception often deflated scores on this test and could be misinterpreted as an inability to identify a form. It also excludes testees that are either blind or have other visual defects. For this reason it was decided to include a test for stereognosis that excludes the visual element.

The choice of form in the Manual Form Perception (SCSIT) could be culturally biased as many of the forms are frequently used in play- and educational apparatus. For this reason forms of the proposed test were selected that children are not exposed to on a regular basis.

- The proposed Form Recognition Test

In this Form Recognition Test the testee is required to identify a form placed in one hand by selecting one of three forms alternatively placed in the other hand, whilst vision is occluded.

A selection of 34 forms were chosen: four forms for trial purposes and 30 forms for testing (See plate 5, p?). The forms were all custom made. Trial items consist of two sets of wooden forms and two sets of bent spring wire forms. Test items consist of seven sets of wooden forms, one set containing wood, glass and metal and 22 sets of bent spring wire forms (see plate 5, p42).

Each set of forms consisted of a stimulus form and three other forms from which the testee had to select only one correct form. To facilitate sorting of forms, the stimulus form and the corresponding alternate form were both coded red. The other two forms were coded yellow and blue. The coding was also done in order to indicate the order of presentation of the forms when testing. For each of the items the order of presentation is indicated on the score sheet (see appendix 3). The scoring column of this test is on the back of the score sheet used for the "Kinesthesia Test".

The testee's time is recorded and one point deducted for each 50 seconds used. Space is provided for accuracy and time scores. Raw scores for the left and right hands are calculated by adding the correct responses. A total raw score is calculated by adding the left and right raw scores and subtracting the time score.

General instructions pertaining to the test milieu was the same for all the tests and appear at the beginning of the test manual (See appendix 1). Operating instructions for this test include a description of the apparatus required, general instructions pertaining to the presentation of the forms to the testee and timing procedures. Specific instructions follow, with verbal instructions given in bold print for English and underlined for Afrikaans (see appendix 1).

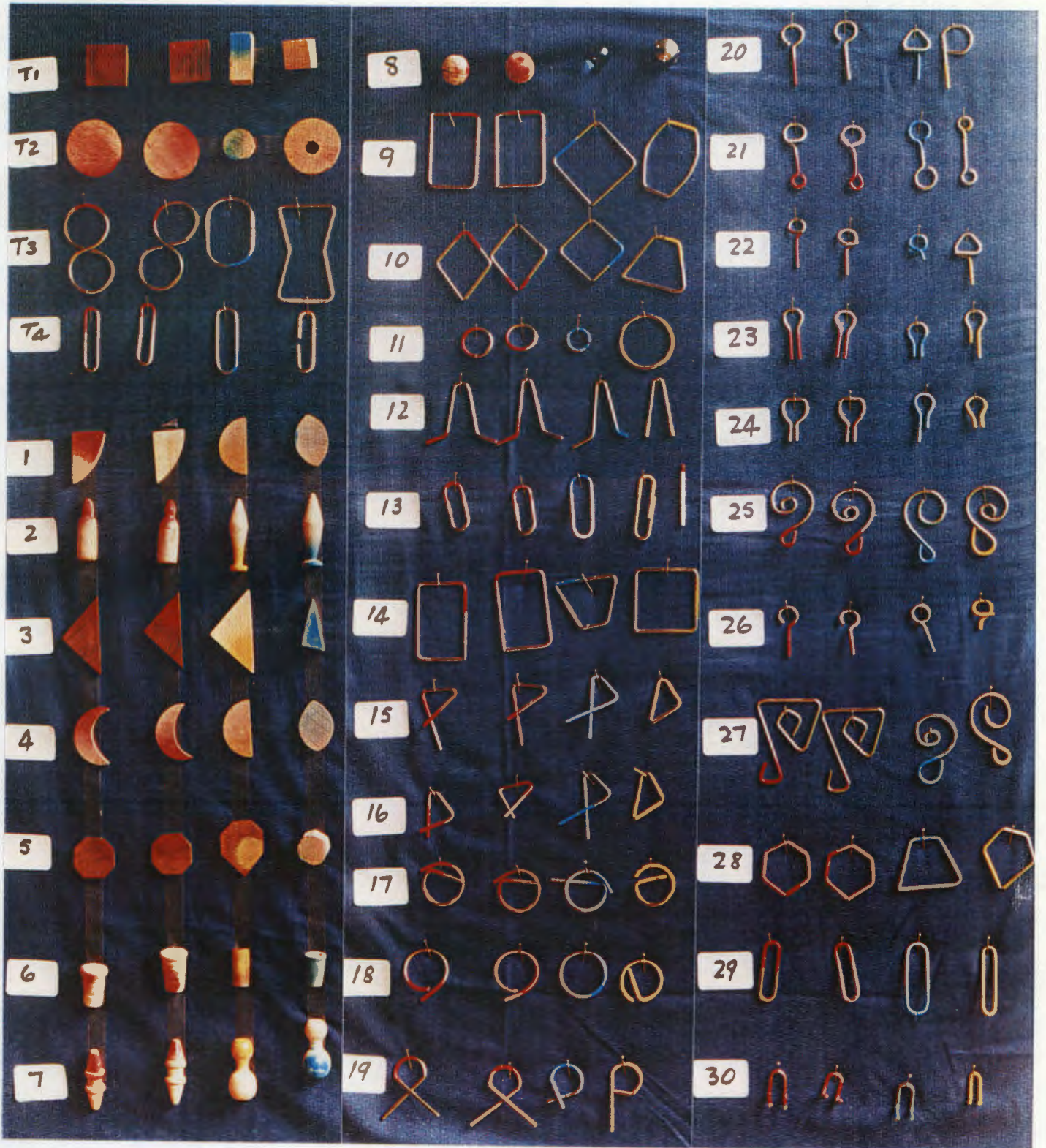


Plate 5: Shapes used in the Form Recognition test (for size comparison, see item 13).

#### 1.4 GRAPHESTHESIA TEST OF THE SCSIT

In this test the testee is required to draw the same design on the back of his/her hand as the tester drew with the eraser of a pencil.

Although this is clinically a well known procedure of evaluation, the candidate proposes that this test not only requires integration of somatosensory perception, but is to a large extent dependent on the testee's ability to plan a motor action. It is felt that it does not discriminate well enough between somatosensory perception deficit and dyspraxia which may be a result of the poor functioning of other subsystems.

The candidate therefore decided not to include a test measuring this ability in the proposed tests, but suggests that it should form part of testing at a higher level of sensory integration.

#### 1.5 DOUBLE TACTILE STIMULI PERCEPTION TEST OF THE SCSIT

This test assesses the appreciation of either one or two tactile stimuli. Single stimuli are applied to either the hand or cheek. Double stimuli are applied simultaneously to two of these locations. Clinically it has long been recognised to be of value to ascertain whether a subject can discriminate between one stimuli or two stimuli applied simultaneously (Romero-Sierra, 1986).

In Double Tactile Stimuli Perception of SCSIT the child stands with his/her back towards the tester and the stimuli are applied with the eraser of a pencil. In practice problems are experienced in placing the stimuli exactly simultaneously when the areas are far removed, i.e. right cheek and left hand. Even a short difference in arrival of the stimuli would invalidate the test item.

Difficulties are also experienced in getting the testee to stand still and not move limbs, often moving the hand away just as tester approaches. This is a particular problem in hyperkinetic

subjects. As this test is placed last in the series of Somatosensory Perception (SCSIT) tests, many children are already tired at this stage which may contribute to restlessness.

In revising the SCSIT, Ayres omitted this particular test. She gave the following reasons:

"Although some faculty members thought this was a valuable test for certain types of children, the nature of maturation of the function is such that it will never meet critics' reliability expectations. Furthermore, it is difficult to give, so it is being omitted." (Ayres, 1983)

The candidate decided to design a test of two point discrimination where the distance between the two stimuli is less in order to make the administration more accurate. The double stimuli is applied to the same area, between 8 and 10mm apart. Although this test differs from the Double Tactile Stimuli test (SCSIT), it is a well accepted procedure included in a neurological evaluation as described by Meij in Meyer, (1988). Meij reports that the shortest distance that two simultaneous stimuli can be appreciated at the level of the palm of the hand, is 2.3mm. This makes the distance of between 8 and 10mm well within the capabilities of normal subjects.

- The proposed Two Point Discrimination Test

In the Two Point Discrimination Test only the surfaces of the hands and lower arms are stimulated. This enables the testee to remain in a seated position, supporting the arms on the table, thus lessening the possibility of the limb being moved away from the approaching stimuli. This also allows the tester full vision of surfaces to be stimulated, enabling him/her to place the stimuli exactly simultaneously.

In the Two Point Discrimination Test the tester uses rubber thimbles for touching the testee on indicated locations. These rubber thimbles are warmed to body temperature by placing them in a garment pocket prior to testing. A finger splint was designed

to hold thumb and index finger at a constant distance away from each other for the double stimuli (see plate 4, p39).

A selection of 24 items were made, including 12 single items and 12 double items. Half of the stimuli are applied to the dorsal surfaces and the other half to the palmar surfaces. Vision is occluded in the same way as for the previous tests. The scoring is done on the score sheet on the back of the "Kinesthesia Test" sheet. Each correct response is scored as 1.

The general instructions regarding the test milieu are the same for this test as for the preceding tests. Operating instructions for this test include a description of the apparatus and sequential position of the test in the series. Specific instructions describe the trial procedure and test procedure. Verbal instructions are highlighted in the same way as in the other tests (see test manual, appendix 1).

Raw scores are obtained for left and right sides by calculating the number of correct responses for each side. The total raw score is the sum of the left and right scores.

#### 1.6 LOCALIZATION OF TACTILE STIMULI TEST OF THE SCSIT

In this test the testee is required to place a finger on a spot previously touched by the tester, thus tapping the spatial appreciation of tactile stimuli.

In the Localization of Tactile Stimuli (SCSIT) the tester touches the skin of the testee with a ball point pen making a mark on the skin. The testee is then required to put his/her finger on the spot where touched. The tester has to measure the distance between the pen mark and the testee's finger immediately to determine the accuracy of placement. The extra tactile stimuli that is afforded by the measurement procedure is an uncontrolled variable and detracts from the standardised administration procedures.

In practice children often tend to move the finger away once they have indicated the spot and this has proved to present problems with accuracy as testers would then have to guesstimate the distance. The tester is also not able to remeasure at a later stage.

In order to overcome both these problems it was decided to let the testee make his/her own mark on the skin when indicating the spot touched by the tester. In this way it does not matter if the testee removes his finger immediately and it allows the tester to do the measurement after all the test items have been completed.

- The Proposed Tactile Stimuli Placement Test

In the Tactile Stimuli Placement Test the tester touches the skin surface with a felt tipped pen. The testee places his/her index finger on a pre-inked stamp with a face on it and transfers the "face" to the spot where he/she was previously touched. A mark is thus left on the skin and the tester can measure the distance between the pen mark and centre of the "face". This measurement is done after all the items have been completed (see plates 6a-c, p47).

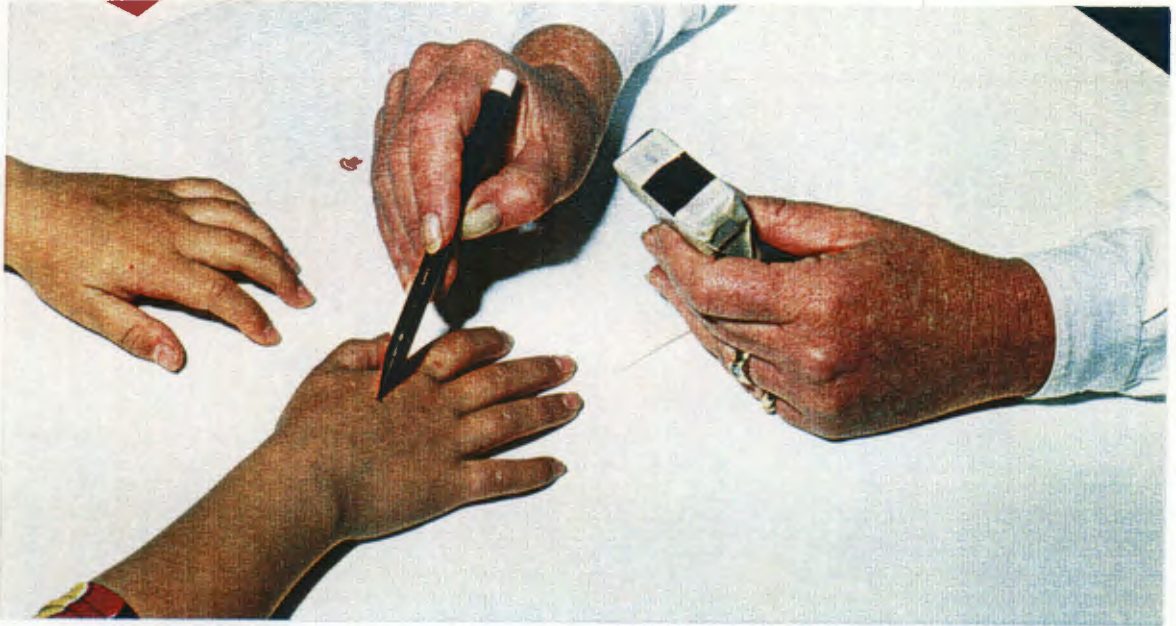
The test is devised as a fantasy game to provide extra appeal for the child. The tester pretends that the mark made with the felt tipped pen is a chocolate and the mark that the testee makes is a child that eats the chocolate.

Vision is occluded in the same way as in the previous tests.

A stamp pad "inked" with surgical spirits is provided for cleaning of the finger after each item so as to prevent smudging.

As this is the last test in the series the testee is offered a reward, a chocolate or star sticker. This is offered to the child before measuring, but withheld until after measuring to encourage him/her to allow measurement.

Plates 6a, 6b and 6c: X-stamper, koki pen and stamp pad used for tactile Stimuli Placement test.



a - tester touches testee's hand with pen;



b - testee places finger on X-stamper;



c - testee indicates where touched by pen, leaving an imprint.

Verbal instructions appear in the test manual and are highlighted in the same way as in previous tests.

Measurement is made of the distance between the pen mark and the centre of the "face". These distances are calculated for both left and right sides and each subtracted from 50 to calculate a raw score for that side. A total raw score is calculated by adding the distances for left and right sides and subtracting from 100.

## 2. QUESTIONNAIRE

A questionnaire was designed (see appendix 2) for the purpose of collecting data on the various field workers' experience with the test. A self administered questionnaire was chosen because of its high response rate, accurate sampling and the limited interviewer bias.

The questionnaire consists of a number of open ended and closed questions. The open ended questions allow for more spontaneous responses, but are time consuming later when a system of categories need to be established for a coding frame. For that reason these open ended questions were kept to a minimum. Preference was given to the closed question where responses were prompted. These prompts include simple yes/no responses, responses on a three and four point scale and others on a five point scale with the fifth category allowing an open ended response. These scales were not given in numerical order, but consist of prompts in the form of phrases, e.g. too difficult, difficult, easy and too easy.

The questionnaire contains a section on factual background information regarding the tester and testee. Factual questions related to the experience of testers, birth dates, first language, race and sex of testees. Closed questions were used in cases where classification of the subject was intended e.g. race, language, etc. Open ended questions were used to obtain an idea of the subject's previous history regarding pathology and therapy.

In the preliminary part of the questionnaire, completion of tests is recorded. Open ended questions are provided to record the reasons for discontinuation.

The questionnaire provides a separate section for each test. This consists of two parts, one section that has to be responded to after all the subtests have been completed and another section that needs to be responded to whilst testing. These latter parts are printed on green paper so that they are easily located whilst testing.

Some of the questions are repeated for each test, e.g. administration and scoring times, sufficiency of trials comprehension of verbal instructions, motivation of the testee, difficulty of administration, difficulty of test for testee and the presence of tactile defensive responses. These are all closed questions, often followed by open ended questions that allow the tester to elaborate by giving non structured comments.

For each of the subtests, questions were designed for the elements of that particular test, which the candidate suspected could present problems. In selecting these questions, the candidate drew from her own experience with other tests as well as from informal discussions with colleagues.

## 2.1 KINESTHESIA TEST

The following aspects were investigated by means of closed questions:

- Ease of movement of the mouse with the testee's hand on it;
- Size of the pen-guide;
- Accurate positioning of the mouse to starting point;
- Correct positioning of the screen;
- Resistance showed by testee to limb being moved;
- Testee's ability to remain within the limits of the score sheet;
- Testee's ability to maintain hand position on mouse;

- Tester's ability to abide by the allotted time for each item;
- Testee's motivation.

Open ended questions were provided for the following aspects:

- Comments/suggestions on verbal instructions;
- Comments on position of the hand on the mouse;
- Size of pen-guide;
- Suggestions for improving the appeal for a child;
- Comments on screen;
- General comments and/or suggestions.

## 2.2 FINGER RECOGNITION TEST

Closed questions were provided for investigation of the following aspects:

- Manipulation of thimbles;
- Switching from single to double stimuli;
- Usefulness of placement mat;
- Testee's motivation.

Open ended questions provided for the following:

- Comments/suggestions on verbal instructions;
- Suggestions for improving appeal for the child;
- General comments and/or suggestions.

## 2.3 FORM RECOGNITION TEST

Closed questions were provided for investigation of the following:

- Scoring of accuracy and time simultaneously;
- Sorting forms for presentation;
- Use of the score sheet whilst testing;
- Opinion on each item;
- Testee's motivation;

- Testee's response to each item;
- Possible problems with shape and size of forms;
- Need for reinstruction;
- Time allocation for each item.

Open ended questions provided for the following:

- Comments on score sheet;
- Number of items to be included in final test;
- Suggestions for improving the appeal for the child;
- Comment on shape and size.

#### 2.4 TWO POINT DISCRIMINATION TEST

Closed questions were provided to investigate the following:

- Use of the finger splint;
- Use of the score sheet;
- Switching from single to double stimuli;
- Testee's motivation.

An open ended question was provide for suggestions on improving the appeal for a child.

#### 2.5 TACTILE STIMULI PLACEMENT TEST

Closed questions were provided for the following:

- Testee's motivation;
- Ease of getting the testee's finger accurately on stamp;
- Willingness of the testee to wipe finger on stamp pad;
- General ease of administration of this test.

Open ended questions were provided for:

- Suggestions for improving the appeal for the child;
- Comments on administration of the test;
- Additional comments and/or suggestions.

### 3. FIELD WORKERS

Voluntary field workers were recruited from colleagues who showed an interest and a willingness to participate in the project. Only field workers with experience in testing qualified.

Criteria for qualification to participate in the study were:

Training by SAISI in test mechanics and passing the test observation. This procedure involves a therapist attending a test mechanics course after which she is observed for competence by two trained testers.

Not more than a month's lapse since the last administration of a SCSIT test.

### 4. GENERAL ARRANGEMENTS

#### 4.1 LETTERS

The questionnaire was accompanied by a letter to the testers (see appendix 4) explaining the aims of this part of the study, giving instructions on completion of the questionnaire, guidelines on selection of testees, obtaining consent and general thanks for participation.

For ethical reasons a consent form was drawn up that had to be signed by the testee's parent or guardian. This was accompanied by a letter of thanks, briefly explaining the intent of the study and offering results of the study if so required (see appendix 5).

#### 4.2 TRAINING FOR THE ADMINISTRATION OF THE TEST

The recruited field workers were geographically far apart, some as far as 60 kilometers. The study also stretched over an extended period of time. It was thus not feasible to train the

testers as a group. The test was demonstrated to each tester individually. She was then given the opportunity to practice test procedures with the candidate as subject.

Each tester was urged to familiarise herself with the procedures by using the test manual.

#### **5. SELECTION OF TESTEES**

As this part of the study was aimed at refining the test mechanics through responses obtained from testers, it was not necessary to stratify the sample.

The testers were however made aware of the age group that these tests were designed for as a guide for the selection of the testees, i.e. between the ages of 5 and 8 years. The only criterion was that the testee should be able to understand either English or Afrikaans as instructions are provided in those two languages.

An available sample from the proposed age group was obtained.

#### **6. STATISTICAL ANALYSIS**

Means, medians and standard deviations were calculated for the continuous variables. Proportions were obtained for discrete variables and a histogram was drawn for in one instance.

The Chi-square test was used to test for differences in proportions between groups, e.g. the two groups of testers that completed different numbers of items on the Form Recognition test. An analysis of variances was done to test for differences in means (with a significance level of 10%).

The Statistical Analysis System (SAS) was utilized for the necessary calculations.

## 7. COST OF TEST KIT CONSTRUCTION

Various items of the test kit had to be custom made. Where items were commercially available, these were used. In some cases adaptations had to be made to commercially available items.

In the case of the design of the score sheet, this was done as a favour and incurred no charge. The design was done on a automatic computer aided design programme using the I.A.Vision programme by MicrografX. An XY-plotter was used to plot the design. Adaptations to the document holder was also done free of charge. These cost are therefore estimated.

1. Document holder	R82.21
2. Wooden shapes (Local carpenter)	R30.00
3. Metal shapes (Cape Well Springs)	R90.00
4. Thimbles	R2.00
5. Boxes for packaging	R42.91
6. Protocol sheet (3hrs @ R80 p.h.)	R240.00
7. Adaptations	R10.00
8. Photostats of score sheets	R12.00
9. X-Stamper	R15.50
10. Stamp pad	R5.00
Total cost	<u>R529.62</u>

## 8. PILOT STUDY TO DETERMINE PROVISIONAL VALIDITY AND RELIABILITY

In the foregoing preparation, a study was made of the mechanics of the proposed somatosensory test in order to refine the procedures, select the most appropriate items and reduce the number of items if possible. These recommendations were implemented to alter the test items, change instructions, alter the score sheet and shorten the test. (See appendix 8 for revised test manual and appendix 9 for score sheet).

Note that the name of the proposed "Kinesthesia Test" was changed to Non-vestibular Proprioception to avoid confusion with the Kinesthesia Test of the SCSIT.

Following these steps, a comparative study was done to ascertain validity. The corresponding subtests of the SCSIT and the proposed somatosensory test, as developed and described above, were compared. The somatosensory tests of the SCSIT was used as the gold standard. The following comparisons were done:

<u>SCSIT</u>	<u>PROPOSED TEST</u>
Kinesthesia (KIN)	Non-vestibular proprioception (PROP)
Finger Identification (FI)	Finger Recognition (FR)
Manual Form Perception (MFP)	Form Recognition (FORM)
Localization of Tactile Stimuli (LTS)	Tactile Stimuli Placement (TSP)

Although the Two Point Discrimination subtest of the proposed test has no corresponding test on the SCSIT, it was also administered as it could possibly indicate provisional normal values. This could be of value in determining sample sizes if the test should be researched further in future.

The score obtained by 2 different raters were correlated to measure the inter-rater reliability of the proposed test. The tests used for this purpose were KIN, FR, FORM and TSP.

### 8.1 SELECTION OF SAMPLE

The target group for this study was Sub A children of the Northern Suburbs of the Cape Metropolitan area. This geographical area is inhabited by white, Cape coloured and black people. The population groups represented in the study were white and coloured children. Black children were excluded from the study. The security situation in black residential areas prevented field work at the time of the study.

The socio-economic groups represented were higher income white, middle to lower income white and lower income coloured children. This information on incomes was obtained from the Department of urban Studies of the Cape Town City Council, and are according to the 1991 census. Children were recruited from three schools in the Northern suburbs of the Cape metropolitan area. The schools were Durbanville Preparatory School (higher income white), Aristea Primary (middle to lower income white) and Alpha Primary School (Coloured group).

It was planned to randomly select between 30 and 40 subjects from the above stratified groups. The minimum necessary to enable statistical comparisons is  $n=30$  and the maximum that could be practically managed within the constraints of time and available work force,  $n=40$ .

Informed consent was obtained from parents/guardians for participation in the study (see Appendix 10). In the cases of Aristea ( $n=42$ ) and Alpha ( $n=36$ ) it was not possible to select random samples as insufficient responses were received. It was decided to include all available subjects from these two schools in the study. In the case of Durbanville a random sample of 36 was selected from 76 responses. A total of 114 subjects were recruited.

For the reliability study 10 subjects were randomly selected from the children selected for the validity study.

## 8.2 FIELD WORKERS

The candidate conducted all the field work relating to the validity study on her own. A voluntary co-worker was recruited to administer the 30 tests for the reliability study. Criteria used in selecting the field worker were formal training in the of standardized tests by the South African Institute of Sensory Integration as well as at least 5 yrs of testing experience in the clinical field.

Training of the field worker was provided by the candidate. The test procedures were demonstrated using the co-worker as subject. The co-worker practised the test procedures on the candidate as well as three children that were not part of the study. The first three tests in the field were monitored by the candidate and it was felt that the field worker's administration resembled that of the candidate. Random observations were done later on five occasions to monitor the uniform administration of the tests.

## 8.3 PLANNING OF SCHEDULES

To eliminate the effects of learning on test scores, half of the subjects were tested on the SCSIT first and the other half on the proposed test first. For the same reason the co-worker tested half of the assigned cases before the candidate and the other half after.

At least 24hrs were allowed between testing of a subject to eliminate the short-term effect of stimulation affecting test scores. Not more than 6 weeks were allowed between administration of tests to eliminate natural maturation having an effect on test scores.

The tests were administered in a small, quiet room provided at each school. A regular classroom table and chairs were provided and as far as possible visually distracting stimuli were minimized, i.e. removal of posters from walls. Only the tester and testee were present during the testing except on the occasion

where the field worker was monitored by the candidate. On these occasions the candidate positioned herself behind the testee prior to commencement of testing in order to have the least distracting effect.

The field work was completed in approximately 8 weeks.

#### 8.4. STATISTICAL ANALYSIS

The F test was used to establish for differences amongst the means of each test for each school. "Least-square" means for each subtest with age as a covariate in the model, were given in the table 4.15, p91.

The student t-test was used to evaluate differences between mean scores when grouped for gender and ethnicity.

Validity of each subtest was assessed. Sensitivity and specificity were estimated given the SCSIT scores. Box plots were done for the deficit "absent" and "present" groups, defined according to SCSIT scores. The student t-tests was used to indicate whether or not the candidate's test could discriminate between these groups.

Reliability was assessed using the Pearson intra-class correlation coefficient to measure agreement between the candidate's readings and those of another rater on 30 of the individuals. Scatter plots illustrate this.

CHAPTER IV  
RESULTS

This chapter reports on the results obtained in the preliminary try-out phase, the pilot study for determining validity and reliability and the statistical analysis thereof.

1. PHASE I: TRY OUT PHASE

1.1 REALIZED TESTERS

Seven voluntary field workers were used in this study. The aim was that each worker should complete 10 tests. Only three testers managed to complete the required number. One tester completed 9, another completed 7 and two testers completed 6 each. 58 tests were administered in total.

Testers complied to the criteria of having passed test mechanics observation by SAISI. Three testers completed observation in 1990, the others respectively in 1983, 1985, 1986, 1989. The group thus constituted a heterogeneous group in terms of experience, some having many years' experience and others with only one year's experience since passing the test mechanics observation.

The time lapse since the last test administered varied between 1 and 0 months. (Five testers had no time lapse and two had a time lapse of 1 month.)

The number of SCSIT tests administered by the field workers in the preceding year varied between 1 and 40. The tester who had only administered 1 test in the past year was included in the study because she has many years of experience, but is presently working in a teaching capacity and for that reason is not using the SCSIT on a regular basis. The other testers had administered 4, 6, 7, 20, 26 and 40 tests respectively.

## 1.2 REALIZED TESTEES

Testers selected testees from a varied group of children available to them. The only criterion was that the testees had to understand either English or Afrikaans as instructions are given in these two languages. They were asked to keep in mind that at this stage of the study the target group is 6 yrs 0 mths to 6 yrs 11 mths. Testees were numbered in chronological order.

The testees varied in age between 5 yrs 3 mths and 10 yrs 5 mths. The mean age was 7 yrs 5 mths (S.D. 1,43), median age 6 yrs 9 mths.

Of the 58 testees 41 (70.7%) were male and 17 (29.3%) were female. 56 (96.6%) of the testees were white and 2 (3.4%) were coloured.

In only 29 (50%) cases the income was known. In 5 (8.6%) of these cases the parents income was between R3000-R4000 per month; in 24 cases the income was >R4000 per month.

Language, comprehension and auditory problems had been identified in 15 (25.86%) of the cases. These were mostly multiple and included general speech and language problems, auditory discrimination, hearing loss, articulation difficulties, fluency, auditory recall and auditory sequencing, the latter two having the highest frequency (5, 6 respectively).

Of the 58 cases, in 38 (65.52%) previous physical, neurological and/or emotional problems had been identified. In 26 of the cases a learning disability had been identified; 8 cases were reported to have received physiotherapy; 4 cases were described as emotionally immature; 3 cases were described as hyperactive; 2 cases showed soft neurological signs and 1 case was reported to be short sighted.

Forty one (70.69%) of the testees had previously been evaluated by an occupational therapist. In 38 (97.4%) of these cases

problems were identified. Problems were mostly multiple (see table 4.1 below).

**TABLE 4.1: FREQUENCY OF PROBLEMS IDENTIFIED BY OCCUPATIONAL THERAPY EVALUATION**

Somatosensory perceptual problems	24
Visuo motor integration problems	24
Fine motor problems	23
Postural control problems	22
Low muscle tone	21
Gross motor problems	20
Visual perception problems	18
Lateralization problems	1
General developmental delay	1

Of these 38 cases 4 had received therapy for tactile defensiveness. The treatment included general occupational therapy, Sensory Integration Therapy and Neuro-Developmental Therapy, but mostly a combination of these techniques, lasting between 6 and 12 months. Treatment for other problems were not reported on.

### 1.3 COMPLETION OF TESTS

On the Kinesthesia test 58 (100%) of the testees completed all 10 test items.

On the Finger Recognition test 56 (96.6%) of the testees completed all 18 items. 1 testee (1.7% of the 58) completed the test up to item 6 and 1 testee (1.7%) completed up to item 13. The reason for discontinuing in both cases was given as poor cooperation.

Once field work had started it became apparent that the Form Recognition Test was unrealistically long (30 items), with the result that very few testees completed all the items. It became apparent that items 16 to 30 were not included in the study as often as items 1 to 15 and subsequently little information was gathered about those items. The decision was then made to shorten the test for testers 6 and 7 by requesting them to do only items 16 to 30. Thus 12 of the testees were not given the opportunity to complete all the items (one of these testees did not attempt any of the items). Of the 58 testees only 11 (19%) completed all 30 items. The mean number of items completed was 17.74 (S.D.=7.45), median 15. In 19 cases the testees became either fatigued, bored or refused to continue. In 15 cases the testers found the test too long.

In order to test for bias, a comparison was made between responses of testers that were requested to administer all 30 items and those who were requested to only administer the latter half of the test. The chi-square test was used with  $p < 0.01$  indicating a significant difference in the responses obtained from these two groups.

On the Two Point Discrimination test 57 (98.3%) of the testees completed all 24 items. Only 1 testee did not attempt any of the items. This testee was difficult to handle and had refused previous items.

On the Tactile Stimuli Placement test 55 (94.8%) of the testees completed all 12 items. 1 testee did not attempt any of the items and 2 testees discontinued at item 5.

#### 1.4 ADMINISTRATION AND SCORING TIMES

The total mean administration time of all 5 subtests was 63.1 minutes and scoring time 15.3 minutes. The administration and scoring times are reflected in Table 4.2, p63.

**TABLE 4.2: ADMINISTRATION AND SCORING TIMES**

Test	Adm. time per item (minutes)			Total	Score time per item (minutes)			Total
	Mean	Med	S.D.		Mean	Med	S.D.	
*Kin	0.96	0.95	0.33	9.6	0.47	0.4	0.23	4.7
*Fing	0.36	0.28	0.22	6.5	0.09	0.06	0.08	1.6
*Form	1.07	0.93	0.45	32.1	0.15	0.1	0.12	4.5
*2Point	0.25	0.21	0.01	6.0	0.08	0.04	0.08	1.9
*Tact	0.74	0.75	0.35	8.9	0.22	0.17	0.15	2.6
Combined adm. time for all tests (min)				63.1	Combined score time for all tests (min)			15.3

- \* Kin - Kinesthesia Test
- Fing - Finger Recognition Test
- Form - Form Recognition Test
- 2Point - Two Point Discrimination Test
- Tact - Tactile Stimuli Placement Test

The testees were numbered in chronological order. The testees were divided into two groups in order to compare administration and scoring times. It was hypothesized that administration and scoring times of the two groups would differ as a learning process could be involved. The administration and scoring times of the group of testees 1 to 4 were compared to the group of testees 5 and above. The mean administration and scoring times did not differ significantly, thus no evidence of a learning process could be found. (Analysis of variance was used with  $p < 0.01$ )

#### 1.5 RESULTS: TEST SCORES

Raw scores were calculated for each test as seen in Table 4.3, p.64.

**TABLE 4.3: TEST SCORES**

Test	n	Mean Score	Median	S.D.	Maximum	Minimum
*Kin	58	34.7	32.9	10.9	62.7	12.1
*Fing	58	27.4	28	6.4	36	5
*Form	58	10.4	9	5.2	25	3
*2Point	57	31.8	33	10.5	48	18
*Tact	57	81	82	6.0	90.6	61.3

## 1.6 KINESTHESIA TEST

### 1.6.1 General

In 53 (91.4%) of cases the number of trials were sufficient (see table 4.4, p68).

In 54 (93.1%) of the cases the testees could understand the verbal instructions easily (see table 4.5, p68). In 3 of the cases the tester had to demonstrate the hand position; in 1 case it was felt that there should be instruction to the testee as to what to do with the hand not in use; in 1 case extra instructions were needed on items 1, 2 and 9 and in 1 case it was reported that the testee did not grasp the instructions at all.

In 56 (96.6%) of cases the "mouse" moved easily. Comments were given as (frequency in brackets):

- the screen was in the way (2)
- tester had to use both hands to move the mouse smoothly (2)
- the tester's hand was not in a functional position (2)
- the tester needed a lot of practice (1)

- the testee showed initial resistance (1)
- the testee was difficult to handle (1)

The pen-guide was large enough in 55 (96.5%) of the cases. 9 testers felt that the pen-guide could be more accurate; in 2 cases the testee's fingers were long and covered the pen-guide and in one case the shield was in the way.

Testers were required to rate the motivation or interest of the tests for the testees on a four-point scale (see table 4.6, p69). In 13 cases the testees suggested that the "mouse" should be made to look more like a real mouse by e.g. adding a face. One tester wanted to use her own words to make the game more interesting and one tester suggested putting a picture on the screen card.

Positioning of the screen was impossible in 28 (48.3%) of the cases; in 9 (15.52%) cases a lot of practice was needed; in 9 (15.52%) cases it was easy with practice and in 12 (20.69%) cases it was easy.

Twenty comments were recorded that the screen needed attention. One tester found it easier to use the screen card on its own by holding it by hand and another tester forgot to use the screen card on the screen and thus found that the tester's vision was not obscured. Four suggestions were made that the screen should be placed opposite the testee. In 3 cases it was reported that the child rested his/her chin on the screen.

#### 1.6.2 General comments on this test (Frequency given in brackets)

- the mouse was difficult to manipulate with one hand only / longer ears would make manipulation easier / needed a lot of practice to manipulate mouse (4)
- the test is too long (7)

- instructions should be added for the testee to keep non-used hand on lap (3)
- child moved in the opposite direction (1)
- verbal instructions are too lengthy (1)
- needed instructions as to how to score item when the hand moves off the protocol sheet (1)
- which side of protocol sheet should face tester (1)
- to draw a line between the two dots only where it is confusing as to save time (1)
- enjoyable game (1)

### 1.6.3 Specific responses recorded whilst testing

On all 10 items of the test >90% of cases had an acceptable level of difficulty for the testees.

In 10% of cases the testers found item 2 too difficult to administer. On the remaining 9 items for >90% of cases the level of difficulty of administration was at an acceptable level.

Slightly more than 10% of cases showed resistance to their limb being moved on item 1. On the remaining 9 items >90% of cases showed an acceptable level of resistance.

14% of cases moved their hand off the scoring sheet on item 6. On the remaining 9 items >90% of cases stayed on the scoring sheet.

14% of cases could not maintain hand position on mouse on item 2. On the remaining 9 items >90% of cases could maintain hand position.

On items 1, 2 and 5 >10% of cases could not abide by the allotted time. On remaining 7 items >90% of cases could abide by the allotted time.

#### 1.6.4 Summary of the Kinesthesia test

Fifty eight testees completed all the items on the Kinesthesia Test obtaining raw scores ranging between 12.1 and 62.7.

The mean administration time was 0.96 minutes per item; scoring time was 0.47 minutes per item.

Verbal instruction were readily comprehended by 93.1% of the testees, with only one of the remaining testees not benefitting from extra instruction and/or demonstration.

Manipulation of the mouse was generally found to be easy (96.6%).

The pen guide was large enough in most cases, but it was commented that it was not accurate enough in 2 cases.

50% Of the testees could easily be motivated for this test. A fair amount of comment was given that the mouse was not realistic enough.

The screen seemed to be the biggest problem in this test. The testers found it difficult to position and/or needed a lot of practice with the screen before it was manageable.

The level of difficulty was generally acceptable.

Item 2 was singled out as being difficult to administer (10% of cases).

Resistance to limb being moved was seen only on item 1.

On item 6 testees' hands tended to move off the score sheet.

Only on item 2 testees tended not to maintain hand position on mouse.

It was generally easy to abide by the allotted time for each item, items 1, 2 and 5 being the exceptions.

**TABLE 4.4: SUFFICIENT NUMBER OF TRIALS**

	* Kin	*Fing	*Form	*2Point	*Tact
Not at all	2(3,4%)	1(1.7%)	0	0	0
> 1 extra needed	0	3(5,4%)	2(3.4%)	1(1.8%)	2(3.5%)
1 extra needed	3 (5.2%)	2(3.4%)	6(10.3%)	1 (1.8%)	1(1.8%)
Sufficient	53(91.4%)	52(89.7%)	50(86.2%)	55(69.5%)	54(94.7%)

**TABLE 4.5: COMPREHENSION OF VERBAL INSTRUCTIONS BY TESTEE**

	* Kin	*Fing	*Form	*2Point	*Tact
Not at all	0	1(1.7%)	0	0	1(1.8%)
Extra instr needed	4(6.9%)	8(13,5%)	12(21.1%)	2 (3.6%)	8(14.0%)
Easily understood	54(93.1%)	49(84.5%)	45(78.9%)	54(96.4%)	48(84.2%)

**TABLE 4.6: MOTIVATION/INTEREST**

	* Kin	*Fing	*Form	*2Point	*Tact
Lost interest immediately	2(3.4%)	0	5(8.8%)	0	1(1.8%)
A lot of encouragem. needed	8(13.8%)	7(12.5%)	30(52.6%)	4(7.1)	6(10.5%)
A little encouragem. needed	19(32.8%)	31(55.4%)	18(31.6%)	36(64.3%)	15(26.3%)
Keenly interested/enjoyed	29(50%)	18(32.1%)	4(7%)	16(28.6%)	35(61.4%)

### 1.7. FINGER RECOGNITION TEST

#### 1.7.1 General

In 52 (89.7%) of the cases the number of trials were sufficient (see table 4.4, p68).

The verbal instructions were easily understood by 49 (84.5%) of cases (see table 4.5, p68). In 11 cases extra instructions were needed for item 15; in 3 cases it was felt that instructions to the testee should include whether they should touch with one or two fingers; in 1 case it was felt that there should be more instructions in general and in 1 case it was necessary to add instructions to the testee to spread the fingers for the lateral surface stimuli.

The manipulation of the thimbles easy or easy with practice in 54 (94.7%) of the cases. In 6 cases it was commented that the thimbles were clumsy when the lateral surfaces had to be touched. One tester found the thimbles very uncomfortable and suggested using a surgical glove instead.

In 53 (93%) of the cases the switching from one to two fingers was easy.

In 23 (40.4%) of the cases it was felt that the placement mat was of no use at all; 22 (38.6%) found it fairly helpful and 12 (21.0%) found it very helpful. Comments were (frequency in brackets):

- the mat was a distraction for the testee (6)
- the hand size was wrong (1)
- mat was useful only initially (1)
- the position of the mat should be adapted for small testees in such a manner that elbows are at the edge of the table (1)

Interest in the test and/or motivation was rated on a 4 point scale (see table 4.6, p69). There were 2 suggestions to add a fantasy theme or use voice intonation to make the game more interesting; in 1 case it was felt that no improvement was necessary for this test.

#### 1.7.2 General comments and/or suggestions (Frequency in Brackets)

- child needed visual input to be able to indicate finger (4)
- test should consist of less items (3)
- tester changed hand usage opposite as per instruction (3)
- undercarriage of screen in way (2)
- tactile defensive responses were elicited (2)

- items 15 -18 easier for older testees (1)
- how should it be scored if more fingers are touched (1)
- should testee be encouraged to change response (1)
- change scoring from 2 to 1 and not as per instruction (1)
- easier when card is hand held instead of attaching it to the holder (1)

#### 1.7.3 Specific responses recorded whilst testing

In 16.7% of the cases it was difficult to administer items 15,16 and 18. On the remaining 15 items an acceptable level of difficulty was recorded. Although item 17 was similar to 15,16 and 18 (stimuli on lateral side of finger), it only was difficult to administer in 5% of cases.

In more than 10% of cases items 3, 4, 15, 17 and 18 were extremely difficult for the testee. In more than 70% of cases items 1, 2, 5, 6, 8, 9, 11, 12, 13, 14, 15, 16, and 17 were fairly easy.

Slight or mild tactile defensive responses were elicited on items 1, 2, 3, 4, 9, 12, 13, and 14. On the remaining 10 items no tactile defensive responses were recorded.

#### 1.7.4 Summary of finger recognition test

There were 58 tests administered with 56 testees completing all the items. Raw scores ranged between 5 and 36.

The mean administration time was 0.36 minutes per item and

scoring 0.09 minutes per item.

The number of trials were regarded as sufficient in 89.7% of the cases.

Verbal instructions were easily understood by 84.5% of the cases. Item 15 was singled out as needing extra instruction.

Manipulation of thimbles was found easy in 94.7% of the cases. The exceptions were noted for the lateral surface stimulation. One tester found that the thimbles were uncomfortable.

Switching from single to double stimuli was easy in 93% of the cases.

The placement mat was found to be of no use in 40.4% of the cases and reported to be a distraction in 6 cases. In only 21.1% of the cases was it found to be very helpful. Comments were made that it was of use only initially.

In 32.1% of the cases the testees were keenly interested in the test and 55.4% needed a little encouragement.

Items 15, 16 and 17 were singled out as being more difficult to administer.

In more than 10% of the cases items 3, 4, 15, 17 and 18 were singled out as being extremely difficult for the testee.

Tactile defensive responses were elicited on items 1, 2, 3, 9, 12, 13, and 14.

## 1.8. FORM RECOGNITION TEST

### 1.8.1 General

In 50 (86.2%) of the cases the number of trials were sufficient (see table 4.4, p68).

As previously reported testers 1 to 5 were grouped together as group A and testers 6 and 7 were grouped together as group B in order to compare their responses for items 15 to 30. Note that the groups were not randomly selected, but grouped on the grounds of the difference in exposure to test items. For comparing responses between the two groups the Chi-Square test was used with  $p < 0.01$ , indicating a significant difference. The exception here was in comparing the mean number of items suggested, where an analysis of variance test was used.

Analysis of responses regarding sufficiency of trials did not illustrate any statistically significant difference between responses of groups A and B for items 15 to 30.

In 45 (78.9%) of the cases the verbal instructions were easily understood. In 12 (21.1%) of the cases extra verbal instructions were necessary (see table 4.5, p68). In one case no comment was made. Statistically there was no significant difference between responses regarding verbal instructions between group A and B for items 15 to 30.

#### 1.8.2 Specific responses recorded whilst testing

Scoring accuracy and time simultaneously needed no practice or a little practice in 46 (79.3%) of the cases. In 10 (17.2%) a lot of practice was needed and in 2(3.4%) of the cases it was impossible. Statistically there was a significant difference between the amount of practice needed between group A and B for items 15 to 30 as seen in table 4.7, group B needing a lot more practice.

**TABLE 4.7: SCORE ACCURACY AND TIME SIMULTANEOUSLY**

Group	n	Impos- sible%	Lot of practice%	Little practice%	No practice%	X <sup>2</sup>	p
A	46	2.2	2.2	67.4	28.2	34.78	<0.0001
B	12	8.3	75.0	16.7	0		

Sorting the forms for presentation was manageable or easy in 33 (56.9%) of the cases. In 21 (36.2%) of the cases it was very confusing and in 4 (6.9%) cases it was impossible. There was statistically no difference between responses of group A and B for items 15 to 30.

Using the the score sheet whilst testing was very easy or fairly easy in 40 (69%) of the cases. In 10 (17.2%) of the cases it was difficult and in 8 (13.8%) of the cases it was extremely confusing. Statistically significant differences were found between the responses of group A and B, group B finding it more difficult as seen in table 4.9, below.

**TABLE 4.9: USE OF SCORE SHEET**

Group	n	Extrem. confusing%	Difficult%	Fairly easy%	Very easy%	X <sup>2</sup>	p
A	46	2.2	15.2	63.0	19.6	26.6	<0.0001
B	12	58.3	25.0	16.7	0		

Comments pertaining to the score sheet were (frequency in brackets):

- leave spaces between items on sheet (5)
- easier for scoring if only correct/wrong items are marked (3)
- extra line needed for time total (1)
- move column to right of sheet so that centre fold does not run through scoring column (1)
- print guide to scoring on sheet (1)

- suggest real colours on sheet (1)

The mean number of items suggested for this test was 12.16 (median 12, S.D.=1.67). Statistically significant differences were found between groups A and B for items 15 to 30. Group A suggested 12.5 (S.D.=1.6) and group B suggested 10.9 (S.D.=1.2) with  $F = 9.53$ ,  $p = 0.003$ .

Testers rated motivation and/or interest for this test on a four point scale (see table 4.6, p69).

Comments and/or suggestions for improving appeal for a child, were (frequency in brackets):

- less metal shapes (2)
- more interesting shapes (2)
- suggest alphabet related shapes (1)

Testers were required to rate their opinion on inclusion of each item on a four point scale. In the analysis this was changed to a three point scale, grouping categories "useful" and "should be included" together. This grouping was done because it was felt that similar responses were obtained in the two categories. These results are reported in table 4.8, p76.

For the purpose of best selecting items for inclusion, a goodness-of fit test (Chi-square) was used with  $p < 0.01$ . Items where significance was obtained are shown in table 4.10a, p77:

ITEM	n	OPINION %			n	DIFFICULTY %			n	SHAPE AND SIZE %						
		USEFUL/ TO INCLUDE	INDIFFERENT	EXCLUDE		TOO DIFFICULT	FAIRLY DIFFICULT/ EASY	TOO EASY		TOO BULKY	TOO SMALL	TOO IRREGULAR	VERY GOOD SIZE/SHAPE	DIFFERENCES TOO SMALL	TOO SMOOTH/ SLIPPERY	TOO MUCH KINESTHETIC INPUT/ NOT TESTING FORM
1	45	66,7	33,3	-	37	2,7	97,3	-	26	-	-	-	100	-	-	-
2	45	64,5	33,3	2,2	37	2,7	97,3	-	26	-	-	-	100	-	-	-
3	45	60,0	26,7	13,3	37	8,1	91,9	-	26	-	-	-	96,2	3,8	-	-
4	45	73,3	26,7	-	37	-	91,9	8,1	27	-	-	-	100	-	-	-
5	45	75,6	24,4	-	37	2,7	97,3	-	26	-	-	-	100	-	-	-
6	45	73,3	26,7	-	38	-	100	-	27	-	-	-	100	-	-	-
7	45	75,6	24,4	-	38	-	100	-	26	-	-	-	100	-	-	-
8	45	40,0	17,8	42,2	38	-	94,5	5,5	28	3,5	-	3,6	64,3	-	-	28,6
9	44	65,9	25,0	9,1	38	25,0	72,2	2,8	27	25,9	-	14,8	55,6	3,7	-	-
10	44	61,3	18,2	20,5	37	32,4	67,6	-	26	-	-	15,4	80,8	3,8	-	-
11	44	61,3	18,2	20,5	38	22,2	72,2	5,6	26	-	-	34,6	65,4	-	-	-
12	44	20,4	43,2	36,4	37	37,8	62,2	-	26	3,8	-	65,5	26,9	3,3	-	-
13	39	20,5	38,5	41,0	21	23,8	76,2	-	17	-	-	35,3	52,9	11,8	-	-
14	37	56,8	21,6	21,6	19	10,5	89,5	-	16	31,3	-	6,2	56,3	6,2	-	-
15	42	26,1	40,6	33,3	25	12,0	88,0	-	22	9,1	-	9,1	54,6	22,7	4,5	-
16	46	34,8	41,3	23,9	29	24,1	75,9	-	26	7,7	-	7,7	57,7	23,1	3,8	-
17	44	34,1	38,6	27,3	28	21,4	78,6	-	25	-	4,0	16,0	44,0	32,0	4,0	-
18	43	53,5	27,9	18,6	27	22,2	77,8	-	24	-	4,2	8,3	58,3	25,0	4,2	-
19	43	46,5	27,9	25,6	26	3,8	96,2	-	23	-	4,3	4,3	87,1	-	4,3	-
20	42	23,8	35,7	40,5	25	44,0	56,0	-	22	-	22,7	4,5	31,8	36,5	4,5	-
21	39	28,2	33,3	38,5	24	25,0	75,0	-	21	-	4,8	4,8	61,9	23,8	4,7	-
22	39	41,0	25,7	33,3	24	12,5	87,5	-	21	-	23,8	4,8	66,7	-	4,7	-
23	37	37,8	21,6	40,6	22	22,7	77,3	-	19	-	26,3	5,3	31,6	31,6	5,2	-
24	35	40,0	37,1	22,9	21	9,5	90,5	-	18	-	22,2	5,6	38,9	22,2	11,1	-
25	34	20,5	32,4	47,1	16	50,0	50,0	-	15	-	-	26,7	26,7	40,0	6,6	-
26	32	40,6	28,1	31,3	15	13,3	86,7	-	17	-	21,4	7,1	50,1	14,3	7,1	-
27	32	21,9	15,6	62,5	14	-	92,9	7,1	14	35,7	-	-	57,2	-	7,1	-
28	32	40,6	18,8	40,6	14	28,6	71,4	-	13	7,7	-	-	46,5	38,2	7,6	-
29	32	59,4	15,6	25,0	14	7,1	92,9	-	13	-	-	-	84,6	7,7	7,7	-
30	32	12,4	43,8	43,8	14	28,6	71,4	-	13	-	-	23,0	23,1	46,2	7,7	-

**TABLE 4.8: FORM RECOGNITION TEST: OPINION ON INCLUSION, DIFFICULTY, SHAPE AND SIZE**

**TABLE 4.10a: ITEMS FOR INCLUSION/EXCLUSION BY OPINION**

Item	n	Useful/ to include%	Indifferent %	Exclude %	X <sup>2</sup>	p
1	45	66.7	33.3	0	11.2	0.0008
2	45	64.7	33.3	2.2	10.1	0.0015
3	45	60.0	26.7	13.3	14.8	<0.0001
4	45	73.3	26.7	0	21.7	<0.0001
5	45	75.6	24.4	0	26.2	<0.0001
6	45	73.3	26.7	0	21.7	<0.0001
7	45	75.6	24.4	0	26.2	<0.0001
8*	45	40.0	17.8	42.2	10.9	0.0043
9	44	65.9	25.0	9.1	51.6	<0.0001
10	44	61.3	18.2	10.5	35.5	<0.0001
11	44	61.3	18.2	20.5	35.5	<0.0001
14	37	56.8	21.6	21.6	24.8	<0.0001
18	43	53.5	27.9	18.6	19.6	<0.0001
25*	34	20.5	32.4	47.1	10.6	0.0050
27*	32	21.9	15.6	62.5	38.9	<0.0001
29	32	59.4	15.6	25.0	31.9	<0.0001
30*	32	12.4	43.8	43.8	19.6	<0.0001

Items marked \* were rated to be excluded, whereas the others shown above were favoured to be included. Borderline items (not shown in table), where p was not <0.01, were 12 (p = 0.070, excluded), 13 (p = 0.0234, excluded), 19 (p = 0.01935, included) and 23 (p = 0.0433, excluded).

Responses of group A on their opinion for inclusion of items were compared to the responses of group B for items 15 to 30 (see table 4.10b, p.78). In indicating opinions on whether items

should be included or not, statistically significant differences could be illustrated between the two groups on items 15, 22, 24 and 27. Group B tended to favour these items more than group A. Other items which showed a similar tendency, but with p values not  $<0.01$ , were items: 16 ( $p = 0.010$ ), 17 ( $p = 0.016$ ), 18 ( $p = 0.017$ ), 19 ( $p = 0.014$ ), 25 ( $p = 0.014$ ), 29 ( $p = 0.013$ ) and 30 ( $p = 0.026$ ).

**TABLE 4.10b: COMPARISON OF A AND B ON ITEMS 15 TO 30 FOR INCLUSION**

Item/group	n	Excl. %	Indiff.%	Useful/Incl.%	X <sup>2</sup>	p
15	A	36	38.9	47.2	13.9	19.3 <0.0001
	B	6	0	0	100	
22	A	28	46.4	25.0	28.6	12.0 0.002
	B	11	0	27.3	72.7	
24	A	27	29.7	44.4	25.9	11.2 0.004
	B	8	0	12.5	87.5	
27	A	25	80	20	0	33.6 <0.0001
	B	7	0	0	100	

Testers were required to rate the difficulty of each item on a four point scale. In the analysis this changed to a three point scale, grouping categories fairly difficult and fairly easy together. This grouping was done because similar responses were obtained in these categories. These responses are reported in table 4.8, p76.

A comparison was also made between the rating of difficulty of items by groups A and B. A tendency was seen in group B to rate items 21, 23 and 24 as more difficult than group A as seen in table 4.11, p79.

**TABLE 4.11: COMPARE A AND B BY DIFFICULTY**

Item/group	n	Too diff%	Fairly diff/ easy %	Too easy %	X <sup>2</sup>	p
21	A	12	16.7	8.3	13.10	0.001
	B	12	33.3	58.4		
23	A	11	18.2	9.1	11.46	0.003
	B	11	27.3	63.6		
24	A	11	9.1	27.3	12.80	0.002
	B	10	10.0	90.0		

Other items where a similar tendency was seen, but with p values not  $<0.01$  were items: 16 ( $p = 0.034$ ), 18 ( $p = 0.014$ ), 26 ( $p = 0.041$ ) and 28 ( $p = 0.044$ ).

Testers were required to give an opinion on the shape and/or size of the test items. Four prompted responses and one open response, ("other"), were provided. The responses obtained in the "other" category were sorted into three additional categories, i.e. "differences too small", "too smooth/slippery" and "too much kinesthetic input / not testing form". These responses are reported on in table 4.8, p76. Here no comparison could be made between groups A and B as the groups were too small.

Time allocation was adequate in 60% or more of the cases for all items except items 13, 16, 20, 23 and 30. In 20% or more of the cases 15 seconds more was required on items 10, 16, 17, 20, 26 and 30. More than 15 seconds more was required in 20% or more cases for items 12, 13, 23 and 30.

In more than 90% of the cases no tactile defensive responses were elicited on all items except items 11, 12, 13 and 19 where only slight or mild responses were elicited.

No statistical data could be processed regarding reasons for non

completion of items by testees as the responses obtained from testers were not uniform and therefore could not be grouped.

1.8.3 General comments on this test were (Frequency in brackets)

too many items	(29)
include instructions to manipulate forms and not to use two hands for manipulation	(5)
instructions to tester should include what to do if the testee accidentally sees the shapes	(5)
items should be better graded	(3)
too many trials	(3)
container is difficult to handle	(3)
suggest a score of 2,1 and 0	(2)
instructions to tester should include whether to wait for a response or not	(2)
tester needed a lot of practice	(2)
a noisy game	(2)
suggest a flat wire with texture to prevent slipping	(2)
shapes hurt testee /tactile defensive response	(1)
tester got sequence wrong	(1)
discontinue after 5 cumulative errors	(1)

tester had to add extra instructions /change  
voice intonation to keep the testee's attention (1)

instructions to tester should include the  
position of the shapes placed in testee's hand (1)

pieces are difficult to handle (1)

which hand is being tested? (1)

#### 1.8.4 Summary of form recognition test

This test was the test that presented most problems, therefore much more statistical analysis was done for it than for the others as can be seen from the text above.

The number of trials were generally considered to be sufficient, but comment was also obtained that there could be fewer trials.

Scoring time and accuracy simultaneously presented no problems in 79% of the cases. It was however found that with more practice this task became easier for the tester as the testers who were only requested to do half of the items needed a lot more practice.

Sorting the forms for presentation was manageable or easy only in 56.9% of the cases. There was no indication that this task became easier with practice.

Use of the score sheet presented little or no problems in 69% of the cases. With more practice this task became easier as the group that only administered half of the items found it more difficult. Suggestions regarding information on the score sheet included better spacing, adding a line for the time total, printing score guide on sheet and moving column to the right so that centre fold does not run through scoring column.

The mean number of items suggested for this test was 12. The

group that only administered half of the items consistently suggested less items.

Only 7% of the cases was keenly interested in or enjoyed this test. Mostly the testees needed to be encouraged to complete this test and 8.8% of cases lost interest almost immediately. It was felt that less metal shapes should be used and shapes could be made more interesting.

Items 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 14, 18 and 29 were rated as useful or to be included in the test. Items 8, 25, 27, and 30 were regarded as items that should be excluded. From these results it was suspected that where an item had been used more often the chances were that it would be chosen more often for inclusion. This bias could be illustrated in items 15, 22, 24, and 27.

In rating the difficulty of items bias could be illustrated for the group that only administered half of the items. This group tended to find items 21, 23 and 24 more difficult than the group that were requested to administer all 30 items. The same tendency was seen for items 16, 18, 26 and 28, but with less significance.

In 60% or more of the cases items 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 19, 21, 22 and 29 were regarded as having a good size and shape. Although item 8 was included here, in 28.6% of the cases it was felt that there was too much kinesthetic input and that it was not suitable for testing form alone. There could not be tested for bias between the group that was requested to administer only half of the items and the other group, because having 7 categories the groups became too small.

It was felt that the time allocation for individual items was adequate in 60% of the cases for all items except items 13, 16, 20, 23 and 30.

Only slight or mild tactile defensive responses could be elicited on items 11, 12, 13, and 19. On the rest of the items no tactile

defensive responses were elicited,

### 1.9. TWO POINT DISCRIMINATION TEST

#### 1.9.1 General

In 55 (96.5%) of the cases the number of trials were sufficient (see table 4.4, p68).

The ease of the use of the finger splint was impossible in 22 (38.6%) of the cases. In 15 (26.3%) of cases it was very difficult; in 10 (17.5%) of the cases it was difficult and in 10(17.5%) it was easy. Nine testers commented that the splint hurt/ was clumsy and/or was taken off.

The use of the score sheet was impossible in 8 (14.3%) of the cases. In 8 (14.3%) of cases it was very difficult; in 21 (37.5%) cases it was difficult and in 19 (33.9%) cases it was easy.

#### 1.9.2 Comments relating to the score sheet were (Frequency given in brackets)

- swap protocol sheet around as to present  
a mirror image (14)
- give scoring guide on sheet (1)

In 54(96.4%) of the cases the verbal instructions were easily understood (see table 4.5, p68).

Switching from one to two stimuli needed no practice / or needed only a little practice in 45 (80.4%) of the cases. In 10 (17.9%) of cases it needed a lot of practice and in 1 (1.8%) case it was impossible. In 2 cases no comment was made here.

Motivation for / and interest in the test for the testee was rated on a four point scale (see table 4.6, p69). Most cases (64.3%) needed little encouragement.

1.9.3 General comments and/or suggestions for this test  
(Frequency in brackets)

- extra verbal instructions were needed to turn arms over, pull up sleeves and/or to keep palms open (7)
- test should have less items and/or trials (6)
- specify pressure needed (1)
- spacing needed practice (1)
- suggest using surgical glove instead of thimbles (1)
- tester used only card and not full screen (1)
- difficult child to test (1)

Items 3, 8, 10, 14 and 17 were difficult to administer in more than 20% of cases. The remaining 19 items were very easy or easy with practice (see histogram 9, p84b).

Items 21 and 24 were extremely difficult in 10.53% of cases items 2, 3, 5, 8, 10, 13, 14, 17, 18, 20, 23 and 24 were fairly difficult in more than 10% of the cases.

In 14% or more of the cases slight or mild tactile defensive responses were elicited on items 3, 4, 5, 7, 9, 12, 14, and 15.

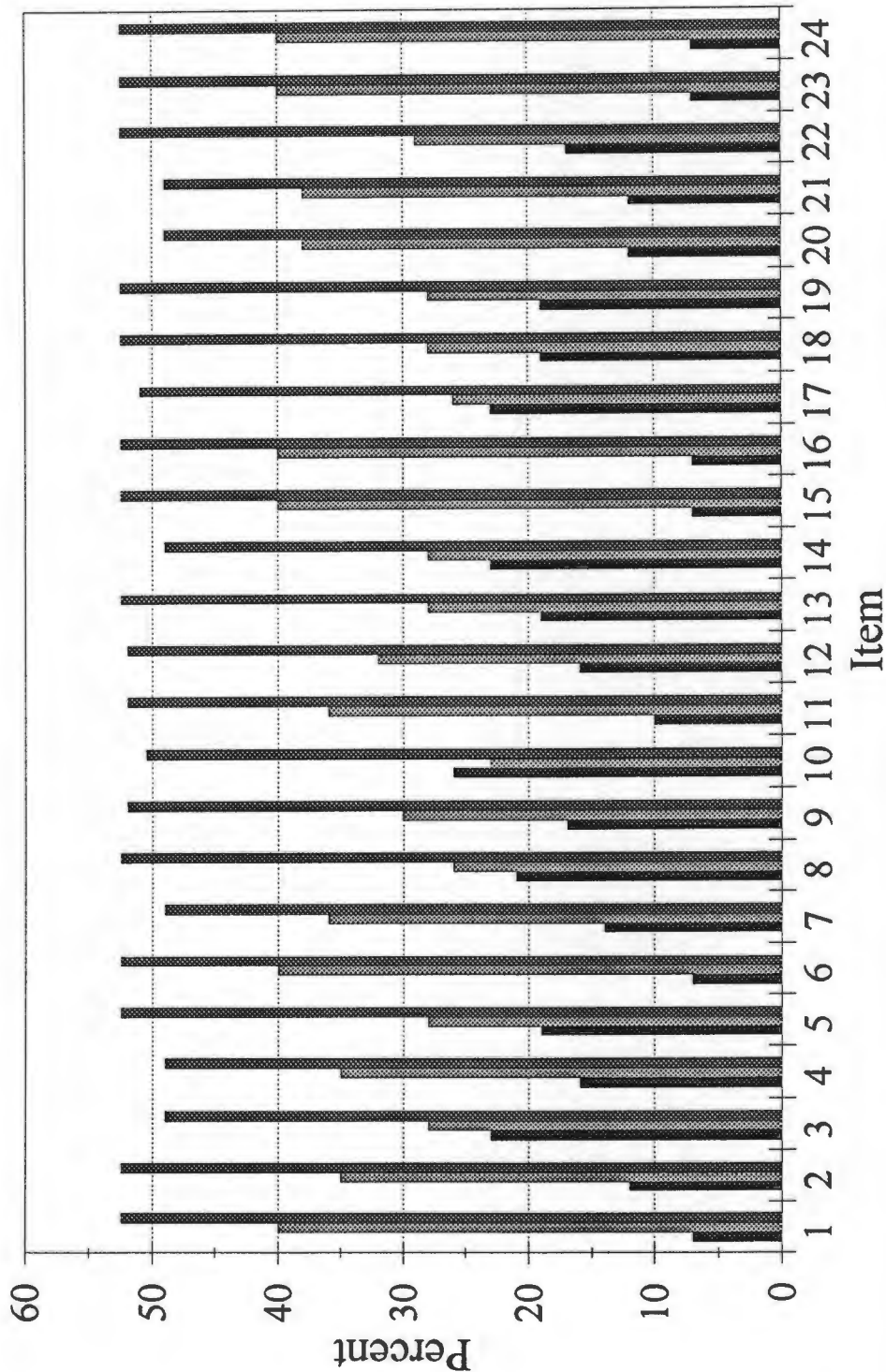
1.9.4 Summary of two point discrimination test

Fifty seven tests were administered and in all cases all the items were completed. Raw scores ranged between 18 and 48.

The mean administration time was 0.25 minutes per item and scoring 0.08 minutes per item.

HISTOGRAM: TWO POINT DISCRIMINATION TEST: DIFFICULTY OF ADMINISTRATION

**TWO POINT DISCRIMINATION TEST  
DIFFICULTY OF ADMINISTRATION**



DIFFICULT
  EASY/PRACTICE
  VERY EASY

The number of trials were generally considered to be adequate.

Use of the finger splint presented problems. In only 17.5% of the cases it was easy. Testers tended to discard the splint and administered the double stimuli by estimating the distance between fingers.

The score sheet was difficult to use as it did not present a mirror image to the tester.

Verbal instructions were generally easily understood. It was suggested that extra instructions were needed for the testees to turn arms over, pull up sleeves and to keep the palms open.

Switching from single to double stimuli needed little or no practice in 80.4% of cases. In only 1 case it was impossible.

Testees could generally be motivated to complete this test with only a little or no encouragement.

Items were generally considered to be easy to administer with the exception of items 3, 8, 10, 14 and 17 where 20% of the cases found it difficult.

Items 21 and 24 were singled out as being the most difficult items for the testees.

Only slight or mild tactile defensive responses could be elicited in 8 of the items in 14% or more of the cases.

#### 1.10 TACTILE STIMULI PLACEMENT TEST

##### 1.10.1 General

The number of trials were sufficient in 54 (94.7%) of the cases (see table 4.4, p68).

In 48 (84.2%) of the cases the verbal instructions were easily

understood (see table 4.5, p68).

Motivation and or interest for this test was rated on a four point scale (see table 4.6, p69). Most cases (61.4%) were keenly interested.

1.10.2 Comments on interest and suggestions for improving the appeal for a child were (Frequency given in brackets)

- child did not like the spots on the arms; some Jewish testees found this particularly stressful (5)
- child loved the game (5)
- child complained of smell of spirits (3)

Getting the testee to place finger correctly on stamp was impossible in 1 (1.8%) of the cases. In 19 (33.8%) of the cases the testee needed to have his/her finger placed by tester; in 21 (36.8%) of cases extra verbal instructions were necessary and in 16 (28.1%) of cases the testees performed this task spontaneously.

In 56 (87.5%) of the cases the testees wiped their fingers on stamp pad upon instruction or only needed a little encouragement In 2 (3.5%) of the cases a lot of encouragement was needed

In 26 (45.6%) of the cases the general administration of the test was easy with a little practice; in 7 (12.3%) of cases a lot of practice was needed. In 19 (33.3%) of cases it was felt that the test consisted of too many steps and in 5 (8.8%) cases it was felt the test was much too cumbersome.

1.10.3 General comments on this test were (Frequency in brackets)

- too many steps involved (3)

- testee used excessive pressure on stamp  
thus smudging the face and/or possibly  
influencing the score (3)
- very messy game (2)
- instructions or trials were inadequate (2)
- screen was difficult to position (2)
- instructions not clear whether to measure  
in cm or mm (1)
- suggest combining cleaning pad and stamp  
in one unit (1)
- suggest two stamps, one on either side (1)
- Afrikaans instructions not exactly the  
same as English (1)
- brown mark resembled a beauty spot and  
was confusing (1)
- swapping the dorsum with upper arm would  
make administration easier for tester (1)

Items 2, 3, 8 and 11 were difficult to administer in more than 20% of the cases.

Items 1, 2, 3, 4, 5, 6, 8, 11 and 12 were fairly difficult for more than 20% of the testees.

Slight tactile defensive responses were elicited in more than 6% of cases on items 1, 2, 3, 4, and 5.

#### 1.10.4 Summary of Tactile Stimuli Placement Test

57 Tests were administered of which 55 testees completed all the items with raw scores ranging between 61.3 and 90.6.

The administration time was 0.74 minutes per item and scoring 0.22 minutes per item.

The number of trials were generally considered adequate.

Verbal instructions were easily understood in 84.2% of the cases.

Motivation for this test was the highest of all the tests with 61.4% of cases being keenly interested and/or enjoying the exercise. It was commented that some children objected to having the mark on their skin and that others didn't like the smell of the spirits.

Problems were experienced with getting the testees to place their fingers correctly on the stamp with some needing extra instruction and others needing their finger initially placed by tester.

Little or no encouragement was needed to get the testees to clean their fingers on the stamp pad.

In only 45.6% of the cases the general administration of the test was found to be easy. It was felt that the test was cumbersome and that there were too many steps involved. Some testers felt that this was a messy game and in some cases the testees used excessive pressure to feel the stamp, thus smudging the print. Suggestions were made to incorporate the stamp and cleaning pad or to use two stamps, one on either side.

The most difficult items to administer were items 2, 3, 8 and 11.

The most difficult items for the testees were items 1, 2, 3, 4, 5, 6, 8, 11 and 12.

Very little tactile defensive responses were elicited with items 1, 2, 3, 4 and 5 eliciting slight responses in more than 6% of cases.

## 2. PHASE II: PILOT STUDY

### 2.1 TESTERS

Table 4.12 below reflects the number of tests administered by the candidate and the co-worker.

**TABLE 4.12: TESTERS AND TESTS ADMINISTERED**

SCSIT		PROPOSED TEST		
Candidate		Candidate		Co-worker
Test	Number	Test	Number	Number
KIN	114	PROP	114	30
MFP	114	FR	114	30
FI	114	FORM	114	3
LTS	114	TPD	114	
		TSP	114	30

#### KEY:

SCSIT: Kinesthesia - KIN  
 Manual Form Perception - MFP  
 Finger Identification - FI  
 Localization of Tactile Stimuli - LTS

PROPOSED TEST: Non-vestibular Proprioception - PROP  
 Finger Recognition - FR  
 Form Recognition - FORM  
 Two Point Discrimination - TPD  
 Tactile Stimuli Placement - TSP

### 2.2 REALIZED TESTEES

A total of 114 subjects were tested. Of these 36 were coloured children and 78 white children. There were 60 male subjects and

54 female (see table 4.13 below). Ages ranged from 6yr 0mths to 8yrs 5mths. For the purpose of the statistical analysis the age group 6yrs 0mths - 6yrs 5mths was discarded since only 1 subject was in that age group (N = 113).

**TABLE 4.13: REALIZED TESTEES**

Age level	Ethnic group			Gender	
	n	White	Coloured	Male	Female
6.0 - 6.5	1	0	1	1	0
6.6 - 6.11	21	7	14	12	9
7.0 - 7.5	50	37	13	20	30
7.6 - 7.11	33	29	4	19	14
8.0 - 8.5	9	5	4	8	1
Total	114	78	36	60	54

### 2.3 A COMPARISON OF SCORES OBTAINED IN DIFFERENT SCHOOLS

Significant differences were found between performance of subjects from Alpha and the other two schools on the SCSIT tests. Scores of Alpha were significantly lower on the Kinesthesia, Manual Form Perception and Finger Identification tests, but higher on the Localization of Tactile Stimuli test (see table 4.15, P.91). All three mean ages for the schools lie within the age group 7yrs 0mths to 7yrs 5mths. (see table 4.14 below)

**TABLE 4.14: MEAN AGES IN SCHOOLS**

School	N	Mean	SD
Alpha	36	7.2	0.51
Durbanville	36	7.4	0.35
Aristea	42	7.5	0.42

**TABLE 4.15: DIFFERENT SCHOOLS vs. TEST SCORES**

Test	School						F	p
	Alpha		Durbanville		Aristea			
	n = 36		n = 36		n = 42			
	Mean	SE	Mean	SE	Mean	SE		
KIN	65.9	1.4	71.7	1.4	73.7	1.3	8.28	0.0004
LTS	82.6	0.9	78.5	0.8	79.1	0.8	6.69	0.0018
MFP	6.3	0.4	8.4	0.4	8.4	0.3	11.39	0.0001
FI	10.2	0.4	11.0	0.4	12.3	0.4	6.03	0.0033

#### 2.4 COMPARISON OF SCORES OBTAINED BY DIFFERENT ETHNIC GROUPS

Significant differences in scores were found between ethnic groups on some tests for specific age groups. Only those differences that were significant are reported (significant at the 5% level). See table 4.16, below.

**TABLE 4.16: ETHNIC GROUPS vs. TESTS SCORES**

Test	Age level	White		Coloured		t	p
		Mean	SD	Mean	SD		
KIN	7.0 - 7.5	73.6	6.6	66.3	6.5	3.40	0.0014
LTS	6.6 - 6.11	74.0	6.2	82.9	3.2	3.55	0.0081
MFP	7.0 - 7.5	8.5	2.1	5.8	2.6	3.73	0.0005
LTS	7.0 - 7.5	80.1	5.0	83.3	4.2	2.08	0.0434
MFP	7.6 - 7.11	8.7	1.9	6.5	2.1	2.15	0.0395
FI	8.0 - 8.5	13.8	1.3	9.8	1.0	5.06	0.0023

## 2.5 GENDER DIFFERENCES IN SCORES

Differences between male and female performance were not significant except in the 7.0 - 7.5 age group on the Localization of Tactile Stimuli test ( $p = 0.0426$ ).

## 2.6 DISTRIBUTION OF SCORES

The following means and standard deviations of the proposed test were obtained (table 4.17):

**TABLE 4.17: DISTRIBUTION OF TEST SCORES FOR 6 MTH AGE INTERVAL:  
TEST vs. AGE**

		PROP		FR		FORM		TPD		TSP	
Age	n	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
6.6 - 6.11	21	65.8	16.5	14.2	4.4	6.7	1.8	9.0	1.6	79.6	5.8
7.0 - 7.5	50	71.1	9.6	15.7	3.7	7.1	1.9	9.4	1.6	80.5	5.0
7.6 - 7.11	33	75.1	6.8	15.6	3.6	7.8	1.9	9.5	1.4	79.7	6.0
8.0 - 8.11	9	66.9	8.2	14.9	4.1	6.9	2.4	9.7	1.7	82.3	4.7

**KEY:** PROP - Non-vestibular Proprioception  
 FR - Finger Recognition  
 FORM - Form Recognition  
 TPD - Two Point Discrimination  
 TSP - Tactile Stimuli Placement

Standard scores were calculated according to the method proposed by Ayres, 1980, i.e.:

$$\text{Standard score} = \frac{\text{Raw score} - \text{mean}}{\text{Standard deviation}}$$

The above values were used to calculate standard scores for each child. A deviation of -1 standard deviation was used for each subtest to determine the group where deficit was present. This cut-off point separates the lower functioning 17% of the population and one can expect to find subjects with poor function in this group.

## 2.7 DETERMINATION OF SENSITIVITY AND SPECIFICITY

In order to evaluate the validity of subtests of the proposed

test, the results obtained for the subtests were compared to results of the SCSIT, which was used as the definitive diagnostic procedure. Acceptable validity of the somatosensory subtests of SCSIT was established by comparing results of the SCSIT tests to results on the Luria-Nebraska Neuropsychological Battery, Children's revision (Kinnealey, 1989).

### 2.7.1 Kinesthesia and Non-vestibular proprioception

In the comparison between the tests KIN and PROP a sensitivity level of 36.36% and a specificity level of 86.27% was obtained (table 4.18 below).

**TABLE 4.18: KINESTHESIA AND NON-VESTIBULAR PROPRIOCEPTION**

		KIN Deficit		Total
		Present	Absent	
PROP Deficit	Present	4 36.36%	14 13.73%	18 15.9%
	Absent	7 63.4%	88 86.27%	95 84.1%
Total		11(9.7%)	102(90.3%)	113

### 2.7.2 Manual Form Perception and Form Recognition

A sensitivity level of 20% and specificity level of 92.31% was obtained in the comparison of scores on MFP and FORM (table 4.19 below).

**TABLE 4.19: MANUAL FORM PERCEPTION AND FORM RECOGNITION**

		MFP Deficit		Total
		Present	Absent	
FORM Deficit	Present	7 20%	6 7.69%	13 11.5%
	Absent	28 80%	72 92.31%	100 88.5%
Total		35(31%)	78(69%)	113

### 2.7.3 Finger Identification and Finger Recognition

In the comparison of scores the Finger Identification and Finger Recognition tests a sensitivity level of 32.14% and specificity level of 87.06% was obtained (table 4.20 below).

**TABEL 4.20: FINGER IDENTIFICATION AND FINGER RECOGNITION**

		FI Deficit		Total
		Present	Absent	
FR Deficit	Present	9 32.4%	11 12.94%	20 17.7%
	Absent	19 67.86%	74 87.06%	93 82.3%
Total		28(24.8%)	85(75.2%)	113

### 2.7.4 Localization of Tactile Stimuli and Tactile Stimuli Placement

A sensitivity level of 15.79% and specificity level of 86.67% was obtained in the comparison of scores on Localization of Tactile Stimuli and Tactile Stimuli Placement tests (table 4.21 below).

**TABLE 4.21: LOCALIZATION OF TACTILE STIMULI AND TACTILE STIMULI PLACEMENT**

		LTS Deficit		Total
		Present	Absent	
TSP Deficit	Present	6 15.79%	10 13.33%	16 14.2%
	Absent	32 84.21%	65 86.67%	97 85.8%
Total		38(33.6%)	75(66.4%)	113

## 2.8 ADDITIONAL VALIDATION FOR ONE AGE GROUP ONLY

Further investigation into the power of discrimination was done by not using the standard scores, since these could not be reliable estimates due to small sample sizes. Analysis was done within age intervals since SCSIT results indicated changes over 6month age intervals (Table 4.15, p.91). The largest of these groups was the one 7yr to 7yrs 6mths (n = 50).

An attempt was made to establish construct validity. The SCSIT was used as the gold standard. From this group of 50 subjects, two groups were defined, i.e. deficit definitely absent (DA) and deficit definitely present (DP). The deficit absent group had to have normal scores on all four sub tests and the deficit present group had to have abnormal scores on two or more of the sub tests. This resulted in 22 deficit absent and 10 deficit present subjects (n = 32).

**TABLE 4.22: DEFICITS VS TESTS**

Deficit						
Present (n = 10)			Absent (n = 22)			
TEST	Mean	SD	Mean	SD	t	p
PROP	67.4	10.3	75.1	7.4	2.388	0.0237
TSP	79.7	4.2	82.1	4.3	1.44	0.1603
FR	13.4	3.3	17.3	2.8	3.44	0.0017
FORM	5.6	2.2	7.8	1.9	2.91	0.0067

A level of 1% was used to determine statistical significance.

Mean differences were not statistically significant ( $p > 0.01$ ) for the Non-vestibular Proprioception and Tactile Stimuli Placement tests.

In the case of the Form Recognition test statistically

significant differences were computed between the deficit absent and deficit present groups ( $p < 0.01$ ). If 7 correct items out of the available 12 are taken as deficit absent, sensitivity of 60% and specificity of 71% is obtained. This implies that if 7 is taken as a cut off point, 29% of the the true normal values fall in the abnormal range and 40% of the true abnormal values fall in the normal range (see box plot 1, p.96a).

Statistically significant mean differences were calculated between the Deficit Present and the Deficit Absent tests ( $p = 0.006$ ). This indicates a statistically significant difference between the deficit present and deficit absent groups, at a cut-off score of 15. Although the sensitivity (27.3%) and specificity (30%) levels were very low, the subtest warrants further investigation (see box plot p.96a).

The apparant differences between the deficit present and absent groups were interesting as these subjects were not intentionally chosen as particularly well functioning or particularly poorly functioning children. It is thus envisaged that if these groups were selected according to clinical measures prior to a follow-up study, one would expect more definite differences between the groups.

Key to box plots:

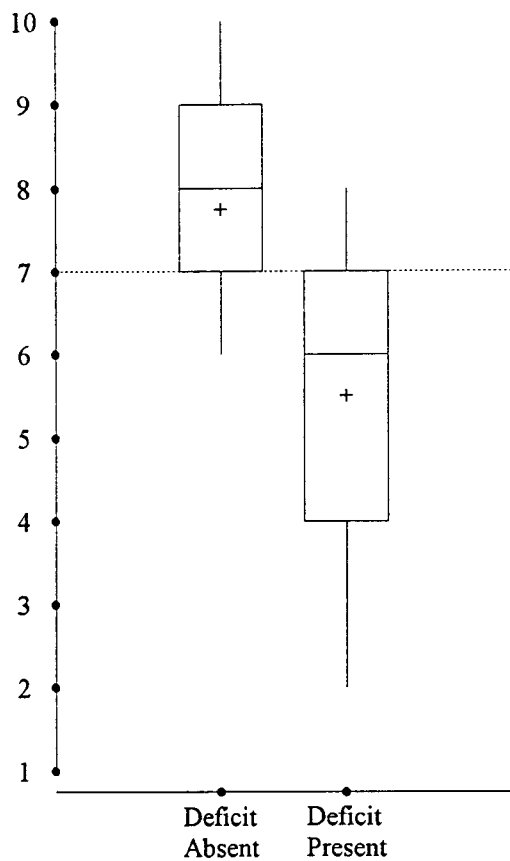
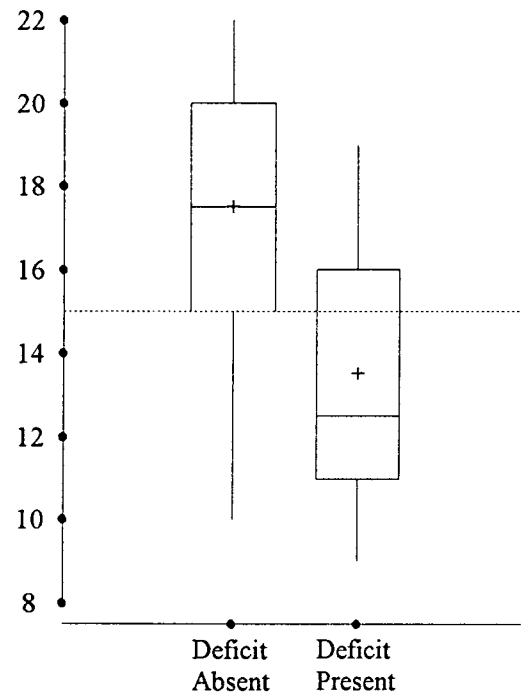
+ : geometric mean

Middle line of box: median

Top line of box: 75th percentile

Bottom line of box: 25th percentile

Whiskers: The whiskers extend to the minimum and maximum data points.

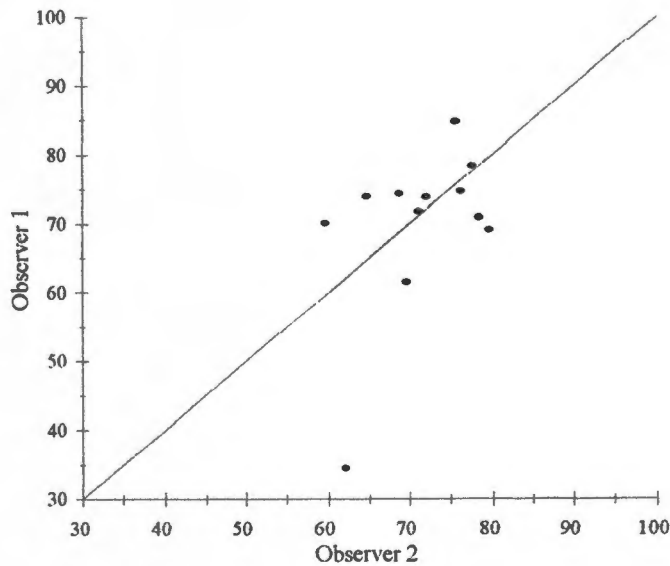
**BOX PLOT 1: FORM RECOGNITION****BOX PLOT 2: FINGER RECOGNITION**

## 2.9 RELIABILITY

Inter-rater reliability of the proposed test was investigated. Pearson's intra-class correlation was used to measure agreement between the two raters.

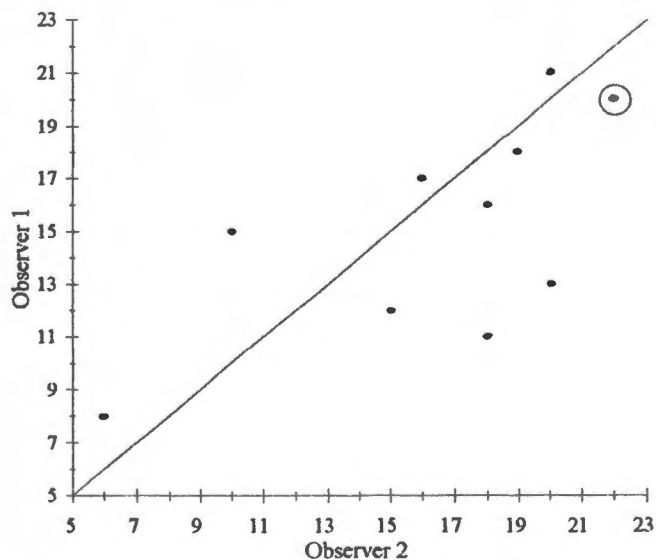
The correlation obtained between scores on the Non-vestibular Proprioception test was 0.475. The distribution can be seen in the scatter plot below.

**SCATTER PLOT 1: NON-VESTIBULAR PROPRIOCEPTION**



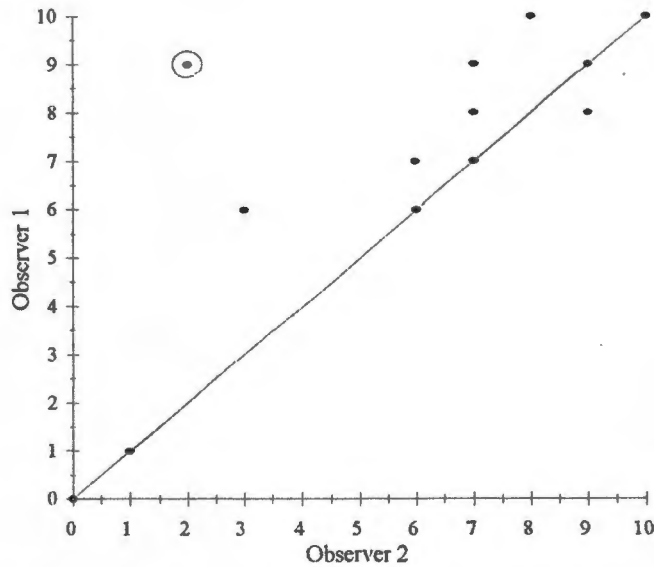
Correlation between scores on the Finger Recognition scores was 0.618 with distribution as reflected in the scatter plot below. The circled data point indicates three overlapping points.

**SCATTER PLOT 2: FINGER RECOGNITION**



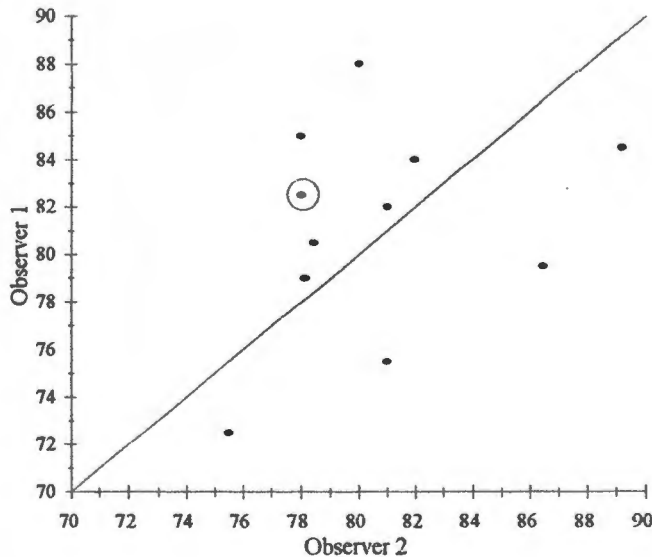
Scores on the Form Recognition correlated at 0.680. The distribution can be seen in the scatter plot below. The individual that scored 9 when tested by the candidate and 2 when tested by the co-worker was identified. This child has a severe attention deficit problem. He has since been placed in a special educational system. If this score is omitted from the calculations, the correlation between the raters is much stronger, i.e. 0.83.

SCATTER PLOT 3: FORM RECOGNITION



A correlation of 0.521 was obtained for the scores on the Tactile Stimuli Placement Test. Distribution seen in scatter plot below. The circled data point indicates two overlapping points.

SCATTER PLOT 4: TACTILE STIMULI PLACEMENT



CHAPTER V  
DISCUSSION

PHASE 1: TRYOUT PHASE

1. FIELD WORKERS (TESTERS)

A heterogeneous group of field workers in terms of experience were recruited. The try-out phase of the study allowed the candidate this freedom as it was not necessary to adhere to such rigorous selection criteria as in formal sampling. It is envisaged that the eventual test should be accessible to basically trained occupational therapist without having to undergo too much extra training. This strategy of using a heterogeneous group of field workers provided some information on how differently experienced therapists could manage the test mechanics.

Only voluntary field workers were recruited. Most testers had a very full work load and had to use their spare time for participation in this study. For this reason field work stretched over a much longer period than was anticipated, lasting well over 6 months. Not all testers were able to complete the anticipated 10 tests, resulting in only 58 tests being administered instead of the anticipated 70. More field workers would have made the results more valid.

Only one test kit was constructed because of the high cost. It was therefore not possible to have more than one tester working at the same time. This also delayed the completion of field work.

Experience was the only variable recorded in this study, but other factors such as personality, interpersonal relationships, intelligence quotient, etc. could also be important. Although the study was not designed to take these differences into account, the candidate suspects that this could well have had an effect on both the quality of responses that were obtained from the testers and the efficiency of administration of the tests. In evaluating the responses it became clear that tactile defensive responses were not always interpreted as such by the less experienced

testers, i.e. those testers that passed the test mechanics observation in 1990. In some of these cases comments were made that the testee became increasingly fidgety as the testing progressed but the tester did not rate this as tactile defensive responses. This could well be attributed to the lack of experience of the particular tester.

### 1.1 RECOMMENDATIONS

In future research it could be helpful to group testers according to their experience and other attributes, to ascertain whether similar groups execute similar rater leniency or severity. This pertains specifically to areas where a clinical judgement has to be made as in the case of tactile defensive responses. Repeatability of the test results should be evaluated, thus assessing the inter and intra variability.

### 2. TESTEES

As this study was solely directed at refining the test, the testers were allowed to choose their subjects from the group of children that were available to them. This resulted in a large age variation, i.e. 5.21 yrs to 10.49 yrs. From this study we thus can deduct that the proposed test can be used for this particular age group, but have no information on the appropriateness of the tests for other age groups. The group that immediately comes to mind is the younger child, who may not necessarily give similar responses in terms of endurance, motivation, comprehension of instructions and cooperation.

The realized group of testees also varied in terms of pathology. Some testers only had access to children with identified pathology whereas other testers only had access to children who have never been evaluated on any scale of performance. Although this study was not designed to discern between groups of children with problems and those without, differences in motivation, endurance/perseverance and comprehension may have influenced results. However since some of testees had identified problems,

it can be concluded that these tests can be used with this group.

The previous test experience of the testees may be another factor that could influence responses. Testees who have been tested on other scales, may be more test sophisticated than others and their general responses could differ.

Many more male testees were recruited than female and of the 58 testees only 2 were not of the white race. The study was not designed to discern between different groups and the size of the sample did not allow for this. It is appreciated, however, that sex and culture could have influenced results.

In the questionnaire an attempt was made to ascertain from which socio-economic groups the testees were drawn, but the information obtained here was too incomplete to analyse statistically.

### 2.1 RECOMMENDATIONS

Future studies with randomly selected stratified groups of subjects in terms of age, pathology, sex, race, test experience and socio-economic status need to be done to ascertain whether similar or dissimilar responses are obtained from these different groups. In this study reference is only made to responses pertaining to comprehension of verbal instructions, motivation for the test, endurance and tactile defensive responses and does not refer to the actual test scores obtained. If other factors are taken into account, the candidate could evaluate the efficacy of the test mechanics more specifically.

A comparison should also be drawn between these tests and similar currently used tests.

### 3. TEST ENVIRONMENT

In the manual, general guidelines were given describing the test room, furniture, placement of tester and testee, etc. During field work this was not controlled. The fact that there could

have been differences here is suspected as some cases reported that the testees tended to rest their chins on the screen, which may be the result of incorrect table height for that particular testee.

### 3.1 RECOMMENDATIONS

In future studies of this kind, it is recommended that the test environment complies with the prescribed form. Standardization of equipment should also be done before commencement of study.

## 4. COMPLETION OF TESTS AND ADMINISTRATION/SCORING TIMES

The Kinesthesia test is the only test where all test items were completed by all testees. The Two Point Discrimination test was completed by 57 cases, with the one testee refusing all items as he had done on previous tests. The Finger Recognition test was completed by 56 testees and the Tactile Stimuli Placement test by 55. The Form Recognition test was only completed by 11 testees.

The candidate suggests that the length of the tests may be responsible for non completion as the total average administration time is in excess of an hour, without allowing for any time in between tests. The average scoring time is 15 minutes and this is regarded as realistic.

### 4.1 RECOMMENDATIONS

It is recommended that the number of items included in the final test should be less than the initial proposed number. Each test will be evaluated in this regard and the necessary reduction of items done.

## 5. KINESTHESIA TEST

### 5.1 ITEM INCLUSION OR EXCLUSION

There 58 tests administered and all testees completed all the

test items. From this the tendency would be to conclude that the length of the test is satisfactory. However it must be kept in mind that this is the first test presented in the series and that testees would not have tended to tire as easily as later in the series of tests. There were 7 comments that the test was too long and 1 comment that the verbal instructions were too lengthy.

Item 6 was the item singled out as the one where testees tended to move off the score sheet more often than the other items. A similar tendency is seen in item 3 which is exactly the same movement on the opposite side.

#### 5.1.1 Recommendations

In considering the shortening of the test, the location of items 3 and 6 should be kept in mind (see appendix 3). Items 3 and 6 resemble items 4 and 7 very closely, the latter being very much the same length but only slightly on the diagonal. As the diagonal plane is already represented by items 1 and 10, it is recommended that items 4 and 7 be eliminated and items 3 and 6 be moved closer to the centre and slightly higher up on the score sheet. If such a change is made the scoring column will also have to be relocated, higher up on the score sheet.

#### 5.2 VERBAL INSTRUCTIONS

The verbal instructions were easily understood by 93.1% of the cases. Only 1 case could not understand the instructions at all. In some cases however the hand position needed to be demonstrated and in other cases extra instructions were needed for items 1, 2 and 9. Some testers felt that additional instructions should be given to the testee to keep his/her non used hand on his/her lap.

As only 1 testee did not understand the instructions at all, it can be postulated that this testee may have some auditory comprehension difficulties. This was not investigated but it could be useful to do so in future if testees with such problems

are to form part of the target group for which the test is eventually intended.

#### 5.2.1 Recommendations

As the verbal instructions appeared to be insufficient in respect of placement of hand on the mouse the manual should provide instructions to the tester to demonstrate hand position. Extra verbal instruction should also be allowed for on items 1, 2 and 9. It is also recommended that verbal instructions be included for the non used hand to remain on the lap of testee. The tester should be allowed to repeat these instructions where necessary.

### 5.3 MANIPULATION OF THE MOUSE

Manipulation of the mouse was easy in 96.6% of the cases. Although a high percentage of testers found it easy, some valuable comments were obtained. Some testers found that their hand was not in a functional position and that practice was needed to feel comfortable with it. Some testers suggested that the ears of the mouse should be made longer so that the mouse could be manipulated by its ears. Some testers found it easier to manipulate the mouse with two hands. From these comments it can be deduced that testers need considerable practice with handling of the mouse before using it in testing and that allowance should be made for different hand positions to be used by testers. Changing the length of the ears can create other problems, for example, obstructing the line of vision for marking or otherwise getting in the way.

#### 5.3.1 Recommendations

In the manual specific instructions should be given to the tester regarding practising with the mouse before commencement of testing. The tester should find the most comfortable method of handling the mouse and provision should be made for the tester to use both hands if necessary. It is felt that the instructions as

to how the tester should hold the mouse cannot be too prescriptive as to allow for individual differences of the testers.

#### 5.4 PEN GUIDE

The pen guide was considered large enough in 96.5% of cases, but was felt to be not accurate enough in 9 cases. If making the hole in the guide slightly smaller is considered, much more accurate aim from the tester would be required and fluidity of testing may be lost. The method of making a mark should therefore rather be considered.

In some cases the testees fingers were very long and covered the pen guide.

##### 5.4.1 Recommendations

The pen guide appears to be large enough, but as some testers had difficulty in marking accurately, it is suggested that testers be instructed to mark with a small circular movement rather than a dot. The measurement should then be made from the centre of this mark. Where the testee's fingers are long and tend to cover the pen guide, the tester should make sure that the placement of the fingers is between the ears of the mouse so as not to overlap the pen guide. These instructions to the tester will be included in the manual.

#### 5.5 INTEREST IN AND MOTIVATION FOR THE TEST

Of the cases, 50% were keenly interested in the test with another 32% of cases needing only a little encouragement. The researcher regards these percentages as satisfactory considering that all testees completed all the items. The comments regarding the unrealistic appearance of the mouse should be considered as this could possibly increase the appeal for a child. The suggestion of allowing the tester to add his/her own words to make the game

more interesting should be rejected as this would not allow for the test to be presented in a standardized form. The suggestion of putting a picture on the screen card is rejected on the grounds that it could distract the testee.

#### 5.5.1 Recommendations

The suggestion of adding a face to the mouse is regarded as valuable and can be easily done. This should increase the appeal for the child.

#### 5.6 SCREEN

The positioning of the screen presented the most problems in this and subsequent tests. The testers needed a lot of practice with the screen before it could be handled with ease. The instructions to testers did not state that this practice was necessary prior to testing. Some testers preferred to have the screen placed opposite the testee. It could be helpful if instructions to the tester allowed the tester to place the screen wherever it was most comfortable after having experimented with it.

The undercarriage of the screen often got in the way and this seems to be a constructional fault and should receive attention. The fact that some children rested their chin on the screen may also relate to the bulk of the screen. The level of the screen together with the height of the table could also be held responsible for this. Instructions could be made clearer as to how far away from the child's face the screen should be positioned.

One tester forgot to use the screen card on the screen and found that the testees' vision could not be obscured. This mistake would be eliminated if the tester received more formal training in the test procedure.

One tester discarded the screen completely and only used the

screen card. It is felt that the advantage of having both hands free for testing weighs heavily against this and that the screen should be adjusted to be made more comfortable for all testers. It is postulated that if this particular tester had spent more time experimenting with the screen, she would not have found it necessary to discard the screen.

#### 5.6.1 Recommendations

The screen needs to be redesigned in such a way that the undercarriage is less bulky and affords more space for movement underneath. Specific instructions should be included in the manual for the tester to experiment with the screen before commencement of testing. These instructions should point out positioning of screen, either next to or opposite testee, and adjusting the height according to the size of the child. Specific instructions should also be included that the screen card should be attached to the screen to enlarge the obscured visual area. Training and observation of the tester should precede the use of the test.

#### 5.7 LEVEL OF DIFFICULTY OF TEST FOR TESTEE

The level of difficulty was rated as acceptable in more than 90% of the cases on all items. This is deemed an acceptable level and need not be changed.

#### 5.8 DIFFICULTY OF ADMINISTRATION

Item 2 was rated as too difficult to administer in 10% of the cases. In this item the right handed tester would have his/her hand directly over the mouse moving in a parallel line from point 2A away from the body towards point 2B. This would make it difficult to see the point 2B that is aimed for. A similar item for the opposite hand, item 5, shows the same tendency, but is probably easier for the right-hander to administer as his/her hand would be stretched diagonally across the table. This item

may be more difficult for the left-hander to administer.

#### 5.8.1 Recommendations

It could be helpful if the direction of movement were changed around for items 2 and 5. The tester would then be moving from the furthest point towards a point directly in his/her vision and be able to locate the starting point more easily as it is the point that has just been moved away from (kinesthetic memory on the part of the tester). Item 2A thus becomes 2B and visa versa. The same will be done for item 5.

#### 5.9 RESISTANCE TO LIMB BEING MOVED

Item 1 was the item where more resistance was shown to the limb being moved than other items. This is understandable as it is the first item and the testee has not yet gotten used to the feeling of being moved passively without monitoring the movement visually.

#### 5.9.1 Recommendations

Instructions to the tester will include a warning that resistance to the limb being moved may be experienced on item 1. The tester must thus ensure that he/she has a firm grip on the mouse and exert enough pull on the mouse. A warning should also be included in the instructions to the testee that his/her limb is going to be moved.

#### 5.10 HAND POSITION ON THE MOUSE

On item 2 more testees tended not to maintain the hand position on the mouse than on the other items. This may again have bearing on the direction in which the movement is made, from a point away from the body towards the body.

#### 5.10.1 Recommendation

As previously mentioned, the direction of items 2 and 5 will be changed around.

#### 5.11 ABIDING BY THE ALLOTTED TIME FOR INDIVIDUAL ITEMS

On items 1, 2 and 5 more testers had difficulty abiding by the allotted time for the movement than on other items. The reason for item 1 may be because it is the first item and the tester is unfamiliar with the timing. This could be prevented by more practice. It is suspected that the reason why items 2 and 5 were difficult to execute in the allotted time was because the point that must be aimed for is not within the visual field of the tester.

##### 5.11.1 Recommendations

As previously mentioned the direction of items 2 and 5 will be changed around. Instructions to the tester will include the fact that extra practice is necessary to perfect this timing before commencement of testing.

#### 5.12 SCORING OF ITEMS WHERE HAND WENT OFF THE SCORE SHEET

Queries were made by testers as to how to score the items where the testee's hand moved off the score sheet. The instructions are not clear on this and should receive attention.

##### 5.12.1 Recommendations

If a testee moves off the sheet the score would probably exceed the maximum score of 5 cm., but because all items are not equal distances away from the edge of the score sheet an attempt should be made to measure that particular item immediately and to write down the measurement next to the item. The tester will be forewarned in the manual about this eventuality so as to prepare

him/her to have a measure handy.

### 5.13 SCORING ITEMS WHERE TESTEE MOVES IN OPPOSITE DIRECTION

Queries were made about how to score an item if the testee moved in the opposite direction as this is not clear from the manual. It is felt that this response could well be attributed to inattention and that the testee should be given a second chance.

#### 5.13.1 Recommendations

When a testee moves in the opposite direction, this response should be ignored and the item repeated after all the other items have been completed. If on repetition of the item the testee still moves in the opposite direction, the item should receive a maximum score of 5 cm. These instructions to the tester will be included in the manual.

### 5.14 LINE BETWEEN TWO MARKINGS OF ITEM

A suggestion was made that drawing lines between the first and second marks for an item should only be done where confusion existed as it was cumbersome and often unnecessary. This is regarded as a valuable suggestion as it would save time and make administration of items more fluent.

#### 5.14.1 Recommendations

The instructions to the tester will state that a line should be drawn between the two markings only if confusion exists as to which item a marking belongs to.

### 5.15 OVERALL POSITIVE VERSUS NEGATIVE FEEDBACK ON TEST

There was only one comment recorded that this was an enjoyable game. As many other verbal comments of this nature were received, the researcher realizes that the questionnaire did not provide

for positive feedback on the test. It was thus lacking in this respect as only the weaknesses could be identified.

#### 5.15.1 Recommendations

The fact that the questionnaire did not allow for positive responses from the testers is unfortunate, but little can be done about it at this stage. It is however recommended that future similar studies provide prompted responses to this effect. This could enable the researcher to build on the positive aspect of the test during test refinement.

### 5.16 MISINTERPRETATION OF INSTRUCTIONS

In general there were very few misinterpretations of the instructions. One tester did not use the screen card on the screen and thus found that the testees' vision was not obscured. In another case the tester queried the positioning of the score sheet on the table as to which side should face the tester.

#### 5.16.1 Recommendations

The fact that one tester could not figure out which side of the score sheet should face the tester may be attributed to her lack of training and/or inattention to the detail on the score sheet. It seems obvious to the researcher that the score sheet can only be placed one way for the tester to be able to read the writing on it. There are clear indications on the screen card as to its purpose, although these are not included in the instructions. These kind of uncertainties will be eliminated with training prior to testing. No further changes to the score sheet are recommended.

## 6. FINGER RECOGNITION TEST

### 6.1 ITEM INCLUSION OR EXCLUSION

A total of 58 Tests were administered, of which 56 (96.6%) were

completed in full. Poor cooperation, which may well be due to fatigue/boredom with the task, was the reason for discontinuance. Three comments were elicited that there were too many items.

In review of the test items for exclusion, it is noted that items 1 and 13, and items 2 and 14 are identical. This duplication is not necessary.

The Finger Identification test (SCSIT) consists of only 12 items. The candidate suggests that the proposed Finger Recognition test need not include any more than 12 as it is based on the SCSIT test. Reviewing the items it is noted that all fingers are stimulated with a single stimuli. If it is considered to reduce the items, some of these single items could be regarded as superfluous. In retrospect it is also noted that for the left hand there is no item where two fingers are stimulated at the same time, but two items where double stimuli are applied to the same finger. It is felt a change is warranted in this regard.

#### 6.1.1 Recommendations

The number of items will be reduced from 18 to 12. Items 13 and 14 will be excluded as they are duplicate items. For the right side the items for the little (item 9) and middle fingers (item 11) will be omitted and for the left side the items for the index (item 1) and ring fingers (item 8) will be omitted. Item 10 will be changed from 2 stimuli to the left index to simultaneous stimuli of left index and ring fingers. In the lateral stimuli it is seen that both the radial and ulnar stimuli on the right side are on the index finger. It is suggested that the radial stimulus to the index finger be changed to a radial stimulus to the little finger.

In the light of the suggested omissions and changes it is recommended that the order of items be reviewed so as to avoid items that are too similar following upon one another. The following are the new suggested items and order:

- |                          |                          |
|--------------------------|--------------------------|
| 1. R Ring                | 2. L Middle              |
| 3. R Middle & Little     | 4. L 2 Stimuli to Ring   |
| 5. R Index               | 6. L Little              |
| 7. 2 Stimuli to Middle   | 8. L Index & Ring        |
| 9. R Ulnar side Index    | 10. L Radial side Middle |
| 11. R Radial side Little | 11. L Ulnar side Ring    |

## 6.2 VERBAL INSTRUCTIONS

The verbal instructions were easily understood by 84.5% of the cases. The researcher feels that this percentage could be increased by attending to the comments that were recorded. Extra instructions were needed where stimuli were administered to the lateral sides of the fingers. It is also deemed necessary to add an extra demonstration item for touching on the lateral side.

### 6.2.1 Recommendations

Extra verbal instructions will be added informing the testee that the sides of fingers are going to be touched and that he/she is to spread the fingers on item 15, re-using the placement mat at this stage. Demonstration of one lateral surface stimuli will be given on the radial side of right index finger whilst saying to the child that he/she must remember to touch the side of the finger and not the top. Instructions to the tester will be added in the manual that extra instructions may be added for spreading of fingers where necessary.

## 6.3 MANIPULATION OF THIMBLES

The manipulation of thimbles was easy in most cases except for the items 15 to 18 where the lateral surfaces of the fingers were stimulated. As the fingers of testees are usually small, it is recognized that the thimbles may be too bulky for those surfaces and that an alternative must be sought.

One tester complained that the thimbles hurt her and she suggested using a surgical glove instead. As the rubber of a

surgical glove is very thin it may not afford such a uniform stimulus as the thimble because the length of nails would still be felt. It is also suspected that this particular tester has difficulty in extinguishing extraneous stimuli from consciousness as this is also the tester that complained about the messiness of the Tactile Stimuli Placement test. However, it should be kept in mind that these tests must be suitable for use by all therapists and that many individuals present with this tendency.

#### 6.3.1 Recommendations

For the lateral surface stimuli it is recommended to use the eraser of a pencil instead of the tester's thimble covered finger. This eraser should also be warmed to approximate body heat before use by placing in a garment pocket.

Where a tester feels uncomfortable with the rubber thimbles the fingers of a cotton glove will be provided in the test kit for use under the rubber thimbles. This will mean that the tester will need a larger size thimble.

#### 6.4 SWITCHING FROM ONE TO TWO STIMULI

In 93% of cases this switch was easy and where it wasn't easy, extra practice would probably solve the problem.

##### 6.4.1 Recommendations

The manual will include instructions to the tester to practise with switching from one to two stimuli prior to testing until a smooth change over is obtained.

#### 6.5 PLACEMENT MAT

In only 59.6% of cases the mat was found to be helpful or fairly helpful. The mat was found to be a distraction in many cases, but some testers found it helpful for initial placement of hands. The size of the hands on the mat was incorrect and some testers felt

that the positioning of the mat should be adapted to the size of the child. It would seem as if the placement mat is of little value.

#### 6.5.1 Recommendations

It is recommended that the mat be used as a non fixed device initially as demonstration of how the fingers should be stretched out. The mat's position could then be adjusted according to the length of the child's arms, aiming for the most comfortable position. The mat should then be removed and placed face down away from the area of testing. The mat will be used again when re-instructing on item 15 and removed directly afterwards. Changing the hand size is not considered as the mat will be used only as a broad indication of how the hands should be placed, i.e. with fingers stretched out.

#### 6.6 INTEREST IN AND MOTIVATION FOR THE TEST

87.5% Of the cases were keenly interested in the test or needed only a little encouragement to complete the test. No cases were reported to have lost interest immediately. This is felt to be satisfactory as in most testing situations children will need a little encouragement. A suggestion of adding a fantasy theme to make the game more interesting was made. This would lengthen the test and is not considered. The suggestion of changing voice intonation is rejected on grounds of the difficulty of standardization of such an addition to the test. The comment that the test needs no changes is regarded as valuable as this comment was obtained from one of the more experienced testers. (Please note that this value judgement is made by the researcher on the the grounds of her own high regard for this particular tester as well as the tester's experience record and has no empirical basis.)

#### 6.6.1 Recommendations

No further recommendations regarding interest and motivation are

made other than the previous recommendation of shortening the test.

## 6.7 VISUAL INPUT

Many testers noted that the testee needed visual input to be able to indicate the correct finger that had been stimulated. This point is regarded as valuable as it is also found to be necessary in the similar Finger Identification test by Ayres. (Southern California Sensory Integration Tests, 1976 and Sensory Integration and Praxis Tests, 1989). It is regarded as necessary as poor kinesthetic awareness may prevent the testee from indicating the correct finger rather than poor tactile discrimination.

### 6.7.1 Recommendations

Extra instructions to the tester will be included in the manual to remove the screen after a stimulus has been applied to a finger.

## 6.8 SCORING

Under general comments the use of a two point score was questioned and there was also a query as to whether the testee should be encouraged to change his/her response. As seen in the methodology section, the reason for the use of a two point scale is that in some subjects the extra stimulus afforded by touching a wrong finger is often enough to enable the subject to then identify the correct finger. Thus this subject's tactile discrimination ability lies somewhere between the subject that is able to immediately indicate the correct finger and that subject that cannot identify the correct finger at all. It has been the experience of the researcher that this tendency is often seen whilst using the Finger Identification test of the SCSIT. It is felt that the testee should only get the benefit of scoring in this way if the change is spontaneous. A second try should not be encouraged as this will give the testee extra clues and encourage

the testee to guess. It will also detract from standardized administration

There was a query about scoring an item where additional fingers were touched as well as the correct finger. This is regarded as an incorrect response as the testee is perceiving a stimulus that does not exist.

#### 6.8.1 Recommendations

No changes are recommended as regards the two point scoring of test items. A score of 0 is given if more finger(s) are touched in addition to the correct one.

#### 6.9 HAND USAGE OF TESTER

In the manual the tester is instructed to place thimbles on his/her dominant hand. Comments were obtained that it was easier to use thimbles on the non dominant hand as they found it difficult to use pencil for marking the response with the thimbles on that hand. In designing the test the researcher did not experience any problems handling a pencil with thimbles on the dominant hand but appreciates that some testers may indeed find this clumsy. If the non dominant hand is used for applying the stimulus, more practice will be needed to apply the stimulus with the right amount of pressure and also applying the double stimuli simultaneously. As standard procedures are aimed for, the researcher has to consider whether to opt for more accurate application of stimuli or ease of marking for the tester. The accuracy of the stimulus is regarded as more important.

#### 6.9.1 Recommendations

It is not recommended that hand usage be changed, but that the tester be urged to practise using a pencil with thimbles on the thumb and index finger until he/she feels comfortable with it, prior to testing.

## 6.10 SCREEN

Again many comments were recorded here about the general difficulty of using the screen. These comments were mostly the same as those for the Kinesthesia test.

### 6.10.1 Recommendations

Changes regarding the screen are the same as for the Kinesthesia test.

## 6.11 DIFFICULTY OF ADMINISTRATION OF INDIVIDUAL ITEMS

The items where lateral surfaces were stimulated were found to be the most difficult to administer. These problems are discussed earlier in the text with the necessary recommendations (see Manipulation of thimbles, p. ).

## 6.12 LEVEL OF DIFFICULTY OF ITEMS FOR TESTEES

Items 3, 4, 15, 17, and 18 were singled out as being the most difficult, but items 15 and 17 were also regarded as fairly easy in more than 70% of cases. The researcher regards this level of difficulty as acceptable as any test would have to include some easy and some difficult tasks.

### 6.12.1 Recommendations

No changes in regard to difficulty is recommended.

## 6.13 TACTILE DEFENSIVE RESPONSES

Only mild or slight tactile defensive responses were elicited in this test. The researcher questions whether testers recorded this uniformly as there was evidence of some tactile defensive response being described and not reported as such. The pattern of responses elicited were that they occurred on initial items (1, 2, 3, and 4) and again on some of the latter items (12, 13 and 14).

The initial defensive responses can be explained in terms of the newness of the test procedure where extinction of stimuli is not so easily achieved. The latter responses may also be as a result of the cumulative effect of the stimuli.

#### 6.13.1 Recommendations

As it is suspected that the testers did not record the tactile defensive responses uniformly, it is recommended that future studies be conducted where recording of responses are monitored to ascertain the true value of this test for observing tactile defensive behaviour.

#### 6.14 OVERALL POSITIVE VERSUS NEGATIVE FEEDBACK ON TEST

One comment was recorded that the test needs no changes, however verbal feedback was received which indicated that many more positive reactions could have been obtained had the questionnaire been designed in such a way that prompted this type of feedback.

#### 6.14.1 Recommendations

It is recommended that future similar studies provide prompted responses of positive kind to enable the researcher to exploit these elements of the test to a larger extent.

### 7. FORM RECOGNITION TEST

#### 7.1 NUMBER OF ITEMS TO BE INCLUDED IN TEST

The Form Recognition test presented with the most problems of all the tests included in this study. In designing the test the researcher made use of a large variety of objects in an attempt to find the most suitable items. There were 30 items selected for this test, which unfortunately made this test unrealistically long. As field work progressed it became apparent that only a few of the testees could complete all 30 items (mean number of items completed was 17.74, median 15). Items 16 to 30 thus received

less exposure to scrutiny than items 1 to 15. For that reason testers 6 and 7 were requested to administer only the latter half of the items.

The opinion of testers on the ideal number of items to be included was 12 (mean = 12.16, median = 12). From the statistical analysis it was apparent that the group of testers who were exposed to fewer items, suggested less items to be included in the final test, i.e. 10.9.

#### 7.1.1 Recommendations

With the results available at the moment the researcher suggests that the number of items to be included in the final test should not be more than 12. It is recognised that further research could reveal a more appropriate number, if all testers were to be exposed to the same number of items. This is recommended for future research.

### 7.2 TRIALS

The trials were generally felt to be sufficient, but comment was also obtained that there were too many trials. In the light of the test being long and motivation for completing this test very low, it should be considered decreasing the number of trial items.

#### 7.2.1 Recommendations

It is recommended that trial items be cut to only two items. There will be one item of the wooden range and one item of the metal range, i.e. retaining trial items 1 and 3 and discarding trial items 2 and 4.

### 7.3 SCORING TIME AND ACCURACY SIMULTANEOUSLY

This task became easier with practice and testers should be instructed to practise with this test until a smooth, flowing

presentation is obtained.

#### 7.3.1 Recommendations

The instruction manual will include instructions to the testers to practise this test prior to testing. As already discussed in the preceding tests it is recommended that training and observation of testers be done before the tester starts testing.

#### 7.4 SORTING THE FORMS FOR PRESENTATION

This task was generally extremely difficult and extra practice did not make it easier. It should thus be considered changing the presentation box in such a way that the forms are presorted for easy, fluent presentation. The correct position of the forms to be placed in the hand of the testee was also queried and should receive attention.

##### 7.4.1 Recommendations

As the number of items will be decreased a more spacious box can be designed in which the forms can be stored and used for presentation. A tray will be designed with 12 sections with allocation for each form. A shadow image will be printed in the box indicating the correct position for placement in the hand of the testee. Instructions in the manual will be added for the tester to prepare the tray prior to testing by placing each shape on its corresponding shadow image. The tray will be provided with an easily removable cover so that it can be placed on the testing table prior to commencement of testing and the cover removed only when it is needed.

#### 7.5 SCORE SHEET

Use of the score sheet became easier with practice. However, valuable suggestions were made that could ease its use. It was suggested that the columns be moved over to the right of the

sheet so that the centre fold does not run through the scoring column. It was also suggested that the items be spaced further apart, which will be easily accomplished with less items. The addition of a time total line and score guide printed on the score sheet was regarded as useful. It was also suggested that using real colours on the score sheet would ease the scoring of items.

#### 7.5.1 Recommendations

It is recommended that the scoring column be moved to the right of the scoring sheet and that spaces be left between items vertically. The scoring guide will be added just below the columns for trial items and a time total line just below the total score line included. If this test should be published commercially, consideration could be given to the addition of real colours on the score sheet, but for research purposes this is not regarded as cost effective.

#### 7.6 INTEREST AND MOTIVATION FOR THE TEST

Motivation to complete this test was generally low (only 7% of the cases were keenly interested in the test). This could in part be contributed to the large number of items presented resulting in fatigue and possibly boredom. Another factor that could have had an influence here, was the difficulties experienced by the testers in the fluent presentation of the items, which made it lengthy for the testees. The fact that the aim was to present as many items as possible, not discontinuing after a certain number of errors, could also have been demotivating for the testees.

Suggestions were made to include more interesting as well as alphabet related shapes. It is recognised that these measures may increase the appeal for a child. More popular shapes (known geometrical shapes) or real life items such as safety pin, car, etc. would not afford the same advantage to all testees as experience and culture of testees differ. The suggestion of alphabet related shapes are rejected on the same grounds. This will bias the test towards the higher socio-economic group.

### 7.6.1 Recommendations

It is recommended that no attempt be made to change shapes as such. Cutting the number of items down to 12 and discontinuing after 5 errors will provide the testee with a more positive experience as the task will not be so long and he will not be subjected to the experience of repeated failure. Also, with the recommended changes to be made to the presentation box and extra practice on the part of the tester, she will be able to present the items more fluently which will in turn shorten the testing time.

In analysis of the suitability of shapes for inclusion in the test, a high priority will be given to shapes that were rated as useful/to be included and very good size and shape. The grading of items in terms of difficulty is also regarded as very important in relation to motivation as the testee with poor discrimination abilities will discontinue after a 5th error and not experience the more difficult items which can be demotivating. The test should therefore start with easier items and progress to the more difficult items. The order of presentation of items will be discussed later in 7.10.

## 7.7 TIME ALLOCATION FOR INDIVIDUAL ITEMS

The time allocation for each item was adequate in 60% of the cases. As this was generally considered to be a difficult test with low motivational value, an increase in the time allocation for items should be considered to afford the testee a better chance at success.

### 7.7.1 Recommendations

It is recommended that the time allocation be changed from 30 seconds to 45 seconds. Points deductible for time will then also be changed from 1 point for every 30 seconds to 1 point for every 45 seconds.

## 7.8 TACTILE DEFENSIVE RESPONSES

Slight or mild tactile defensive responses were elicited on only 4 items. It is suggested that this task of active touch would generally elicit less tactile defensive responses than a passive touch stimuli would as the testee is more in control of the stimuli received. It was recorded though that some of the shapes "hurt" the testees. These could be interpreted as tactile defensive responses.

### 7.8.1 Recommendations

It is recommended that the interpretation of tactile defensive responses be more closely monitored in future studies to ensure a uniform rating of these responses. Guidelines to this effect should be provided to the tester, i.e. to define responses such as "hurt" as a tactile defensive response.

## 7.9 MANIPULATION OF OBJECTS

It was frequently reported that testees failed to manipulate objects when placed in the hand. The tendency not to manipulate objects spontaneously is fairly well recognised and is common amongst children with somatosensory based dyspraxia or somatodyspraxia (Ayres, 1972, 1979, Cermack in Fisher et al). As the child with suspected somatodyspraxia will mostly be the target group for which this test is being developed, it is deemed important that extra instruction be provided for the tester to urge the child to manipulate the objects.

### 7.9.1 Recommendations

Verbal instructions will be added in the manual for the tester to say to the child "close your hand around the shape and feel it/ maak jou hand toe om die vormpie en voel dit". These instructions will only be used where the testee does not spontaneously manipulate the object and may be repeated as often as is necessary. This need for instruction for manipulation must however be noted as a clinical observation.

## 7.10 SELECTION OF ITEMS FOR INCLUSION IN THE TEST

In selecting the most appropriate items to be included in the test, three ratings by testers should be taken into account, i.e. opinion on inclusion, level of difficulty and opinion on shape and size. Responses to these questions were very incomplete as can be seen from the n values in table 8. Where testers were requested to administer only the latter half of the items, significant differences could be established in their opinion on usefulness and level of difficulty. A similar comparison could not be drawn regarding the opinion on shape and size as the groups were too small. It is felt that more in depth research of the items could reveal valuable information regarding them.

However, twelve items have been selected as the most suitable for inclusion and will be graded from 1 through 12 according to difficulty with item 1 being the easier and the initial starting point of the test. Items were selected on grounds of highest ratings in positive categories, i.e. useful/to include and good shape and size. Items are given below in order of difficulty as rated by testers.

### 7.10.1 Item 1 (original item 4)

This item had a rating of 73.3% of being useful/to be included. An 8.1% rating was obtained as being too easy with 91.9% as being fairly easy/difficult. It had a 100% rating for good shape and size. From these ratings it is the easiest item that also complies with a high rating in the other categories and is therefore chosen as item 1.

### 7.10.2 Item 2 (original item 7)

This item had a rating of 75.6% as being useful/to be included. In 100% of cases it was rated as fairly easy/difficult and a 100% rating for good shape and size. As it is rated as slightly less easy than the previous item, it is chosen as item 2. The original item 6 has ratings very similar to original item 7 except on

useful/ to be included where it is slightly lower at 73.3% It is felt that with such a close rating , on of the item should be ignored in preference to other items which are more dissimilar. Thus original item 6 is not considered for inclusion.

#### 7.10.3 Item 3 (original item 1)

This item has a 66.7% rating as being useful/to be included. The level of difficulty was rated as fairly difficult/easy in 97.3% of cases with 2.7% rating it as extremely difficult. In 100% of cases it was rated as having a very good shape and size. The difficulty level is thus rated slightly higher than the previous item and for that reason is placed as item 3.

#### 7.10.4 Item 4 (original item 2)

This item has a 64.5% rating as being useful/ to be included. The difficulty level was rated as fairly easy/difficult in 97.3% of cases and good shape and size in 100% of cases. This item has the same ratings for difficulty and opinion on shape and size as the previous item, but is placed in this position on the ground that it has a lower rating on useful/ to be included category.

#### 7.10.5 Item 5 (original item 5)

This item has a rating of 75.6% as being useful/ to be included. In 100% of cases it was rated as having a good shape and size. A 2.7% rating as being extremely difficult places this item in the position of item 5.

#### 7.10.6 Item 6 (original item 29)

This item has a rating of 59.4% as being useful/ to be included, but only a 25% rating of excluded. This difference was found to be statistically significant. The item is considered for inclusion because of its high rating for good shape and size, i.e. 84.6%. It was rated at 7.7% for differences too small and 7.7% for too smooth and slippery. The rating of 7.1% on extremely

difficult places this item after item 5.

7.10.7 Item 7 (original item 3)

This item has a rating of 60% on useful/ to be included. In 8.1% of cases it was rated as extremely difficult with a 91.9% rating as fairly easy/difficult. 96.2% of cases rated it as having a good size and shape with 3.8% of cases rating it as differences too small.

7.10.8 Item 8 (original item 14)

On this item the rating for useful/ to be included is 56.8% with the excluded rating at 21.6% was found. Statistically this difference was found to be significant and for that reason this item is included. A rating of extremely difficult is 10.5%. In 56.3% of cases it is rated as having good shape and size. A 31.3% rating was given for too bulky, 6.2% for too irregular and 6.2% for differences too small.

7.10.9 Item 9 (original item 11)

This item has a rating of 61.3% for useful to be included with an excluded rating of 20.5%. The difference between these two ratings were found to be statistically significant and therefore this item is included. A rating of 22.2% is found for extremely difficult. In 65.4% of cases it was rated as having a good shape and size, with a 34.6% rating as too irregular. The researcher suggests that this additional factor on shape and size would make this a more difficult item and thus the placement as item 9.

7.10.10 Item 10 (original item 18)

On this item the rating for useful/ to be included is 53.5%. This item has the lowest rating in this category of all the items selected for inclusion, but only has a rating of 18.6% on the excluded category. It has a rating of extremely difficult of 22.2% which is the same as for item 9 but is placed after item 9

for its lower rating on useful/ to be included category. It has a rating of 58.3% on good shape and size, 4.2% on too small, 8.3% on too irregular, 25% on differences too small and 4.2% on too smooth and slippery.

#### 7.10.11 Item 11 (original item 9)

This item has a rating of 65.9% on useful/ to be included. A rating of 25% is found on extremely difficult which makes this a one of the more difficult items. A rating of 55.6% was obtained for good shape and size, 25.9% for too bulky, 14.8% for too irregular and 3.7% for differences too small. These latter factors are seen as the reasons for this item being a more difficult one.

#### 7.10.12 Item 12 (original item 10)

This item has a rating of 61.3% on useful/ to be included. A rating of 32.4% on extremely difficult makes this the most difficult item considered for inclusion. A rating of 80.8% was obtained in the category good shape and size with 15.4% on too irregular and 3.8% on differences too small.

#### 7.10.13 Other items

The items with a rating of 40% or more on the exclude category are items 8, 13, 20, 23, 25, 27, 28 and 30. Item 8 is regarded to have good shape and size in 64.3% of cases and could be considered for further investigation. Items 13, 20, 23, 25, 27, 28 and 30 are thus the items that should not be considered for any further investigation.

The candidate personally favours item 8 as a measure of stereognosis (round balls of different materials/weight and slightly different sizes). It is suspected that in responding to the questions, the testers rated this item negatively because of the title of the test, i.e. Form Recognition. It is suggested that if the name of the test be changed to Stereognosis or Haptic

Perception, the response to this item may well have been more positive. The critique on this item was mostly that it was not a measure of form perception and that kinaesthetic awareness was tapped too heavily. As this test was designed to measure stereognosis it should be considered that the naming of the test is incorrect and therefor item 8 should be considered for further investigation.

Item 19 has a rating of 46.5% on the category useful/ to be included and this rating is just outside the statistically significant level of difference ( $p = 0.01035$ ). This item is favoured in 87.1% of cases as having a good shape and size with 3.8% of cases finding it extremely difficult. This item could possibly be considered if need be.

The nine remaining items 12, 15, 16, 17, 21, 22, 24, 26 and 27 fall into a grey area. It may be significant that all these items are in the latter part of the test and that fatigue/boredom on the part of the testees may have been responsible for the lower rating of these items. The number of attempts made at these items are also much lower than for other earlier items (see n values, table 8, p?????). The researcher suggests that if these items were included in the test in a different order, the items could have been rated differently by the testers.

#### 7.10.14 Recommendations

As the information on the ratings of the items by testers is very incomplete, it has made the task of selecting items very difficult. The reason for this is seen as the large number of items that were included in the test. It is unfortunate that more in depth information could not be obtained at this stage but the suggested selection below is seen as the most appropriate with the available information.

It is recommended that the following 12 items be included in the test in the given order of difficulty: items 4, 7, 1, 2, 5, 29, 3, 14, 11, 18, 9 and 10.

Item 8 and item 19 should be considered as strong alternatives for the reasons given in the preceding text. Items 12, 15, 16, 17, 21, 22, 24, 26 and 27 should also receive further attention in future research as their position in the test may have led to the negative responses obtained on them.

Items 13, 20, 23, 25, 27, 28 and 30 are rejected at this stage and need no further consideration.

It is strongly recommended that further research be done on the group of items that have been provisionally selected as well as on the group of items the candidate is uncertain about. At this stage it is uncertain whether the most appropriate items have been selected.

It is also recommended that the name of this test be changed to allow for more appropriate inclusion of items which could aid in the assessment of stereognosis.

#### 7.11 IF TESTER SHOULD SEE THE SHAPES

Queries were made as to the procedure to follow if the testee accidentally sees the shapes. It is understandable that this may happen and instructions in the manual should be clear on what to do in such a case.

##### 7.11.1 Recommendations

It is recommended that the score on items that are seen be ignored and that the item be repeated after all the other items have been completed or after the 5th error. This item will not be calculated as an error unless the testee fails on it on the second presentation. Instructions to this effect will be included in the manual.

#### 7.12 CHANGE OF SCORING

Suggestions were made to change the scoring from 1 and 0 to 2,1

and 0. The candidate can see no purpose in this change as the time score adjusts the score.

#### 7.12.1 Recommendations

No change to scoring is recommended.

#### 7.13 WAITING FOR A RESPONSE

It was queried whether the tester should wait for a response before continuing. It is recognised that some testees will continue to try and find the correct response long after the allotted time has expired. This can be very time consuming and make for extended testing time. It would thus be appropriate to encourage the testee to hazard a guess after the 45 seconds have expired. The wording of this encouragement should however be carefully considered so as not to encourage random responses on subsequent items.

#### 7.13.1 Recommendations

The following verbal instructions to the tester will be added in the manual to encourage the testee to make a decision when the allotted time has run out: "Choose the one that feels the most like the correct/right one / Kies die een wat vir jou die meeste soos reg voel".

#### 7.14 NOISY GAME

Comments were recorded that this test had a high noise element. This could be attributed to the plastic container that has no insulation. Also, testers often had to fumble to get the shapes sorted in their correct order of presentation.

#### 7.14.1 Recommendations

It is recommended that in redesigning the presentation tray, the tray should be made of wood instead of plastic. With the

additional shadow images added to the tray, the tester will be able to present the items more easily and without extra noise. The instructions to the tester will also include the fact that practice is necessary to present the shapes noiselessly.

#### 7.15 WHICH HAND IS BEING TESTED

It was queried which hand was being tested. The researcher did not set out in this test to differentiate between the function of left and right in this test. In the Manual Form Perception test of Ayres (1972) such a differentiation is made. The candidate felt that the visual perceptual skills involved in the Ayres test were too vast and favoured being able to exclude these visual elements above being able to differentiate between left and right.

##### 7.15.1 Recommendations

No recommendations are made in this regard.

#### 7.16 DIFFICULTY OF HANDLING SHAPES

Comments were recorded that the pieces were slippery and difficult to handle. Going back to the questionnaires it was found that these comments were all from one tester and that similar comments were not recorded from the other testers. The researcher recognises that manual skills amongst testers will necessarily differ from person to person and that this particular tester would need more practice before being able to handle the different pieces with ease. The suggested changes on the presentation tray and the reduced number of items would also ease the handling of objects for the tester.

##### 7.16.1 Recommendations

No further changes to the physical structure of the test are recommended apart from the ones already mentioned regarding the reduced number of items and the presentation tray. The

instructions to the tester for extra practice before commencement of testing will stress that she should become proficient in handling the pieces before testing.

## 8. TWO POINT DISCRIMINATION TEST

### 8.1 ITEM INCLUSION OR EXCLUSION

57 Tests were administered and all 57 testees completed all the items (one of the testees did not attempt any of the items). From these results it is assumed that the number of items are ideal. However with 24 items to be administered with a mean administration time of 0.25 minutes per item, the test would take on an average 6 minutes to administer. Considering the total time of test administration, shortening this test should be considered. Comments were also recorded that there should be less items and/or trials.

In designing the test the researcher provided both single and double stimuli for each locus of stimulation. In retrospect this appears superfluous as the information that needs to be obtained is just whether the testee can discriminate between single and double stimuli. It seems reasonable that the items could be cut down allowing for only a single or double stimuli on each locus.

The number of trials were questioned, but with the reduction in number of test items this may not be an issue and the candidate attaches a high value to the testee fully understanding what is expected of him/her.

#### 8.1.1 Recommendations

The number of items will be reduced to 12, affording 6 single and 6 double stimuli. The items will be as follows:

##### Printed:

Item 1: Single stimuli to left dorsum

Item 2: Double stimuli to right upper forearm

- Item 3: Double stimuli to left lower forearm
- Item 4: Single stimuli to right lower forearm
- Item 5: Single stimuli to left upper forearm
- Item 6: Double stimuli to right dorsum

**Supinated:**

- Item 7: Double stimuli to right lower forearm
- Item 8: Single stimuli to left lower forearm
- Item 9: Single stimuli to right palm
- Item 10: Double stimuli to left upper forearm
- Item 11: Single stimuli to right upper forearm
- Item 12: Double stimuli to left palm

These changes will be made to the score sheet.

It is recognised that the order in which the items are presented may advantage some testees as they might be able to work out a pattern on a cognitive level. It is recommended that future studies should investigate this probability.

It is recommended that the number of trials remain the same.

## 8.2 VERBAL INSTRUCTIONS

The verbal instructions were easily understood by 96.4% of the cases. There were no instructions in the manual to turn arms over for stimulation in the supinated position and/or to pull sleeves up.

### 8.2.1 Recommendations

Initial verbal instructions will be added in the manual for the testee to pull sleeves up where necessary and also to remove any jewelry: "Please pull up your sleeves and remove your watch, etc./ Trek asseblief jou moue op en haal jou horlosie, ens. af". Verbal instructions to the testee will be added in the manual to be given after item 6: "Turn your arms over like this/ Draai jou arms om, so", whilst demonstrating. The screen should be removed

whilst demonstrating and this instruction to the tester will be added to the manual.

### 8.3 FINGER SPLINT

In only 17.5% of cases the use of the finger splint was easy. Comments were recorded that the splint hurt, was clumsy and was discarded. It is recognised from these responses that the finger splint has very little value. As the candidate is recommending more practice with this test as well as observation of testers before testing, it should be possible for testers to learn to apply the stimuli uniformly without having to use a splint.

#### 8.3.1 Recommendations

It is recommended that the finger splint be discarded. The tester will however have to practice this task and be observed for accuracy before testing.

### 8.4 SCORE SHEET

As the images of the forearm on the score sheet did not represent a picture of the testee's arms as seen by the tester, many problems were created. The score sheet should be changed around. The score guide was omitted from the score sheet.

#### 8.4.1 Recommendations

The score sheet will be redesigned to present images of the forearms as they are seen by the tester. The score guide will be added to the score sheet.

### 8.5 SWITCHING FROM ONE TO TWO STIMULI

This procedure was relatively easily learnt and comments were obtained that extra practice made this task easier.

### 8.5.1 Recommendations

No changes are suggested apart from extra practice and observation.

## 8.6 INTEREST IN AND MOTIVATION FOR THIS TEST

92.9% Of the cases were keenly interested or needed only a little encouragement to complete this test. No cases were reported to have lost interest almost immediately. With the reduction of number of items this level of motivation may even be increased.

### 8.6.1 Recommendations

No recommendations other than reducing the number of items are made.

## 8.7 DIFFICULTY OF ADMINISTRATION OF ITEMS

From the responses on the most difficult items to be administered, it is found that these items are mostly the items that are higher up on the forearm and may well be as a result of the problems experienced with the screen in general. This task should become easier with the recommended changes made to the screen

### 8.7.1 Recommendations

No further recommendations are made here other than those already made in regard to the screen and extra practice and observation on the part of the tester.

## 8.8 DIFFICULTY OF ITEMS FOR THE TESTEE

Items 21 and 24 were singled out as the most difficult items for the testee. However this was only the case in 10.53% of cases. In selecting items for inclusion item 20 is retained and item 24

discarded. 10 Other items were commented on as being fairly difficult in more than 10% of the cases.

#### 8.8.1 Recommendations

The level of difficulty is regarded as adequate. Other than the previously suggested reduction in number of items, no further changes are recommended in this regard.

#### 8.9 THIMBLES

As in the Finger Recognition test, the same tester commented on the discomfort of the thimbles.

##### 8.9.1 Recommendations

The same recommendations for using a cotton glove under the thimbles is made for this test as in the Finger Recognition test, if necessary.

#### 8.10 PRESSURE APPLIED

The manual omitted to specify the pressure to be applied for the stimuli and this should receive attention.

##### 8.10.1 Recommendations

Instructions will be added in the manual to the tester to practice exerting pressure of between 10 and 15 milligrams. This is the same as for the Finger Recognition test and should be practiced before commencement of testing. A postal scale is recommended for practice.

#### 8.11 SCREEN

Similar comments were obtained in this test as in the previous tests regarding the screen and will receive attention.

#### 8.11.1 Recommendations

The same recommendations regarding the screen are applicable here as in preceding tests.

#### 8.12 SPACING OF STIMULI

Comment was recorded that the spacing of items needed practice. The researcher recognises that this practice would be necessary and will be accomplished with the recommendations made previously regarding practice and observation.

#### 8.12.1 Recommendations

The same recommendations regarding practice and observation apply to this test.

#### 8.13 TACTILE DEFENSIVE RESPONSES

This test has the highest rating of all tests presented on tactile defensive responses (14% or more on 8 items). The researcher recognises that reducing the number of items may result in this characteristic of the test being reduced, but points out that the items where this tendency was seen are not necessarily the latter items and thus the effect may not be altogether lost. The items that were identified were: 3, 4, 5, 7, 9, 12, 14 and 15. The candidate again questions the accuracy of recording of these responses. In the instance where a testee was described as difficult to test, there was not a corresponding comment made on possible tactile defensive response.

#### 8.13.1 Recommendations

As this test appears to be the most sensitive measure for eliciting tactile defensive responses of all five tests included in this study, the tester should be made aware of this in the instruction manual. A guide for observation behaviours related to tactile defensiveness will be supplied in the manual. In the

recommended observation of testers prior to testing attention should be given to the observation of tactile defensive responses.

## 9. TACTILE STIMULI PLACEMENT TEST

### 9.1 ITEM INCLUSION OR EXCLUSION

57 tests were administered of which 55 testees completed all the items (one testee did not attempt any of the items). The two testees that did not complete all the items, both discontinued at item 5. In one of these cases tactile defensive responses were queried and may well be the reason for discontinuation. In the other case the testee objected to the smell of the spirits which may be an indication of olfactory defensiveness as described by Knickerbocker (1980).

#### 9.1.1 Recommendations

As it appears that the length of the test was not the reason for discontinuation of test, the researcher is confident that the length of the the test should not be changed and that all suggested items should be retained in the final test.

### 9.2 VERBAL INSTRUCTIONS

The verbal instructions were found to be easily understood in only 84.2% of the cases. As this test involves many steps it is recognised that this may be confusing for the testees. It is felt that optional extra verbal instructions and/or demonstration for the trials should be allowed. This allowance is already provided for in the manual.

#### 9.2.1 Recommendations

As the instructions in the manual allows for extra verbal instruction to be given as well as for demonstration of placement of finger no further recommendations are made here.

### 9.3 INTEREST IN AND MOTIVATION FOR THIS TEST

This test was the test of all five in this study with the highest motivation level. The intention of the researcher was to place this test with a high fun element last as most testees would already be fatigued at this point. Demotivating factors that were recorded were that the testee did not like the spots on his/her skin and that he/she objected to the smell of the spirits.

The researcher values being able to measure the placement of the testee's finger after testing very highly and is reluctant to make changes to the effect that would make immediate measurement necessary. The testee can however be reassured that his/her skin will be cleaned by demonstrating the cleaning procedure.

The reaction to the smell of spirits is appreciated as many children have had unpleasant experiences with this particular odour with injuries and hospital visits. An alternative cleaning agent should be found.

#### 9.3.1 Recommendations

It is recommended that instructions be included to the tester to reassure the testee about cleaning the spots from the skin after testing. To be able to afford the same amount of tactile stimuli to all testees, this will be included in the instructions for all testees and not only where necessary. This procedure will take place after the demonstration on the testee's hand.

The surgical spirits will be replaced with pure alcohol which is a non noxious substance and has not such a strong smell.

### 9.4 PLACEMENT OF FINGER ON STAMP

In only 64.9% of cases did the testees place their fingers on stamp pad spontaneously or with extra verbal instructions. In many cases the finger needed to be placed by the tester as demonstration. Some testees used excessive pressure on the stamp

in order to feel it, thus smudging the face. The researcher interprets this as an inability on the part of the testee to feel the stamp with light touch only and may reflect poor tactile discrimination. This may be a valuable clinical observation to record. However, it is felt necessary that the way in which the stamp should be touched to get a light print on the finger, should be demonstrated by the tester.

#### 9.4.1 Recommendations

Additional, optional instructions will be added in the manual for the tester to demonstrate placement of the finger on the stamp and to ensure that this task is accomplished by testing on the sheet of paper before starting the test items. The instructions will emphasise to the testee that the stamp should be lightly touched by saying: "Look how I put my finger on this face without pressing too hard/ Kyk hoe sit ek my vinger op die gesiggie sonder om te hard te druk".

#### 9.5 CLEANING OF FINGER ON STAMP PAD

87.5% of cases cleaned their fingers spontaneously and only two cases needed a lot of encouragement. In all cases this task could be accomplished.

#### 9.5.1 Recommendations

No changes are recommended in this regard.

#### 9.6 EASE OF ADMINISTRATION OF THE TEST

In less than half of the cases, the administration was found to be easy with practice. In 7 cases it was reported that a lot of practice was needed. There were 24 reports that the test consisted of too many steps or were too cumbersome. The researcher recognises that the complexity of this task will need a lot of practice, but should aim at simplifying the procedures.

The stamp and stamp pad are loose items that constantly need to be moved around and a suggestion was made that if these could be combined in one unit, it could ease the presentation for the tester. A suggestion was also made that using two stamps, one on either side could ease administration.

#### 9.6.1 Recommendations

It is recommended that the stamp and stamp pad be mounted on a wooden block as to form a unit. Two of these units will be included in the test kit to obviate moving these from side to side. It is also recommended that the initial cleaning of the finger be done on the stamp pad thus excluding the use of piece of cotton wool cutting down on the number of articles that are used and also reducing the amount of steps that need to be learnt.

The previous recommended changes made to the screen will ease administration.

#### 9.7 MESSY GAME

It is not clear from the data collected whether the comments on the messiness of the game was a response from the tester or testee. In the latter case this may reflect some tactile defensive response on the part of the testee and should be recorded as such.

##### 9.7.1 Recommendations

The previously suggested simplification of steps in this test will contribute to making it more compact and will leave less chance of spilling liquid or smearing the ink on the stamp.

It is recommended that future research be done as to the relationship between tactile defensiveness and the perception of this game as "messy".

## 9.8 COLOUR OF MARK

Comment was recorded that the brown mark of the marker resembled a beauty spot and that this was confusing. The researcher recognises this as a problem.

### 9.8.1 Recommendations

As play allows the child to break away from the constraints of reality, it is not necessary to use only a brown koki for this "game" (Bundy in Fisher et al, 1991). It is recommended that in the case of freckles or different skin colour, the tester may choose a colour koki that contrasts well.

## 9.9 UNIT OF MEASUREMENT

It was queried whether the measurement should be made in centimeters or millimeters as this was not clear in the manual.

### 9.9.1 Recommendations

Instructions in the manual will be added that measurement should be made in centimeters with one decimal point. These decimal points should be calculated.

## 9.10 ENGLISH VERSUS AFRIKAANS VERBAL INSTRUCTIONS

Comments were obtained that the two sets of verbal instructions were not exactly the same. This should receive attention.

### 9.10.1 Recommendations

The first instruction to the testee in Afrikaans omits to state that this is the last game in the series. This will be added in the manual: "Hierdie is ons laaste speletjie". Other differences refer to instances where the "him/her" term is used in English and "die kind" in Afrikaans. These will be changed in order to make the instructions more uniform. At the end of the game the

testee is told about a "reward" in the English version and in the Afrikaans version it is not called a reward. This will be changed in the manual.

#### 9.11 TACTILE DEFENSIVE RESPONSES

Very little tactile defensive responses are recorded for this test (less than 6% of cases showed a slight response on the first 5 items). It is however suspected that some of the tactile defensive responses were not interpreted as such as discussed earlier in "Messy game".

##### 9.11.1 Recommendations

Future research should investigate the tactile defensive responses elicited by this test more closely.

### 10. GENERAL

#### 10.1 TACTILE DEFENSIVENESS

The results obtained in the study indicate that not much information was gathered regarding tactile defensive responses. This may be attributed to the quality of observation skills on the part of the testers, but it may also indicate that these tests are not particularly sensitive to tactile defensive behaviour.

##### 10.1.1 Recommendations

As previously mentioned an attempt should be made to train testers in recognizing tactile defensive responses uniformly. It is suggested that a checklist of possible behaviours that indicate tactile defensive responses be included in the test manual.

It is also recommended that the TIE: Touch Inventory for Elementary School-Aged Children by Royeen (1990) be used in

conjunction with the proposed test. (See appendix)

## 10.2 CLINICAL OBSERVATIONS

Although a space was provided on the score sheet for clinical observations, it was seldom used.

### 10.2.1 Recommendations

It is recommended that specific clinical observations be recorded on the score sheet. A four point scale is suggested. The following table will be added to the score sheet:

#### Observation list

1. Postural background movements:	Poor	1	2	3	4	Good
2. Tactile defensive responses:	Severe	1	2	3	4	None
3. Concentration:	Poor	1	2	3	4	Good
4. Posture:	Poor	1	2	3	4	Good
5. Hyperkinetic:	Yes	1	2	3	4	No
6. Manipulation of shapes in Form Recognition test:	Poor	1	2	3	4	Good
7. Cooperation/Motivation:	Poor	1	2	3	4	Good

## PHASE II: PILOT STUDY

### 11.1 TESTERS

As the work of the co-worker was aimed at establishing the repeatability of the tests, the candidate erred in not including the Two Point Discrimination test for this purpose. This was an

conjunction with the proposed test. (See appendix)

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6. Manipulation of shapes in Form Recognition test:	Poor	1	2	3	4	Good
7. Cooperation/Motivation:	Poor	1	2	3	4	Good

## 11. PHASE II: PILOT STUDY

### 11.1. TESTERS

As the work of the co-worker was aimed at establishing the repeatability of the tests, the candidate erred in not including the Two Point Discrimination test for this purpose. This was an

oversight that was only realized in retrospect. A future study will have to be done to establish the inter-rater reliability of this test.

### 11.2. TESTEES

The candidate chose the Sub A group of children with the intent of selecting a fairly homogenous group in terms of ages. The realized group of children ranged in age groups 6yrs 6mths to 8yrs 5mths. Six month intervals were chosen as there is evidence in the SCSIT data that maturational differences occur over six months. This resulted in very small numbers in each group.

It could have been a more valuable study if the age group could have been limited to one or perhaps two groupings of 6month intervals. This would have required the candidate to include more schools in the study, but could ultimately have been worth the effort.

### 11.3 PERFORMANCE DIFFERENCES BETWEEN THE VARIOUS SCHOOLS

The comparison of performance of children on the SCSIT tests in the different schools, showed that children from Alpha school (coloured children) was consistently different from those in the white schools (see table 4.15, p.91). In three of the tests, Kinesthesia, Manual Form Perception and Finger Identification the scores were significantly lower, but on the Localization of Tactile Stimuli Perception test, the scores were higher. These differences between schools suggested differences between ethnic groups, as Alpha school has only coloured children and the other two school only white children. These comparisons rendered similar results (see table 4.16, p.91).

Reasons for poorer performance of the coloured children on tests may be found amongst the following, but will have to be researched:

--- Differences in perceptual skill between ethnic groups could also contribute to poorer performance on these tests especially Manual Form Perception. In a longitudinal study of coloured children from birth to 5years, Molteno (1985) found that although infant development was not associated with social variables at birth, there was a strong correlation between growth, development and social milieu at age five. In a study by Van Rensburg (1993) on Sub A children of the low income coloured group, a high incidence of poor sensory motor skills was identified. This suggests that if these subtest should be developed further, different normative data would have to be established for different sub sets of the population.

--- In the community of Alpha school there are no pre-primary schools whereas in the white communities ample facilities are available. It could be reasoned that the white children received stimulation through these programmes which enhanced these perceptual abilities. This would especially have an influence on Manual Form Perception where the visual recognition of forms are involved ( see table ).

There are no apparent reasons for better performance on the Localization of Tactile Stimuli Perception test. However, living conditions of this socio economic group could be considered, where space is limited and families live in closer physical proximity, affording much more tactile stimulation in day to day living.

These results suggest that different norms would have to be established for the different ethnic groups.

#### 11.4 GENDER DIFFERENCES

As gender differences were only found on only one test for only one age group ( $p = 0.0426$ ), this can be regarded as negligible. There would thus not be any justification for different norms for male and female.

### 11.5 NORMAL VALUES OF THE PROPOSED TEST

The sample size was too small to regard the calculated standard values as normal values. This should ideally also have been a separate study using a much larger sample ( $\pm 100$  per 6month age interval)

### 11.6 SENSITIVITY AND SPECIFICITY

#### 11.6.1 Kinesthesia and Non-Vestibular Proprioception

The sensitivity level of 36%, implies that the Non-vestibular proprioception test could only identify 4 out of the 11 cases that the Kinesthesia identified. However the Non-vestibular Proprioception test identified 14 cases as having a deficit present. There is a possibility that the two subtests do not measure the same variable. For this reason the differences between the two tests are considered.

The Kinesthesia test may not measure the differences in position of the hand accurately. In this subtest the child's hand is passively moved to a designated spot and again moved back to the starting point. The child then has to move his hand to the spot previously indicated. The tester is required to make a measurement of the differences of position and record it immediately. This does not allow the tester a remeasurement at a later stage. Impulsive children may also remove their hands immediately after indicating the spot, forcing the tester to estimate the spot indicated. The proposed test was designed to enable the tester to make a more accurate measurement as the child's hand is stabilized in the chosen position and will not be affected by poor postural background movements or low muscle tone. The disposable protocol sheet enables the tester to mark the chosen position to enable measurement of the differences at a later stage. This prevents mistakes in measurement and also allows for a remeasurement.

It is postulated that for the above mentioned reasons the Kinesthesia test of the SCSIT does not measure as accurately as

the Non-vestibular Proprioception test.

In personal communication with Fisher (Fisher, et al 1991) Ayres recognised the limitations of the Kinesthesia test of the SCSIT when reviewing its poor loading with other vestibular-proprioceptive assessments. She stated: "I suspect ... that it is not really a good test." Thus the gold standard that the Non-vestibular Proprioception test was compared to, is also questionable.

The fact that the Non-vestibular Proprioception test identified some different subjects as having a deficit, may suggest that different variables are measured by these two tests. This can only be clarified by investigating construct validity using an external criterion as the gold standard, i.e. clinical diagnosis.

The comparatively high specificity level (86.27%) suggests that the proposed test is capable of identifying that proportion of the population that has no problems in this area.

Future research should be aimed at validating this test by comparing results to clinical data.

#### 11.6.2 Manual Form Perception and Form Recognition

Comparisons that were done for the whole group of 114 subjects indicated a sensitivity level of 20% and a specificity level of 92,3%. This implies that the proposed test could only identify 20% of the cases that the corresponding SCSIT test did.

The differences between the two tests should be considered. The Manual Form Perception test requires the subject to identify a shape on a two dimensional chart once the corresponding shape is placed in the hand. This task requires adequate vision and visual perception, especially figure ground perception. The child with poor figure ground perception would take longer to find the visual image of the form that he has in his hand. Children would also tend to guess randomly if they are not able to immediately

find the correct picture. It appears that this was recognized by Ayres when the SCSIT was revised. In the Sensory Integration and Praxis tests (SIPIT) these visual elements were avoided.

The Form Recognition test is designed in such a way that elements of vision and visual perception are excluded. This may account for a sensitivity level of only 20%. It can be postulated that the MFP identified subjects in the deficit area for reasons other than poor stereognosis, eg. poor figure ground perception. This can only be verified through further research.

An attempt was made to investigate construct validity by additional investigation of the largest of the age groups, 7 to 7.5yrs (n = 50). Here comparisons of true normals and true abnormals were made and statistically significant differences were found (p = .0067). These values enable one to draw the inference that the proposed test can identify abnormal cases in 60% of the instances when the deficit present and absent groups were more refined.

The sensitivity of 60%, although not ideal suggests that when the range is widened there is enough reason to believe that this test could be developed into a valid measure of stereognosis. In order to do this future research will entail comparing results with clinical evidence of dysfunction.

### 11.6.3 Finger Identification and Finger Recognition

In comparing the results obtained on the Finger Identification test with that obtained on the Finger Recognition test (N=114) unacceptably low sensitivity (32.14%) was calculated, but high specificity (87.06%).

When examining results of one age group only (n=50) statistically significant differences were found between the means of the groups with deficit present and deficit absent. However the sensitivity (27.3%) and specificity (30%) levels were both unacceptably low.

Being able to identify which finger is touched is a recognised method of clinical sensory evaluation and has also been incorporated in standardized tests (Miller, 1988). It could be valuable to obtain sensitivity of this test by testing the learning disabled population. It should also be kept in mind that Ayres recommended that results of an individual subtest should not be interpreted singly as the test becomes more valuable as a whole (Kinnealey, 1989).

Future validation studies should thus be aimed at comparing test results to clinical evidence.

#### 11.6.4 Localization of Tactile Stimuli and Tactile Stimuli Placement

Comparing results on the Localization of Tactile Stimuli and Tactile Stimuli Placement tests (N=114) resulted in very low sensitivity (15.79%), but high specificity (86.67%). Even when in the one age group (n=50) true normals and true abnormal were examined, it was not possible to demonstrate statistically significant differences. In both of these analyses the SCSIT identified more children that have a deficit present than the proposed test.

There are differences between the mechanics of these two tests that could partly be responsible for this discrepancy. In the LTS the tester touches the child's skin with a felt tipped pen leaving a mark. The child is then required to indicate the exact spot by touching it. The tester is required to measure any discrepancy between the locations. This method does not allow the tester any remeasurement. The child often touches the spot and removes his hand immediately resulting in the tester having to estimate the distance. This could lead to inaccuracy.

The TSP is designed in a way that the child leaves a mark whilst indicating the spot that had been touched. This would result in not having to make an estimate of the exact spot and also allows the tester remeasurement at a later stage. It is therefore

speculated that the LTS may have erroneously identified children in the deficit present group because of inaccuracy of measurement. This could only be verified in future research where test results are compared to clinical data.

#### 11.6.5 Summary of Results of Validity Study and Recommendations

The proposed test was unable to identify the same number of children within the deficit present group as the SCSIT was able to, although in the case of the Form Recognition and Finger Recognition there were statistically significant differences between the means of true normal and true abnormal.

In the foregoing discussion some speculations were made as to the reasons why the proposed test appears less sensitive than the gold standard used. The tests investigated are derivatives of recognised clinical evaluation procedures with established usefulness particularly with brain injured adult patients. These have been adapted for use with children and could be useful evaluation tools if an acceptable power of discrimination could be established.

The original procedures were not designed for use with the neurologically average person and it can thus be speculated that for the same reasons the proposed test would also discriminate better when used on a group of dysfunctional children.

It is recommended that the information gained from this pilot study be used in determining sample sizes for future development of the proposed test and that sampling also be done amongst children with clinically diagnosed dysfunction. The Two Point Discrimination test, which was not subjected to any validation in this study, can be validated at the same time by the same method.

#### 11.7 RELIABILITY

The inter-rater reliability obtained for all tests was relatively

low with the Form Recognition test having the highest at .68. According to King-Thomas and Hacker (1987) .90 is required for diagnostic purposes.

More stringent control over uniform administration procedures may have increased inter-rater reliability. At the time of the study the candidate chose not to investigate the intra-rater reliability because of limited time and funds. In retrospect this is regretted. Information gained in this way could have made reasons for poor inter-rater reliability clearer, i.e, if intra-rater reliability was sufficient, the lack of uniformity of testing amongst raters could be the cause of poor inter-rater reliability.

In the case of the Form recognition test one individual correlation was seen to be very different from all the others. The child was identified and his history as well as clinical observations show him to have a severe attention deficit. The difference in scores between the raters may well reflect their differing abilities in controlling children with this kind of problem within the testing situation. Additional training and more rigorous control over testing procedures are indicated

The variables investigated in this study are non-discreet and for that reason an accurate measurement was not always obtainable. If the mean score of three tests administered a few days apart could be calculated, it would probably be closer to the true performance of the child. The standard error of measurement should also be considered for each test as Ayres originally suggested (Ayres, 1983).

Future research into reliability of the proposed test would need to address aspects of reliability pertaining to training of testers and control of uniform testing procedures. Identification of typical cases that need more than one testing with averaging of scores, should also be investigated.

CHAPTER VI  
CONCLUSION

An assessment tool was designed and constructed for the assessment of somatosensory perception. It comprises five subtests, i.e. Non-vestibular proprioception, Finger Recognition, Form Recognition, Two Point Discrimination and Tactile Stimuli Placement Test.

A field study was conducted to evaluate the mechanics of the subtests. Seven field workers were recruited and 58 children were tested. Each field worker completed a self administered questionnaire for every completed test.

The field workers were all occupational therapist with experience in test administration. They all met the criteria of both having been trained in test mechanics by SAISI and passing in test observation. Only voluntary workers were used in this study.

A sample of convenience was used when selecting children for phase one of the study. No restrictions were placed on age as the field workers had to choose from a group of children that was available to them. The field workers were however urged to keep the intended age group in mind when selecting children. The only criterium implemented for inclusion, was that the subject should understand either Afrikaans or English. All children participated voluntarily with parental consent.

The data obtained through the questionnaire were statistically analysed and these results were used to refine the subtests. The number of items was reduced; verbal instructions were changed where indicated; the score sheet was altered and the instruction manual was changed accordingly.

The preparatory work that was done in phase one was very time consuming although it was executed on a relatively small scale (N =58). This was however a very necessary exercise to enable the researcher to sort out the practical side of test administration. If more time and manpower had been available, this part of the study could well have been extended, possibly rendering different results. The candidate is satisfied that within the constraints of limited resources the best possible end product was obtained.

In the ensuing pilot study the validity and reliability of the refined and developed evaluation tool was investigated.

For the validity study the somatosensory subtests of the Southern California Sensory Integration Tests were used as the gold standard. The subtests of the proposed test that were investigated for validity were Non-vestibular Proprioception, Finger Recognition, Form Recognition and Tactile Stimuli Placement tests. As there is no subtest of the SCSIT that corresponds with the Two-point Discrimination subtest, no investigation for validity was done for this test.

A representative sample (n = 114) was tested on the somatosensory subtests of the SCSIT and the corresponding subtests of the proposed test. Results were compared and levels of sensitivity and specificity were established.

In generally higher specificity than sensitivity was obtained. This implies that all four subtests of the proposed test could identify at least 85% of children who have no deficits. However the proposed test did not identify as many of the children with a deficit as did the definitive diagnostic procedure, except in the case of Non-vestibular Proprioception.

The Non-vestibular Proprioception subtest identified more children as having deficits than the Kinesthesia test, but they were mostly different subjects. The Non-vestibular proprioception test identified 16% of children as opposed to the Kinesthesia's 10%, but only 4 out of 11 were the same subjects as those identified by the Kinesthesia test. The possibility exists that the Non-vestibular proprioception test did not measure exactly the same variable as the Kinesthesia test. This can only be clarified by using an external criterion, such as clinical diagnosis, as gold standard.

The other three subtests of the proposed test identified fewer children with a deficit than the SCSIT tests did. In the case of Form Recognition there were 12% versus 31%, Finger Recognition, 18% versus 25% and Tactile Stimuli Placement, 14% versus 34%.

An attempt was made to establish construct validity by selecting from one age group ( $n = 50$ ) groups with deficit definitely present ( $n = 10$ ) and deficit definitely absent ( $n = 12$ ). After refining the deficit present and absent groups in this way the sensitivity was three times higher for the Form Recognition test. This supports the assumption that the sample range was not sufficiently large. In future studies an effort should be made to sample within the dysfunctional group of children, i.e. using clinical diagnosis as gold standard.

The foregoing results suggest that by widening the range artificially as was done in the exercise, the proposed test increased in discriminate power. The overall deduction that can be made here is that future studies would have to focus on the dysfunctional group of children as clinically diagnosed.

Inter-rater reliability was investigated by comparing results obtained by the candidate to those obtained by an independent field worker.

A co-worker was recruited to assist with the reliability study. Thirty children were randomly selected from the larger group in the study and tested by both the candidate and the co-worker. Results were compared and inter-rater reliability was established.

Inter-rater reliability varied for the different subtests with Form Recognition obtaining the highest, 0.717. If one case with severe attention deficit is excluded, the correlation is higher, 0.83. This discrepancy may reflect the differing abilities of the two testers to elicit the best response from a child with attention deficit. Additional training could address this problem, but it may be necessary to recommend multiple testing for similar cases and averaging of scores. However this suggests that the test has the intrinsic capacity to be reliably repeated for most cases and that stringent control over uniform testing procedures should be maintained. These measures could possibly increase the reliability of the other subtests as well.

For the remaining subtests the correlations were lower, i.e. Non-vestibular Proprioception, 0.513, Finger Recognition, 0.653 and

Tactile Stimuli Placement, 0.521. The literature suggests that reliability for individual tests are less than when composite scores are used (Kinnealey, 1989). In practice these tests would never be interpreted singly, as a clinical diagnosis is always made on a cluster of test scores. Future reliability studies should be conducted along these lines.

Many insights have been gained in conducting the two phases of this study. Some indications of future research strategies could be ascertained. The most important fact that has emerged, is that all the work that has been done thus far is preliminary to the larger task of test development. From the data collected during this study, it would seem that for each 6 month interval age group, between 250 and 300 children would need to be investigated in order to establish normal values.

This is a task that will require a much larger budget and also a research team rather than a single researcher. Support in terms of finance and manpower would have to be obtained if the test is to be developed further.

The candidate set out to design and construct an evaluation tool, to refine it and to conduct preliminary validity and reliability studies. This is the start of test development and through this exercise the candidate has obtained a working knowledge of the process.

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## **APPENDICES**

**APPENDIX 1**  
**TEST MANUAL**

## GENERAL INSTRUCTIONS FOR ADMINISTERING THE SOMATOSENSORY TESTS

The test consists of five subtests, i.e. Kinesthesia, Finger Recognition, Form Recognition, Two Point Discrimination and Tactile Stimuli Placement Test. Each of these tests have specific instructions pertaining to that test alone.

Here are some general instructions that pertain to all the subtests:

The arrangement of the room should be complete before the child enters the room. The room should have adequate lighting, heating and ventilation. Distractions such as wall posters, toys, etc should be kept to a minimum.

Furniture should consist of a table and two chairs.

The child should be seated comfortably at the table with ankles, knees, hips and elbows (when resting on the table) at 90° angles. It may be necessary to use an adjustable table and have chairs of varying heights available.

The tester sits directly opposite the child. The screen is attached to the table in such a way that it can be easily positioned in front of the child, approximately 15cm from his/her face.

It is suggested that a quick screening of postural control mechanisms be done beforehand to prepare the tester for responses such as poor postural background movements. General information is obtained from the child (name, age, address, school, etc., depending on the child's age) as to introduce the child to the situation and to reassure him/her.

After the final test a reward is given. Check with the caretaker of the child whether he/she may have a chocolate. If not a star/sticker is offered.

## OPERATING INSTRUCTIONS FOR KINESTHESIA TEST

**Apparatus:** Adapted "mouse", screen, red fine-liner, scoring sheet, ruler/tape measure, table and chair.

### General instructions:

The child should be seated comfortably at the table. The tester sits directly opposite the child. The tester should check the positioning of the screen before commencement and adjustments should be made if necessary

The Kinesthesia measurement chart should be taped to the table 10cm from the edge of the table prior to commencement of test.

The tester's hand may touch the child's hand whilst moving the mouse if necessary (e.g. child withdrawing hand), but in the stabilizing period of 3 seconds the tester may not touch the child's hand, only stabilizing by holding onto the mouse. It is suggested that the tester use his/her non-dominant hand for moving of the mouse and the dominant hand for marking. This may however not be the most comfortable/functional usage of hands and it is thus suggested that the tester practises the movements beforehand and find the most comfortable way of holding the mouse.

Special attention should be given to the timing of movement on the various items. Items 3 and 6 should be timed for one second. Trial items and items 2, 4, 5 and 7 should be timed at two seconds and items 1 and 8 should be timed at three seconds. Tester should practice this timing with the help of a stop watch before commencement of test.

Specific Instructions: (Verbal instructions appear in bold print. Afrikaans instructions follow directly and are underlined).

Trial:

Say to the child:

We are going to play a mouse game. Here is the mouse. Here are his ears. You must hold him between his ears.

Ons gaan 'n muisspeletjie speel. Hier is die muis en hier is sy ore. Jy moet hom tussen sy ore vashou.

Place the child's fingers of his right hand between the ears of mouse. Say:

That's right.

Dis reg.

Ensure that the child's left hand is on his/her lap. Touch the left hand, saying:

Keep this hand on your lap so that we don't crash into it.

Hou hierdie hand op jou skoot sodat ons nie daarmee bots nie.

Make sure at this stage that the hand is correctly positioned. Additional help and/or verbal instructions can be given to ensure that the positioning is correct. Say:

We are going to show the mouse where to find some cheese. This is where we start from, the nest of the mouse. I'm going to move your hand with the mouse.

Ons gaan nou vir die muis wys waar hy kaas kan kry. Ons begin hier waar sy nes is. Ek gaan jou hand saam met die muis beweeg.

Place the mouse with the child's hand on it on position T1 so that pencil point will be in the small circle when put through the guide.

This trial part is executed with full vision of the child. Before moving the child's hand to position T2, say:

We will take the mouse to where the cheese is, here.

Ons gaan nou die muis neem na waar die kaas is, hierso.

Move the child's hand to position T2. Allow 3 seconds whilst holding the mouse in a stationary position and making a circular movement through the guide. The tester's hand should not touch that of the child whilst in the stationary position. Now say:

We will now take the mouse back to his nest, here.

Ons neem nou die muis terug na sy nes, hierso.

The tester moves the mouse back to position T1 and checks position by inserting pen through guide into the small circle. Say to the child:

Now you must take the mouse to fetch the cheese.

Jy moet nou die muis neem om die kaas te gaan haal.

Let the child move to the required position. Immediately when the child's hand stops the tester should again stabilize the mouse to prevent the child from moving it any further, whilst saying:

That's right.

Dis reg.

Again make a circular mark through the guide. Draw a line between two red dots for future measurement.

Say to the child:

Now we will use the other hand. Put your other hand here between the mouse's ears. That's right.

Ons gaan nou jou ander hand gebruik. Sit jou ander hand tussen die muis se ore. Dis reg.

Make sure that the hand is again comfortable on the mouse in the correct position. Move the child's hand to T2.

Here is where the mouse has his nest now.

Die muis se nes is nou hier.

Move the mouse so that the pen can be placed on the small circle when placed through the guide. Say:

We will again show the mouse where to find the cheese, here.

Ons sal die muis wys waar die kaas is, hier so.

Move the mouse to position T1 and make a circular mark through the guide with the pen. Wait 3 seconds whilst holding the mouse stable and then say:

We will take the mouse back to his nest.

Ons neem nou die muis terug na sy nes.

Move the mouse back to position T2 and place correctly by using the pen through the guide. Say:

Now you must take the mouse to fetch the cheese.

Jy moet nou die muis neem om sie kaas te kry.

Again stabilize the mouse as soon as movement has stopped and mark through the guide and connect the two dots. Say:

That's right.

Dis reg.

#### Test items:

Say to the child:

We will now play this game without your eyes helping you. That's why we pull this screen down in front of your face.

Ons sal nou hierdie speletjie speel sonder dat jou oë jou help. Daarom plaas ons hierdie skerm voor jou gesig, so.

Pull screen down in front of the child's face so that hands are obscured. Say:

This is where the mouse has his nest now.

Hier is die muis se nes nou.

Move the child's hand to position 1a. Say:

I will show you where the mouse can find the cheese. I'm going to move your hand with the mouse.

Ek sal jou wys waar die muis die kaas kan kry. Ek gaan jou hand saam met die muis beweeg.

Move the mouse to position 1b. Say:

Here is the cheese.

Hier is die kaas.

Wait 3 seconds whilst stabilizing the mouse and marking through the guide. Say:

Now we take him back to his nest

Ons neem hom nou terug na sy nes.

Move the mouse back to position 1a. Say:

Now you take the mouse to fetch the cheese.

Neem jy nou die muis om die kaas te gaan haal.

Again stabilize the mouse once movement has stopped and mark through the guide and connect the two dots.

Continue in the same way for items 2 to 10 each time asking the child to change his hands on the mouse. Verbal instructions can be shortened once the tester is confident the child understands what is expected of him. Shortened instructions are:

Here is the mouse's nest. Here is the cheese. Here is the nest. Now you go to the cheese.

Hier die die muis se nes. Hier is die kaas. Hier is die nes.  
Gaan jy nou na die kaas toe.

If at any time the testee's hand should move off the scoring sheet, the tester should mark the spot immediately with a circular sticker and make the measurement immediately after completing all the test items, before removing the sheet.

If the testee moves in the opposite direction, the item is ignored and repeated after the last item as this may be due to inattention. If on a second attempt the testee still moves in the opposite direction, the maximum score of 5cm should be awarded.

After all the items have been completed remove the measurement sheet before removing the screen and then say:

Thank you, that was good,  
Dankie dit was goed.

indicating that the test has been completed.

Scoring: For each of the items 1 to 10 the distance between the two dots are measured and recorded in the recording blocks on the measurement sheet. The total is subtracted from 50 to calculate a raw score for each hand. The total of both hand's scores are subtracted from 100 to calculate a total raw score.

## OPERATING INSTRUCTIONS FOR FINGER RECOGNITION TEST

Apparatus: Rubber thimbles to fit snugly on the thumb and index fingers of the testers dominant hand when turned inside out, Pencil with rubber, screen, placement sheet, masking tape and scoring sheet (on the back of the Kinesthesia measurement chart).

### General instructions:

The child is seated in the same way as for the Kinesthesia test. This test should follow immediately after the Kinesthesia test. It is suggested that the thimbles be warmed to approximate body heat in cold weather. This can be done by placing the thimbles in a trouser/skirt or breast pocket 30 minutes prior to testing. It is advisable to practice the pressure of touching to make sure that the correct pressure is used, approximately 10 - 15 milligrams of pressure.

The placement sheet is placed on the table, approximately 10cm from the edge of the table or alternately in the position where the elbow is touching the edge of the table. Once the child's hands are in the required position the sheet should be removed and placed face down away from the area of testing. This placement sheet should again be used when reinstructing on items 9 for the lateral surfaces.

### Trials:

Say to the child:

Place your hands in front of you on these hands like this.

Plaas jou hande voor jou op hierdie hande. 50.

Point briefly to the placement sheet and place own hands on table with fingers spread out as on placement chart. If the child has difficulty in understanding these instructions, the hands may be lifted and placed in position. Say:

Touch this finger.

Raak aan hierdie vinger.

Tester touches the right index finger on the middle phalanx. Pointing to the left index finger, say:

Touch with this finger.

Raak met hierdie vinger.

Wait for the child's response before proceeding to the next trial item. If the child does not point to the indicated finger spontaneously, his left index finger may be lifted and brought to touch the indicated finger. Proceed in the same way for the other three trial items.

Test items:

Say:

Let us see if you can tell which finger I am touching if you can't see where I'm touching. We will again pull this screen down in front of your face.

Kom ons kyk of jy vir my kan sê aan watter vinger ek raak sonder dat jy sien waar ek raak. Ons sal weer hierdie skerm voor jou gesig sit.

Pull screen down in position. Say whilst applying the stimuli for item 1:

Which finger am I touching now?

Aan watter vinger raak ek nou?

Move screen away from the child's visual field so that he/she can see hands. Once the child has indicated a finger, say:

Thank you.

Dankie.

and replace screen, again obscuring the child's vision.

Proceed through all items in the same way. After item 8, instruction should be done to make the child aware of the fact that the lateral surfaces of the fingers are to be touched. Move the screen away and say:

I am now going to touch the sides of your fingers, but first put your hands on these hands again.

Ek gaan nou jou vingers aan die kante raak, maar sit eers weer jou hande op hierdie hande.

Replace the placement chart in the previous position.

Say:

Touch the side of your finger like this,

Raak aan die kant van jou vinger, so.

whilst touching the radial side of the right middle finger with the rubber of the pencil. Say:

Remember to touch the side of your finger and not the top.

Onthou om die kant van jou vinger te raak en nie die bokant nie.

Again remove the placement chart before continuing with items 9 to 11.

When the child has completed all the items, say:

Thank you, that was good

Dankie dit was goed.

to indicate the end of the test. Replace thimbles in pocket for further use in Two-Point Discrimination Test.

Scoring: Score two points for each item correct on the first try. Score one point if the child touches the wrong finger at first and then corrects himself spontaneously. This is not encouraged during the test items. The total score obtained is the raw score for this test.

### INSTRUCTIONS FOR FORM RECOGNITION TEST

Apparatus: Selection of wooden and metal shapes, screen, stopwatch and scoring sheet (on back of Kinesthesia measuring chart).

General instructions: The child is seated in the same way as for the previous two tests. This test should follow directly upon the Finger Recognition Test. The tester should acquaint her/himself with the sequence in which the forms are presented so as to make the presentation fluent.

#### Specific instructions:

Say:

I have some shapes/forms here.

Ek het 'n aantal/klomp vormpies hier.

Show the child the first set of four forms. Place stimulus shape in child's right hand, saying:

Feel this shape. Does it feel like this one,

Voel aan hierdie vormpie. Voel dit soos hierdie een.

placing the first of the distractor items in the left hand for 3 seconds. Retrieve the shape and replace it with the second distractor and say:

Or this one.

Of hierdie een.

Again wait 3 seconds, retrieve it and replace it with the third item, saying:

Or this one.

Of hierdie een?

Allow the child to manipulate and look at the shapes.

If the child was correct the tester says:

Yes, that is right. They feel the same and they look the same.  
Ja, dis reg. Hulle voel dieselfde en hulle lyk dieselfde.

If he was incorrect the differences and similarities should be pointed out by saying:

Look, here these two are the same, but these two are different.

Kyk hierdie twee is dieselfde, maar hierdie twee is verskillend/anders.

Allow the child then to hold the two matching items in each hand and say:

Can you feel that they feel the same?

Kan jy voel hulle voel dieselfde?

Make sure at this stage that the child has felt the difference between the items. Additional instruction can be given.

The second trial item is administered in the same way with the stimulus form placed in the left hand and the distractor items in the right hand.

Test items:

Says:

We will use this screen again to see if you can tell which forms feel the same, without your eyes helping you.

Ons sal weer hierdie skerm gebruik om te sien of jy vir my kan kan sê watter vormpies dieselfde voel sonder dat jou oë jou help.

Draw the screen in front of the child's face. Say:

We will put the first shape in this hand.

Ons sal die eerste vormpie in hierdie hand sit.

Lightly touch the right hand,

and the other shapes in this hand,

en die ander in hierdie hand.

touching the left hand. Place the first test shape in the right hand and say:

Here, feel this shape. Does it feel like this one

Voel aan hierdie vormpie. Voel dit soos hierdie een.

Place first distractor item in left hand and start the stopwatch. Wait 3 seconds and retrieve shape from left hand replacing it with the second distractor item saying:

Or this one.

of hierdie een.

Wait 3 seconds and retrieve the shape replacing it with the third distractor, saying:

Or this one?  
Of hierdie een?

The time is recorded when the child chooses the correct item. It is advisable to keep the stopwatch running in case the child chooses an additional shape.

If the child chooses more than one shape or the incorrect shape, the shapes are again presented in reverse order, saying:

Let's feel them again. Is it this one, this one or this one?  
Kom ons voel hulle weer. Is dit hierdie een, hierdie een of hierdie een?

pausing for 3 seconds between presentations. If the child still is unable to choose the correct item, proceed to the next item and score that item as incorrect and give no time score for that item.

Mark the appropriate letter, R, Y or B, for the response of either red, yellow or blue. (The correct response is always red).

If for any reason the child accidentally sees the shape, ignore this score and repeat the item again at the end of all the items or after the 5th error.

If the child has not yet made a decision after 45seconds the tester should encourage him/her to make a guess as not to waste any more time on that item.

#### Scoring:

Score all responses on red as 1 point, other responses as 0. The correct items are calculated for the total item score. The time taken for each response is recorded on the record sheet. Any item requiring more than 45 seconds is scored as incorrect and that time is not calculated in the time score. Total time is calculated and one point is deducted for each 45 seconds. This adjusted total is the raw score for this test.

## INSTRUCTIONS FOR THE TWO-POINT DISCRIMINATION TEST

Apparatus: Two rubber thimbles as used in the Finger Recognition Test, screen, placement sheet, score sheet (on back of Kinesthesia Measuring Chart).

### General instructions:

Child and tester are again seated as in previous tests. This test should follow immediately after the Form Recognition Test. Before commencing the child should be asked to remove jewelry/watch and pull sleeves up where applicable.

### Specific instructions:

The placement sheet is taped to the table so that the full forearm of the child rests on the table when hands placed in position. Say:

Place your hands on these hands.

Sit jou hand op hierdie hande .so

Indicate the hands on the placement sheet and place own hands on table as in placement sheet.

### Trial items:

Say:

I am now going to touch you either with one or two fingers like this.

Ek gaan nou aan jou raak .f met een .f met twee vingers. so.

First touch the dorsum of the child's right hand with thimble index finger. Say:

See, I touched you with one finger. Now I'm touching you with two fingers.

Sien ek het jou nou met een vinger geraak. Nou raak ek jou met twee vingers.

Touch the dorsum of the right hand with thimble index finger and thumb horizontally next to each other.

See, I touched you with two fingers.

Kyk ek het jou met twee vingers geraak.

Say:

Now you tell me whether I'm touching with one or two fingers.

Sê nou vir my of ek met een of twee vingers raak.

Touch the left hand with the index finger, whilst the child's arms and hands are still in his visual field. If the child responds correctly, say:

That is right.

Dis reg.

If he responds incorrectly touch him again and say:

See, I'm touching you with one finger.

Kyk. ek raak aan jou met een vinger.

Wait for a response. If the child is unable to indicate that he was touched by one finger only, discontinue this test.

When the child has responded correctly on the third trial item, say:

Am I now touching with one or two fingers?

Raak ek nou aan jou met een of twee vingers?

whilst touching the dorsum of the left hand with thumb and index finger horizontally next to each other. Wait for a response and confirm a correct response by saying:

Yes, that is right.

Ja, dis reg.

If the child still responds incorrectly discontinue this test by saying:

Let's play another game.

Kom ons speel 'n ander spelatjie.

If the child has clearly indicated that he understands what is expected of him, continue with the test items.

Test items:

Say:

Now you must tell me if I use one or two fingers without your eyes helping you. That is why I will pull this screen down in front of your face like this.

Nou moet jy vir my sê of ek aan een of twee vingers raak sonder dat jou oë jou help. Daarom sit ek weer hierdie skerm voor jou oë, so.

Draw screen down into position. Say:

Tell me if I'm touching with one finger or two fingers.

Sê vir my of ek met een of twee vingers aan jou raak.

Continue with items 1 to 8 in the same way as for the trials. On each item, when the child has responded, say:

Yes,

Ja

indicating that you are satisfied with his response regardless of whether he was correct or not.

Scoring: Both double and single stimuli are scored. Each correct response is scored two points. If the child spontaneously changes his mind, the item is scored one point. This is not encouraged during the test items. The total score for each side is calculated as well as a combined total score. These are the raw scores for this test.

## INSTRUCTIONS FOR THE TACTILE STIMULI PLACEMENT TEST

Apparatus: Pre-inked X-Stampers with written part masked out in such a manner that spring is kept in position, surgical spirits and wad of cotton wool, black koki pen, a clean stamp pad that has been "inked" with pure alcohol, a clean sheet of white paper, screen and measuring tape.

### General Instructions:

Child and tester are again seated as in previous tests. This test should follow immediately after the Two Point Discrimination Test.

### Specific instructions:

The clean white sheet of paper is placed in front of the child (not taped down). Say:

This is our last game for now. We will take a pretend child to eat a pretend piece of chocolate. Before we do this we first have to clean our fingers like this.

Hierdie is ons laaste speletjie. Ons gaan hierdie kamma kind neem om 'n kamma stukkie sjokolade te eet. Voor ons dit doen, moet ons eers ons vingers skoonmaak, so.

First wipe your own index fingers on the stamp pad that has some alcohol on. Then wipe the child's index fingers in the same way. If the child shows reluctance to having his fingers cleaned, encouragement can be given eg. explaining that one always has to clean up before eating for hygienic reasons.

This is the chocolate

Hierdie is die sjokolade

show the child the koki pen whilst making a mark on the paper,

and this is the child

en hier is die kind

making an imprint of the face on the paper with your own index finger.

We will try to get him/her to eat the chocolate by putting his/her face on the chocolate, like this.

Ons gaan probeer om die kind te kry om die sjokolade te eet deur sy/haar gesiggie bo-op die sjokolade te sit, so.

Make an imprint of the face on the brown mark on the paper. Say:

Now it is your turn to take him/her to get the chocolate. I will put a piece of chocolate here

Nou is dit jou beurt om hom/haar te neem om die sjokolade te kry. Ek sit 'n stukkie sjokolade hier.

Make a new brown mark on the page. Say:

Put your finger on his/her face

sit jou vinger hier op sy/haar gesig

indicating the face on the stamper

and take him/her to eat the chocolate. Yes, that is right.

en neem hom/haar om die sjokolade te eet. Ja, dis reg.

Make sure at this stage that the child understands that he has to make an imprint on the brown mark. Extra instructions are allowed here. If the child still does not grasp the instructions, you can move his/her finger by holding it between your thumb and index finger on the distal phalanx and placing it on the brown marker.

The child's finger should be cleaned after each mark has been made. Use the stamp pad that has been "inked" with alcohol for this purpose. Say to the child:

Let's clean your finger again by wiping it on this pad  
Kom ons maak jou vinger weer skoon. Vee dit af op hierdie kussinkie.

Wipe your own finger on stamp pad as demonstration. Remember to do this after each item.

Remove the sheet of paper and say:

We are now going to play this game on you. Put your hands down on the table like this.

Ons gaan nou hierdie spelletjie op jou speel. Sit jou hande voor jou neer. so.

Place your hands in front of you, palms down, indicating to the child that he/she should do the same. Say:

I'm going to put a piece of chocolate on your hand like this.

Ek gaan 'n stukkie sjokolade op jou hand sit. so.

Make a mark with the marker on the <sup>WRIST</sup> ~~thumb~~ of the child's right hand and say:

Now, put your finger on the child's face and take him to get the chocolate. Don't move your finger once you've got chocolate otherwise his/her face will smudge. Yes that is right.

Sit nou jou vinger hier op die gesiggie en neem die kind om die sjokolade te kry. Moenie jou vinger beweeg as jy die sjokolade gekry het nie. want anders sal sy/haar gesiggie klad. Ja. dis req.

Make sure that the child grasps the idea of making an imprint on the brown mark before continuing with the test part of the test.

Place the X-stamper to the right of the child so that it will be in the visual field of the child when the screen is in position. Stabilize the X-stamper with your own hand.

Say to the child:

We are again going to use this screen to see if the child can find the chocolate without your eyes helping him. Put this finger on the little face and keep this hand flat down on the table.

Ons gaan nou weer hierdie skerm gebruik om te sien of kind self die sjokolade kan kry sonder dat jou oë help. Sit hierdie vinger op die gesiggie en hou jou ander hand plat op die tafel.

Indicate the child's right index finger and also the face on the stamper and then pull the screen down into position. If the child does not place his finger correctly he/she may be prompted or otherwise his/her finger may be lifted, holding it between thumb and index finger on the distal phalanx and placed on the face of the X-stamper

Say to the child:

Here is the chocolate  
Hier is die sjokolade

whilst touching the child's forearm on position 1 with the marker. Say:

That's right  
Dis reg

Continue in the same way for all the items from 2 to 6. Ask the child to turn arms over with palm facing up whilst demonstrating and saying:

Turn your hands over like this.

Draai nou jou hande om, so.

Continue with items 7 to 12. Once all the items have been completed, remove the screen and say to the child:

Thank you. We have now come to the end of our games. I have a little reward here for you for your hard work.

Dankie. Ons is nou klaar met hierdie speletjies. Ek het iets hier vir jou om dankie te sê.

Indicate the chocolate or star/sticker as appropriate.

Say to the child:

Before I give you the chocolate/star, I would like you to help me measure how close the child got to the chocolates. Please put your arms on the table for me again, like this.

Voor ek vir jou die sjokolade/sterretjie gee, wil ek hê dat jy vir my moet help om te meet hoe naby die kind aan die sjokolade gekom het. Sit weer vir my jou arms op die tafel, so.

Demonstrate to the child by placing own arms on the table as previously.

Proceed to measure the distances between the brown pen-mark and the centre of each face (approximately the nose position) for each test item. Record the distance in centimetres to one decimal point. Calculate the total for the left and right sides rounding off the decimal point.. These are the raw scores for the left and right sides. Calculate left and right totals for the total raw score.

**APPENDIX 2**  
**QUESTIONNAIRE**



HAS THE TESTEE BEEN EVALUATED BY AN OCCUPATIONAL THERAPIST BEFORE:

Y	N
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34

IF SO, WERE ANY PROBLEMS IDENTIFIED:

Y	N
---	---

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35

SPECIFY:

--	--

37

IF TACTILE DEFENSIVENESS WAS IDENTIFIED, HAS TESTEE BEEN TREATED FOR TACTILE DEFENSIVENESS:

Y	N
---	---

--

38

TYPE OF TREATMENT:

--	--

40

DURATION OF TREATMENT IN MONTHS:

--	--

42

DID THE TESTEE DISCONTINUE ANY OF THE TESTS:

--

43

KINESTHESIA:

Y	N
---	---

Reasons:

--	--

45

AT NUMBER:

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

55

FINGER RECOGNITION:

Y	N
---	---

Reasons:

--

56

AT NUMBER:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----

58

76

1
---

80

FORM RECOGNITION:

 Y  N

Reasons:

AT NUMBER:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

21  
36

TWO POINT DISCRIMINATION:

 Y  N

Reasons:

AT NUMBER:

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24

39  
51  
63

TACTILE STIMULI PLACEMENT TEST:

 Y  N

Reasons:

AT NUMBER:

1	2	3	4	5	6	7	8	9	10	11	12
---	---	---	---	---	---	---	---	---	----	----	----

66  
78

 2

80

KINESTHESIA TEST

Administration time:

Time started

		h	
--	--	---	--

Time completed

		h	
--	--	---	--

Scoring time:

Time started

		h	
--	--	---	--

Time completed

		h	
--	--	---	--

Were the number of trials sufficient

not at all
sufficient
one extra trial needed
more than one extra trial needed

Could the testee understand the verbal instructions:

not at all
extra instruction needed
easily understood

Comments/suggestions:

Did the "mouse" move easily with the testee's hand on it:

Y	N
---	---

Comments:

Was the pen-guide large enough to make a mark through:

Y	N
---	---

Comments:

--

--	--

3

	:	
--	---	--

8

	:	
--	---	--

13

	:	
--	---	--

15

	:	
--	---	--

23

--

24

--

25

--	--

27

--

28

--	--

30

--

31

--	--

33

Kinesthesia Test cont.

Motivation/interest: the testee:

lost interest almost immediately
a lot of encouragement needed to continue
a little encouragement needed to complete the test
was keenly interested and/or showed enjoyment

34

Suggestions for improving appeal for a child:

36

Was the accurate repositioning of "mouse" to starting point:

impossible
difficult
fairly easy
easy

37

Was the correct positioning of the screen:

impossible
a lot of practice needed
easy with practice
easy

38

Comments

40

Kinesthesia Test cont.

KINESTHESIA TEST

ITEMS 1 - 10: (Try to mark your comments regarding the individual items as you are administering them.)

The following items proved too difficult for testee:

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

50

The following items proved too difficult to administer:

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

60

On the following items the testee showed resistance to having his/her limb moved:

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

70

3

80

1

On the following items the testee moved his/her hand off the scoring sheet:

3

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

13

On the following items the testee did not maintain handposition on the "mouse":

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

23

Was the allotted time for individual items easy to abide by:

Y  N

24

On the following items it was difficult to abide by allotted time:

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

34

Comments on timing: (Give a general idea of how much more/less time was used on individual items) .

36

Additional comments and/or suggestions:

38

FINGER RECOGNITION TEST:

Administration time: Time started:

		h	
--	--	---	--

Time completed:

		h	
--	--	---	--

Scoring time:

Time started:

		h	
--	--	---	--

Time completed:

		h	
--	--	---	--

	:		
--	---	--	--

43

	:		
--	---	--	--

48

	:		
--	---	--	--

53

	:		
--	---	--	--

58

Were the number of trials sufficient:

sufficient
one extra trial needed
more than one extra trial needed
not at all sufficient

--

59

Could the testee understand the verbal instructions:

not at all
extra instruction needed
easily understood

--

60

Comments and/or suggestions:

--	--

62

Could the thimbles be easily manipulated:

impossible
a lot of practice needed
easy, with a little practice
easy, no practice needed

--

63

Finger Recognition cont.

Switching from single to double stimuli was:

impossible
a lot of practice needed
a little practice needed
no practice needed at all

64

Usefulness of placement mat in keeping the child's hands in one position

of no use at all
fairly helpful
very helpful

65

Motivation/interest: the testee:

lost interest almost immediately
a lot of encouragement needed to continue
a little encouragement needed to complete the test
was keenly interested and/or showed enjoyment

66

Suggestions for improving appeal for a child:

68

4  
80

Finger Recognition cont.

FINGER RECOGNITION TEST

ITEMS 1-18 (Try to mark your comments regarding the individual items as you are administering them.)

Rate the difficulty of administration of each item by using the following key:

1 - impossible
2 - difficult
3 - easy with practice
4 - very easy


1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

21

Rate the difficulty of each item for testee by using the following key:

1 - extremely difficult
2 - fairly difficult
3 - fairly easy
4 - too easy

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

39

Rate the quality of tactile defensive responses by using the following key:

Quality Key:

1 - no T.D. response
2 - very slight T.D. response
3 - mild T.D. response
4 - severe T.D. response

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

57

Comments and/or recommendations:

--

58

FORM RECOGNITION TEST

Administration time: Time started:

	h	
	h	

Time completed:

Scoring time:

Time started:

	h	
	h	

Time completed:

Were the number of trials sufficient:

sufficient
one extra trial needed
more than one extra trial needed
not at all sufficient

Could the testee understand the verbal instructions:

not at all
extra instruction needed
easily understood

Managing to score accuracy and time simultaneously was:

impossible
needed a lot of practice
needed a little practice
needed no practice at all

Was it easy to sort forms for presentation to testee:

impossible
very confusing
manageable
easy

	:		
	:		
	:		
	:		

63  
68  
73  
78

5
---

80

--

1

--	--

3

--

4

--

5

--

6

Was it easy to use the score sheet whilst testing:

extremely confusing
difficult
fairly easy
very easy

7

Comments and/or suggestions:

9

How many items would you suggest should the final test consist of:

11

Indicate your opinion of each item using the following key:

1 - should be excluded
2 - indifferent
3 - useful
4 - should be included

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

26

41

Motivation/interest: the testee:

lost interest almost immediately
a lot of encouragement needed to continue
a little encouragement needed to complete the test
was keenly interested and/or showed enjoyment

42

Suggestions for improving appeal for a child:

44

FORM RECOGNITION TEST

ITEMS 1-30 (Try to mark your comments regarding the individual items whilst you are administering them.)

Mark the testee's response to each item by using the following key:

- |   |
|---|
| 1 - completed this item                           |
| 2 - refused item because of tactile defensiveness |
| 3 - refused item because of fatigue               |
| 4 - refused item for no apparent reason           |

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

59  
74

Comment on the possible problems with shapes/size of each item by using the following key:

- |                              |
|------------------------------|
| 1 - too bulky                |
| 2 - too small                |
| 3 - too irregular            |
| 4 - very good size and shape |
| 5 - other                    |

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

6  
80  
1  
3

Comment on code 5:

Mark with X the appropriate block where reinstruction was necessary during the test:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

35

50  
65

7  
80

Form Recognition Test cont.

Comment on time allocation for each item by using the following key:

- |                                      |
|--------------------------------------|
| 1 - too much time allowed            |
| 2 - adequate time allowed            |
| 3 - needed 15 seconds more           |
| 4 - needed more than 15 seconds more |

--

--	--

3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

18

30

Rate the degree of difficulty of each item by using the following key

- |                      |
|----------------------|
| 1 - too difficult    |
| 2 - fairly difficult |
| 3 - fairly easy      |
| 4 - too easy         |

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

48

60

Rate tactile defensive responses by using the following key:

- |                               |
|-------------------------------|
| 1 - no T.D. response          |
| 2 - very slight T.D. response |
| 3 - mild T.D. response        |
| 4 - severe T.D. response      |

8
---

80

1
---

--	--

3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

18

30

TWO POINT DISCRIMINATION TEST

Administration time: Time started:

		h	
		h	

Time completed:

Scoring time:

Time started:

		h	
		h	

Time completed:

		:		
--	--	---	--	--

38

		:		
--	--	---	--	--

43

		:		
--	--	---	--	--

48

		:		
--	--	---	--	--

53

Were the number of trials sufficient:

sufficient
one extra trial needed
more than one extra trial needed
not at all sufficient

--

54

Was it easy to use the finger splint to keep thumb and index finger at a constant distance apart:

impossible
very difficult
difficult
easy

--

55

Was it easy to use the score sheet for scoring:

impossible
very difficult
difficult
easy

--

56

Two Point Discrimination Test cont

Could the testee understand the verbal instructions:

- |                          |
|--------------------------|
| not at all               |
| extra instruction needed |
| easily understood        |

57

Switching from single to double stimuli was:

- |                               |
|-------------------------------|
| impossible                    |
| a lot of practice was needed  |
| a little practice was needed  |
| no practice was needed at all |

58

Motivation/interest: the testee:

- |  |
|--|
| lost interest almost immediately                   |
| a lot of encouragement needed to continue          |
| a little encouragement needed to complete the test |
| was keenly interested and/or showed enjoyment      |

59

Suggestions for improving appeal for a child:

61

9  
80



TACTILE STIMULI PLACEMENT TEST

Administration time: Time started: 

	h	

  
Time completed: 

	h	

Scoring time: Time started: 

	h	

  
Time completed: 

	h	

Were the number of trials sufficient:

sufficient
one extra trial needed
more than one extra trial needed
not at all sufficient

Could the testee understand the verbal instructions:

not at all
extra instruction needed
easily understood

Motivation/interest: the testee:

lost interest almost immediately
a lot of encouragement needed to continue
a little encouragement needed to complete the test
was keenly interested and/or showed enjoyment

Suggestions for improving appeal for a child:

--	--

--	--	--	--

--	--	--	--

--	--	--	--

--	--	--	--

--

  
24

--

  
25

--

  
26

--	--

  
28

Tactile Stimuli Placement Test cont.

Getting the child's index finger accurately on the stamp face was:

- |  |
|--|
| 1 - impossible                                 |
| 2 - needed to have finger placed by tester     |
| 3 - needed only extra verbal instruction       |
| 4 - could spontaneously place finger correctly |

29

Getting the child to wipe his finger on stamp pad after each item was:

- |   |
|---|
| 1 - child refused to do this                |
| 2 - needed a lot of encouragement           |
| 3 - needed a little encouragement           |
| 4 - did this spontaneously upon instruction |

30

Comment on the general ease of administration of this test:

- |                                       |
|---------------------------------------|
| 1 - much too cumbersome               |
| 2 - too many different steps involved |
| 3 - needed a lot of practice          |
| 4 - easy with a little practice       |
| 5 - other                             |

31

Comment on code 5 (other):

--	--

33

Additional comments and/or suggestions:

--	--

35

Tactile Stimuli Placement Test cont.

TACTILE STIMULI PLACEMENT TEST

ITEMS 1-12: (Try to mark your comments regarding the individual items as you are administering them)

Rate the difficulty of administration of each item by using the following key:

- |                        |
|------------------------|
| 1 - impossible         |
| 2 - difficult          |
| 3 - easy with practice |
| 4 - very easy          |

1	2	3	4	5	6	7	8	9	10	11	12

47

Rate the difficulty of each item for testees by using the following key:

- |                         |
|-------------------------|
| 1 - extremely difficult |
| 2 - fairly difficult    |
| 3 - fairly easy         |
| 4 - too easy            |

1	2	3	4	5	6	7	8	9	10	11	12

59

Rate the quality of tactile defensive responses by using the following key:

- |                               |
|-------------------------------|
| 1 - no T.D. response          |
| 2 - very slight T.D. response |
| 3 - mild T.D. response        |
| 4 - severe T.D. response      |

1	2	3	4	5	6	7	8	9	10	11	12

71

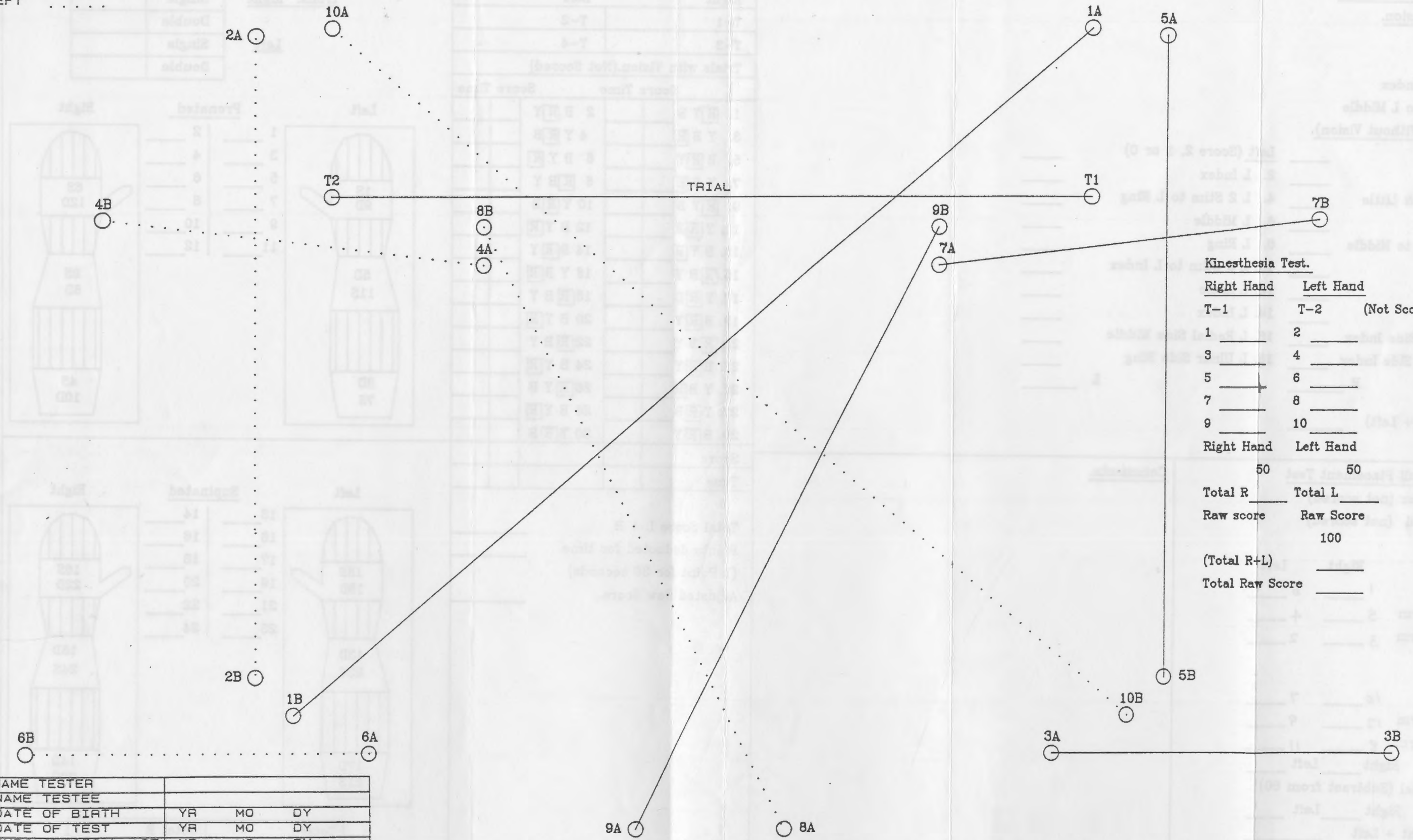
1	1
---	---

80

**APPENDIX 3**  
**SCORE SHEET**

# KINESTHESIA SCORING SHEET

RIGHT \_\_\_\_\_  
LEFT .....



### Kinesthesia Test.

Right Hand		Left Hand	
T-1	T-2	(Not Scored)	
1 _____	2 _____		
3 _____	4 _____		
5 _____	6 _____		
7 _____	8 _____		
9 _____	10 _____		
Right Hand	Left Hand		
50	50		
Total R _____	Total L _____		
Raw score	Raw Score		
	100		
(Total R+L) _____			
Total Raw Score _____			

NAME TESTER			
NAME TESTEE			
DATE OF BIRTH	YR	MO	DY
DATE OF TEST	YR	MO	DY
CHRONOLOGICAL AGE	YR	MO	DY
FILE: TEST1A			



**APPENDIX 4**  
**EXPLANATORY LETTER TO FIELD WORKERS**

# A. Lombard

B. Occupational Therapy (Siell.)  
PR 6600778 Reg OT 601

Tel. 96-7878

Registered Occupational Therapist  
Geregistreeerde Arbeidsterapeut  
13 Helderberg Rd/Weg 13  
Valmary Park  
Durbanville  
7550

Dear Colleague

Thank you for participating in this stage of the development of a test for the evaluation of somatosensory perception.

You have agreed to use this test on ten (10) children. At this stage the selection of the children is of no great importance as it is mechanics of the test that is being investigated. You can therefore choose any children that are available to you.

It is however suggested that you don't choose children that you know are particularly difficult to test (e.g., severely spastic children). You may find it easier to choose subjects between the ages of 5 and 8 yrs as this is the group that was kept in mind in designing the test. It is envisaged that at a later stage the test will be adapted, if need be, for a wider age group. You may choose children from any race group as long as the test can be conducted in either English or Afrikaans.

In the light of the varied group of children that are going to participate in this stage of the study, the demographic information on the first two pages of the questionnaire is very important. Please complete this in full.

This "Try-Out" stage is important for the refinement of the test before finalizing the standardized form. It is therefore necessary for you to be critical in your approach to the test in its present form. Your objective opinion is needed in completing the attached questionnaire.

The ultimate objective is to refine this test to such an extent that it would be easy to administer by Occupational Therapists in the field. This final form of the test depends to a large extent on your contribution at this stage as your input will be statistically analysed and used to make the necessary changes.

In the standardized form of the test the verbal instructions will be strictly adhered to. However, during this stage of the study one has to also evaluate the appropriateness of the verbal instructions. You are therefore requested to use the verbal instructions as they appear in the test, but additional instructions may be given where it is essential. This must however be clearly indicated in the allotted space or under general comments.

Here are some general instructions for completing the questionnaire. More specific instructions are given in the various parts of the questionnaire.

You are requested to acquaint yourself with the contents of the questionnaire before commencement of testing

Each sub-test has general questions printed on white paper. These question should be answered as soon as possible after completing the test.

More specific questions regarding the individual items are printed on green paper. You are requested to mark your responses to these questions while you are testing.

You are requested to use an HB pencil for marking your responses. Where block markings are required, mark the appropriate block with X. Where comments and/or suggestions are required, please give a short but frank opinion. If you have no comment for any of these sections, mark clearly with N/C so that it can be recorded that you have responded to that question. Please do not leave any spaces unmarked.

Please do not mark any of the areas in the right-hand margin as that space is for office use only, except in those cases where the block to be marked by you stretches into the margin area.

In dealing with some of the children that you use as subjects, you may become aware of problems that exist that have not previously been identified. It must be stressed that this test is not at this stage to be used for interpretation. It thus remains your ethical responsibility to investigate such children further or at least make a recommendation to the parent or guardian.

In some instances you will be asked to express an opinion. These will be repeatedly required on each questionnaire. Do not be concerned if you realize that your opinion changes as you become more familiar with the test. This will be recorded as such and may be of statistical importance. You are thus discouraged to go back to previously completed questionnaires in order to make amendments or correlate responses.

If at any stage during testing and/or completing the questionnaire you have problems, do not hesitate to call me at 967878 (work and after hours).

A consent form is attached which should be completed by the parent or guardian. Please have this completed and signed before commencement of tests.

Thanking you once again for your help and cooperation.

Nita Lombard

/ **Signed**

APPENDIX 5  
EXPLANATORY LETTER TO PARENT/  
GUARDIAN AND CONSENT FORM

# A. Lombard

B. Occupational Therapy (Siell.)  
PR 6600778 Reg OT 601

Tel. 96-7878

Registered Occupational Therapist  
Geregistreeerde Arbeidsterapeut  
13 Helderberg Rd/Weg 13  
Valmary Park  
Durbanville  
7550

Dear Parent/Guardian

Thank you for permitting your child to participate in this research project.

The purpose of the project is the development of a test to evaluate developmental aspects of body perception as this is known to influence development in general. At this stage of the study the object is to refine the test. All the information obtained at this stage will be used to analyse the test statistically. Certain information regarding your child and his/her background will be required. You are assured of the confidentiality of this information.

You are requested to fill in the attached consent form.

If at any stage you have any queries about this exercise, you are welcome to contact me personally at above tel. no. or address.

The object at this stage of the project is to use the responses of the therapists to refine the tests. Although the main aim is not the recording of test results (since these might not be reliable as yet) you are welcome to enquire about them from me personally. The results should be available towards the end of this year.

I greatly appreciate your participation and cooperation.

**Signed**

Mrs.A.Lombard  
Project Leader

.....

I.....(full name), hereby consent to my child/guard .....(full name) participating in the research project undertaken by Mrs.A.Lombard. I trust that the confidentiality of all information obtained will be strictly guarded.

.....

Signed

.....

Date

**APPENDIX 6**  
**TOUCH INVENTORY**

**TOUCH INVENTORY FOR ELEMENTARY SCHOOL-AGED CHILDREN (TIE)**

by Charlotte Brasic Royeen

Date: \_\_\_\_\_

Subject: \_\_\_\_\_

Examiner: \_\_\_\_\_

Procedure: Administer the scale according to standard instructions. Response of "No" is scored "1"; a response of "A Little" is scored "2"; and a response of "A Lot" is scored "3".

<i>Response</i>			<i>No.</i>	<i>Question</i>
<i>(Check)</i>				
1	2	3		
[ ]	[ ]	[ ]	1.	Does it bother you to go barefooted?
[ ]	[ ]	[ ]	2.	Do fuzzy shirts bother you?
[ ]	[ ]	[ ]	3.	Do fuzzy socks bother you?
[ ]	[ ]	[ ]	4.	Do turtleneck shirts bother you?
[ ]	[ ]	[ ]	5.	Does it bother you to have your face washed?
[ ]	[ ]	[ ]	6.	Does it bother you to have your nails cut?
[ ]	[ ]	[ ]	7.	Does it bother you to have your hair combed by someone else?
[ ]	[ ]	[ ]	8.	Does it bother you to play on a carpet?
[ ]	[ ]	[ ]	9.	After someone touches you, do you feel like scratching that spot?
[ ]	[ ]	[ ]	10.	After someone touches you, do you feel like rubbing that spot?
[ ]	[ ]	[ ]	11.	Does it bother you to walk barefooted in the grass and sand?
[ ]	[ ]	[ ]	12.	Does getting dirty bother you?
[ ]	[ ]	[ ]	13.	Do you find it hard to pay attention?
[ ]	[ ]	[ ]	14.	Does it bother you if you cannot see who is touching you?
[ ]	[ ]	[ ]	15.	Does fingerpainting bother you?
[ ]	[ ]	[ ]	16.	Do rough bedsheets bother you?
[ ]	[ ]	[ ]	17.	Do you like to touch people, but it bothers you when they touch you back?
[ ]	[ ]	[ ]	18.	Does it bother you when people come from behind?
[ ]	[ ]	[ ]	19.	Does it bother you to be kissed by someone other than your parents?
[ ]	[ ]	[ ]	20.	Does it bother you to be hugged or held?
[ ]	[ ]	[ ]	21.	Does it bother you to play games with your feet?
[ ]	[ ]	[ ]	22.	Does it bother you to have your face touched?
[ ]	[ ]	[ ]	23.	Does it bother you to be touched if you don't expect it?
[ ]	[ ]	[ ]	24.	Do you have difficulty making friends?
[ ]	[ ]	[ ]	25.	Does it bother you to stand in line?
[ ]	[ ]	[ ]	26.	Does it bother you when someone is close by?

[ ] (no. of responses scored "1") × 1 = [ ]  
 + [ ] (no. of responses scored "2") × 2 = [ ]  
 + [ ] (no. of responses scored "3") × 3 = [ ]

Total Score = [ ]  
 Percentile Score = [ ]

## SCORING AND INTERPRETING THE TIE

The TIE is easily scored by summing the child's response scores (i.e., adding the scores from items 1 through 26). The child's score is then compared to the normative data supplied in Table 5-A.

Proper interpretation of Table 5-A is contingent upon understanding that a high raw score does not mean a better performance on part of the child. Recall that the response format for the TIE is 1 = no, 2 = a little, and 3 = a lot. Therefore, a child who responds with "a lot" for many of the test items will receive a higher raw score than the child who answers with "a little" for many of the test items. Thus, *the higher the score, the more the child's self-reported behaviors are associated with behaviors indicative of tactile defensiveness. Conversely, the lower the score, the less the subject's self-reported behaviors are associated with behaviors indicative of tactile defensiveness.*

Conversion of raw scores into corresponding percentile scores using Table 5-A provides a standard reference for how a given child responds to test items compared to the normative sample. Again, it is important to note that a higher percentile score does not mean a better test performance. Rather, a higher percentile score, for example, the range of the 75th percentile and above, means that at least 75 percent of the normative sample answered with responses *less* associated with tactile defensiveness: Only 25 percent of the normative sample answered with responses *more* associated with tactile defensiveness.

**TABLE 5-A. DATA FOR SCORING THE TIE**

Mean score = 41

Standard Deviation = 7.8

Standard Error of the Mean = 0.38

Percentile Score	Raw Score
100	60
90	51
75	45
50	40
25	35
10	31
0	25

Percentile Score	0	10	25	50	75	90	100
Raw Score	25	30	35	40	45	50	60

APPENDIX 7  
OVERVIEW OF ANATOMY & PHYSIOLOGY

## 5. OVERVIEW OF BASIC ANATOMY AND PHYSIOLOGY OF THE SOMATOSENSORY SYSTEM

### 5.1 ANATOMY

In the following section the anatomy of the somatosensory system will be discussed. The work of the following authors were consulted: Ayres (1972 and 1979), Brodal (1981), Fisher et al (1991), Ganong (1979), Garoute (1981), Geldard (1972), Guyton (1986), Meyer (1988), Romero-Sierra (1986) and Walton (1987) and a synthesis was extracted. Additional sources were used for background information that are not directly quoted.

The somatic senses are those neural mechanisms that receive sensory information from the body and do not include the information from the special senses such as sight, hearing, smell and taste.

The somatosensory system interprets the following sensory stimuli: touch, pressure, pain (two types), position sense, kinaesthetic sense, warmth, cold and vibration sense.

As early as the nineteenth century distinctive anatomical structures were identified as being responsible for various specific tactile qualities. Kinaesthetic sensation relies on the receptors within the joints as well as those in the muscles and tendons. In earlier writings (Brodal, 1967) the general feeling was that the joint receptors are mainly responsible for accurately interpreting the position and movement of the joint. Grigg, Finerman and Riley, 1976, refuted this (as cited by Brodal, 1981 & Moore, 1984). They found that almost normal joint sense was present after total joint replacement which would then suggest that receptors outside of the joint can adequately interpret joint position and movement. The currently accepted trend of thought is that proprioceptive feedback arises primarily from muscle spindles, mechanoreceptors of the skin and centrally generated motor commands (Fisher, 1991).

The somatosensory system is made up of the (1) receptors, (2) the afferent nerves and the connecting neurons and (3) the connections in the central nervous system.

#### 5.1.1 The receptors

A general classification of receptors is as follows (Guyton, 1986):

- **Mechanoreceptors:** These are stimulated by mechanical displacement of some tissue of the body.
- **Thermoreceptors:** These are sensitive to heat and cold.
- **Pain receptors:** These are activated by any factor that is damaging to tissue.

Guyton gives an alternative classification:

- **Exteroceptors:** Conveying information from the surface of the body.
- **Proprioceptors:** Conveying information from the muscles, joints and tendons.

For the purpose of this study, consideration will be given only to those receptors concerned with touch and nonvestibular proprioception. The senses of pain, temperature and vestibular proprioception will be excluded, not because they are less important, but because they have no direct bearing on this study.

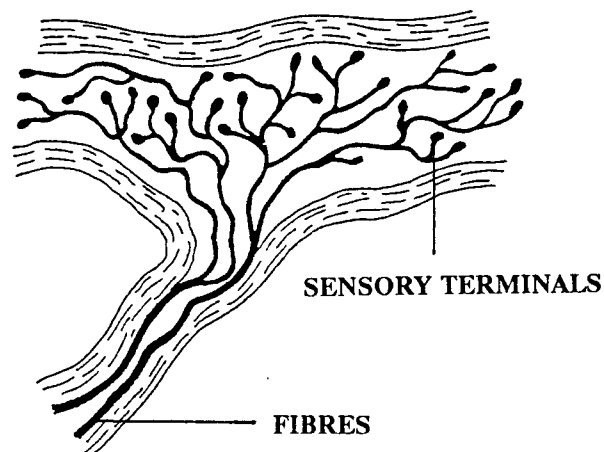
##### 5.1.1.1 **Cutaneous mechanoreceptors**

Many receptors are found in the skin and appear at superficial and deeper levels. A great variety of nerve endings are found and vary in size from the larger, deep lying Pacinian corpuscles (can be seen by the unaided eye), to the finest fibrils in the

superficial epidermis. The following are generally regarded as being responsible for conveying stimuli from the skin (Brodal, 1981; Guyton, 1986; Romero-Sierra, 1986; Garoute, 1981 & Ganong 1979).

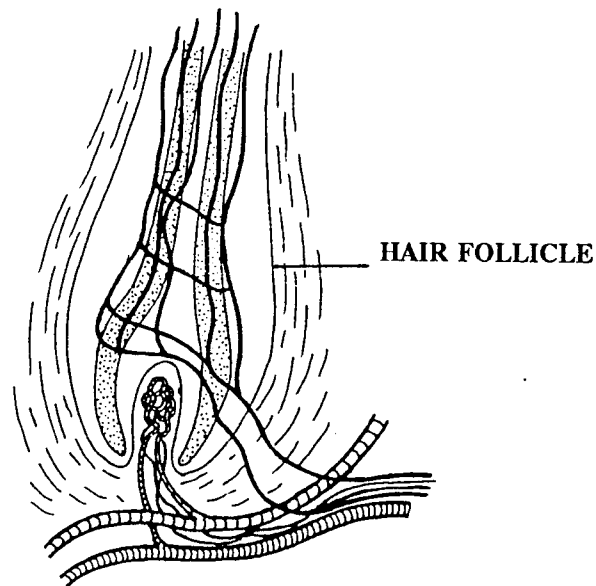
- Free/unencapsulated nerve endings:

These nerve endings are nearly everywhere in the body and are also the most numerous. In the skin these nerve endings emerge from the subepithelial nerve nets to the deeper layers of the stratum germinativum where they terminate with branches between epithelial cells. In the deeper connective tissue of the subcutis and corium, many free nerve endings are also found. These free nerve endings are postulated to be supplied by unmyelinated axons. These fibres are covered by Schwann cells except at their tips where they appear naked. They elicit touch and pressure sensations (figure 1.1).



**FIGURE 1.1:** Free nerve endings (Adapted from Cull, 1989)

The nerve endings around the hair follicle are fine, densely networked fibres and are supplied by myelinated axons. They adapt readily. Movement of an object over the skin's surface will move the hair itself which in turn will activate the nerve endings around the hair follicle. These receptors detect mainly movement of objects on the surface of the skin or initial contact of objects with the skin. They respond to very slight movement (low threshold) and adapt rapidly. These receptors are found in all skin that contains hair (figure 1.2).

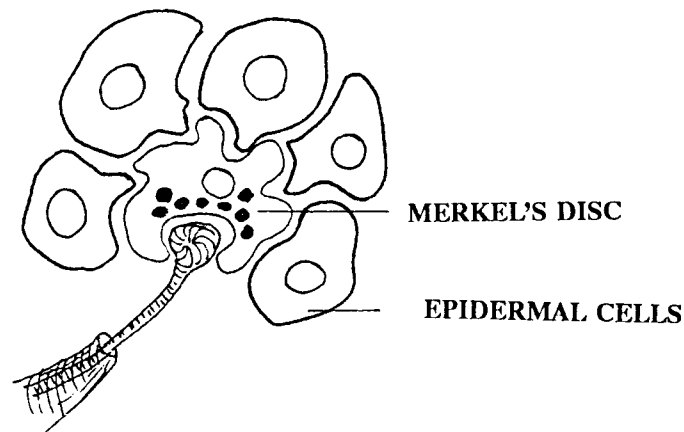


**FIGURE 1.2:** Free nerve endings around hair follicle (Adapted from Cull, 1989)

A specialized free nerve ending is the Merkels disk, also described as "expanded tip tactile receptors" (Guyton, 1986).

This nerve ending branches several times and eventually ends in concave, flattened, disk-like formations. These are usually grouped together in a single organ called the Iggo dome receptor. The group of disks are innervated by a single large type of myelinated nerve fibre. These receptors initially transmit a strong, partially adapting signal and then a continuing weaker signal which will allow interpretation of continuous touch of an

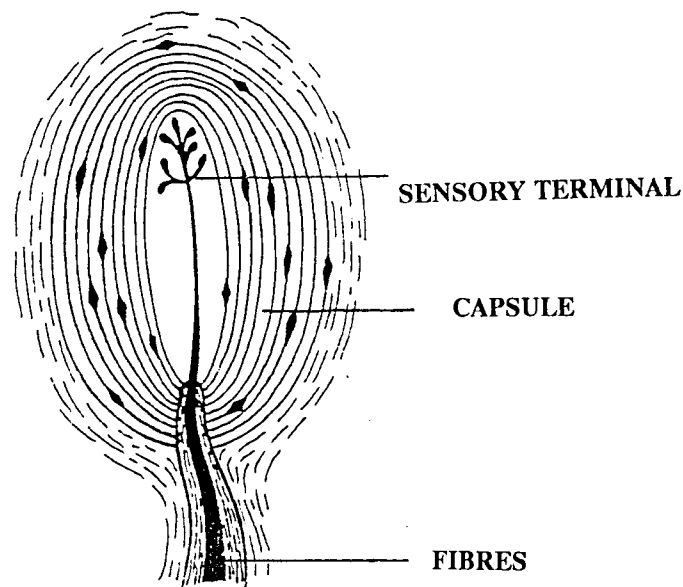
object to the skin. These receptors play an important role in localizing touch sensations to the specific surface areas of the body. They are found in great numbers in the glabrous skin, the hairy skin and the skin of the external genitals (figure 1.3).



**FIGURE 1.3: Merkel's disk (Redrawn from Aarounte, 1981)**

- Encapsulated nerve endings:

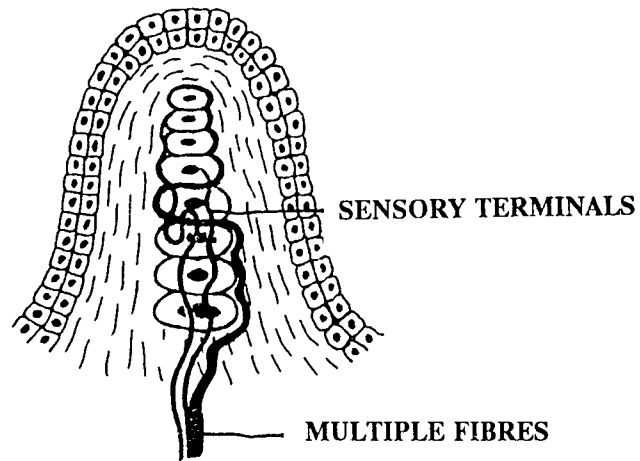
The most elaborate and probably most studied of the encapsulated nerve endings is the Pacinian corpuscle (figure 1.4). They are fairly large and can be detected by the unaided eye (0,5 to 4,5 mm long and 1,0 to 2,0 m wide). They consist of white egg shaped bodies covered by a capsule of connective tissue rich in fibrils, arranged in concentric layers. The capsule encloses a protoplasmic bulb, comprising of a number of cytoplasmic layers, separated by fluid spaces. There is a central nerve fibre running through the corpuscle. The receptor is supplied by a large myelinated fibre which loses its myelination upon entering the corpuscle. These receptors are extremely fast adapting (a few thousandths of a second) and are thus stimulated only by very rapid movement of the tissues. They are thus very important in detecting tissue vibration and other extremely rapid changes in the mechanical state of the tissues. They lie superficially beneath the skin (especially abundant on the tips of the fingers and toes, the palms and soles) and also in the deeper tissues of the body such as ligaments.



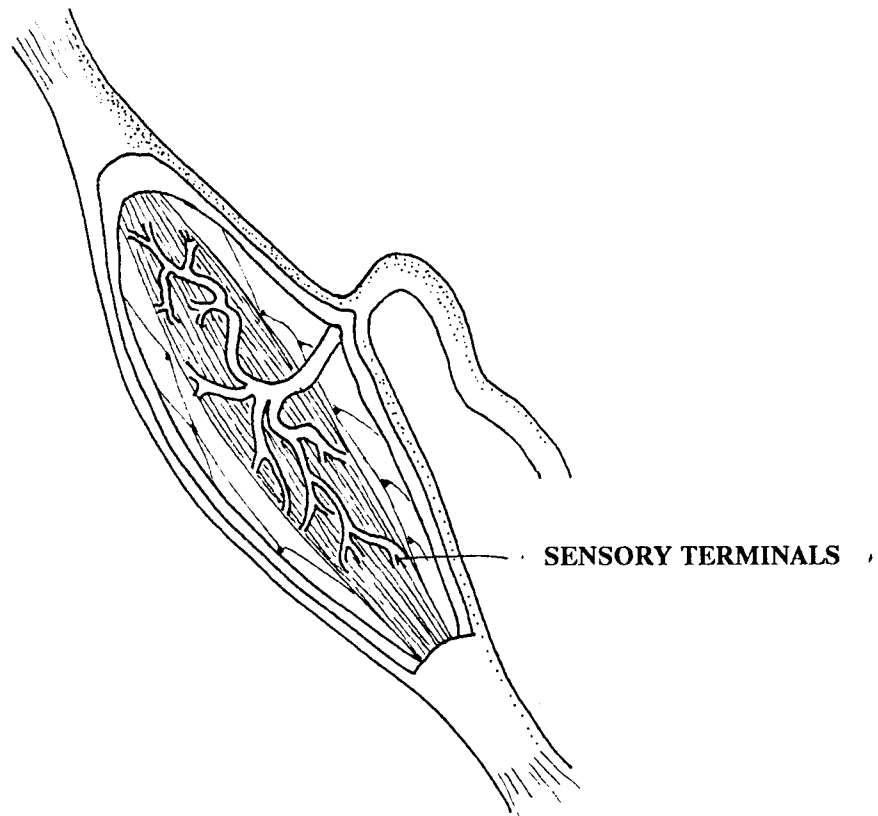
**FIGURE 1.4:** Pacinian corpuscle (Adapted from Cull, 1989)

The Meisners corpuscles are another kind of encapsulated nerve ending. Inside the capsulation are many whorls of terminal nerve endings. They are supplied by thick myelinated axons and adapt in less than one second. They are therefore particularly sensitive to movement of very light objects over the skin's surface and also to low frequency vibration. These receptors are present in the glabrous (non-hairy) skin and particularly abundant in the fingertips, lips and other areas of skin where one's ability to discern spatial characteristics of touch sensations is well developed (figure 1.5).

In the deeper layers of the skin the Ruffini end-organs are found (figure 1.6). These multi-branched nerve terminals are intimately associated with collagen fibrils in the capsule merging with the dermal collagen. They are supplied by a large myelinated axon and adapt very little. These receptors are important in signaling continuous states of deformation of the skin and deeper tissues such as heavy, continuous touch and deep pressure. They are often thought not to be encapsulated endings (Geldard, 1972).

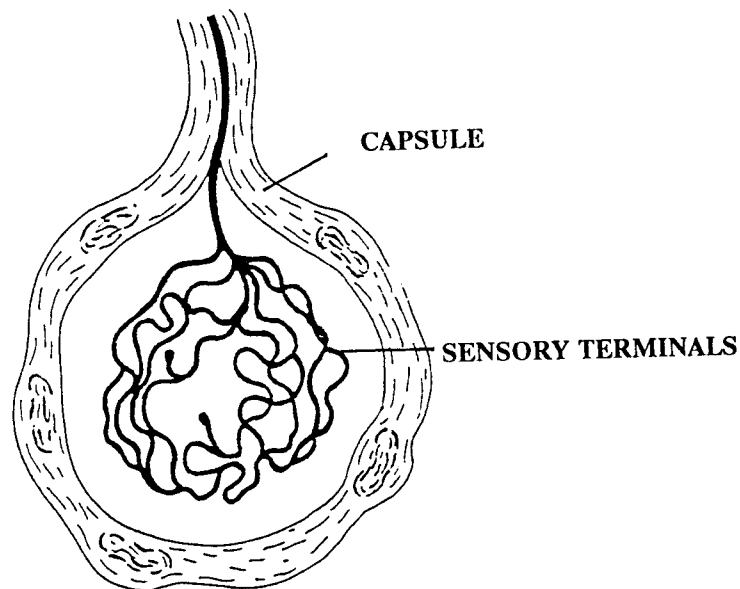


**FIGURE 1.5:** Meisners corpuscle (Adapted from Cull, 1989)



**FIGURE 1.6:** Ruffini end-organs (Redrawn from Brodal, 1981)

The Krause end bulb is often viewed as an encapsulated ending, but some authorities view it simply as an elaborate, intertwining of fine fibrils (Brodal, 1969) (figure 1.7). They have been observed in the eye area near the margin of the cornea, and also in the tissues of the external genitals and the tongue. They appear characteristically in the transitional areas between glabrous skin and mucous membrane and have been named a "mucocutaneous end-organ" by Winkelmann (as cited by Geldard, 1972). They are also compared to the hair endorgans in non-hairy skin, where such an ending does not have a hair follicle to invade. Otherwise, they are also compared to the Meisner corpuscle in the glabrous skin (Iggo, 1977 as cited by Brodal, 1981).



**FIGURE 1.7:** Krause end bulb (Adapted from Cull, 1989)

#### 5.1.1.2 Mechanoreceptors in and around the joints and in muscles

The relative importance of joint receptors, as opposed to receptors in muscles, tendons and skin, has been a controversial topic over the years. It was thought that the elaborate organ in the muscle (muscle spindles and tendon organs) were solely responsible for kinaesthetic sensation. Later experiments led to the view that the receptors in and around the joints are mainly

responsible for kinaesthetic sense (Brodal, 1981). Later still, it was argued that the muscle and tendon organs play an important part in proprioceptive sensation (Brodal, 1981 & Moore, 1984). Fisher (Fisher et al, 1991) reports on experimental findings that all proprioceptive inputs can contribute to conscious proprioception. Consideration will therefore be given to the nerve endings in the joints, tendons and muscles.

Within the joints, structures are found that resemble receptor organs found in other tissues such as Ruffini endings, Pacinian corpuscles, etc. Such analogies could be misleading and the designation as done by Freeman and Wyke (1967) as cited by Brodal (1981), will be used. Each type of receptor has its own function and they are all stretch receptors.

The four categories as suggested by Freeman and Wyke (1967) are:

(i) Type I receptor:

These are egg shaped corpuscles within a connective tissue capsule. They are supplied by small myelinated fibres which branch in the capsule. These receptors occur almost exclusively in the fibrous joint capsule with a few in the extrinsic ligaments. They adapt slowly and act as mechanoreceptors/stretch receptors. Structurally and functionally they resemble the Ruffini endings in the skin. Because of their slow adaptation, they respond with a sustained discharge to continuous stimulation. Impulse frequency will depend on the position of the joint and the speed of movement to or from their neutral position. Each receptor has a range of movement where it functions optimally. Changing frequencies will thus signal direction and speed of movement and the position of the joint. ).

(ii) Type II receptor:

These receptors are much larger and are supplied by thicker myelinated fibre ending in a single terminal

within a layered capsule. These endings resemble Pacinian corpuscles. They occur only in the fibrous joint capsule and adapt rapidly. They have been termed Acceleration receptors as they are very sensitive to rapid movements starting from any joint position.

(iii) Type III receptor:

These are the largest of nerve endings in the joints and are supplied by a thick myelinated fibre that branches profusely. These endings resemble the Golgi tendon organ. They occur only in the extrinsic and intrinsic ligaments. They have a high threshold and adapt very slowly. Because of their high threshold they would possibly be unsuitable for recording of position. There is still some uncertainty about their specific function but they are thought to have a protective function (Petersen and Stener, 1959 as cited by Brodal).

(iv) Type IV receptor:

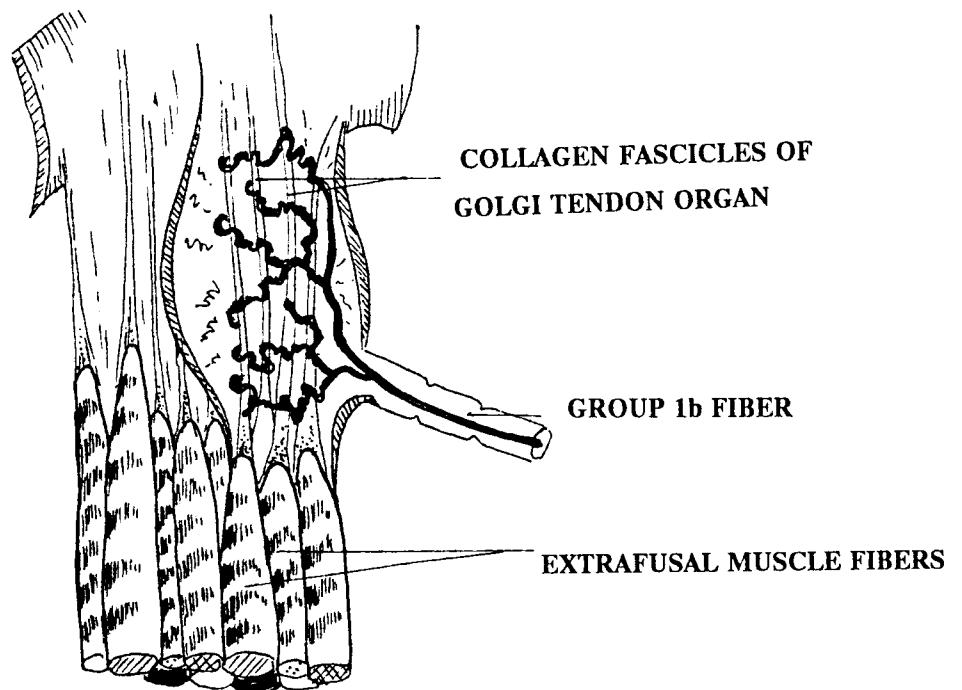
These are plexuses of fine unmyelinated fibres which occur in the fibrous capsule, the ligaments, the synovial capsule and the fat pads. These are mostly interpreted as pain receptors and perform a protective function whereby activation of these fibres will cause muscles around the joint to go into spasm thus immobilizing it.

Other authors (Guyton, 1986 & Skoglund, 1973) identify only three different types of joint receptors, i.e. the spray type ending which is a Ruffini-like receptor in the capsule and like the Golgi tendon organ when in the ligaments, the encapsulated Pacinian-like corpuscle and the free nerve endings.

- The Golgi Tendon Organ:

Even though the Golgi tendon Organ was identified as early as 1898 by Golgi Camillo, its structure was only known much later.

This organ is associated with tendons, and/or tendinous-like structures called aponeuroses. The Golgi Tendon Organs (figure 1.8). in the human are encapsulated and are located at the musculotendinous or musculoponeurotic junctions. It consists of a netlike collection of knobby nerve endings among the fascicles of a tendon. The close relationship between the collagen bundles of the encapsulated tendon organ and the extrafusal muscle fibres enable the tendon organ to be extremely sensitive to any change in tension in the individual muscle fibres to which they are attached.

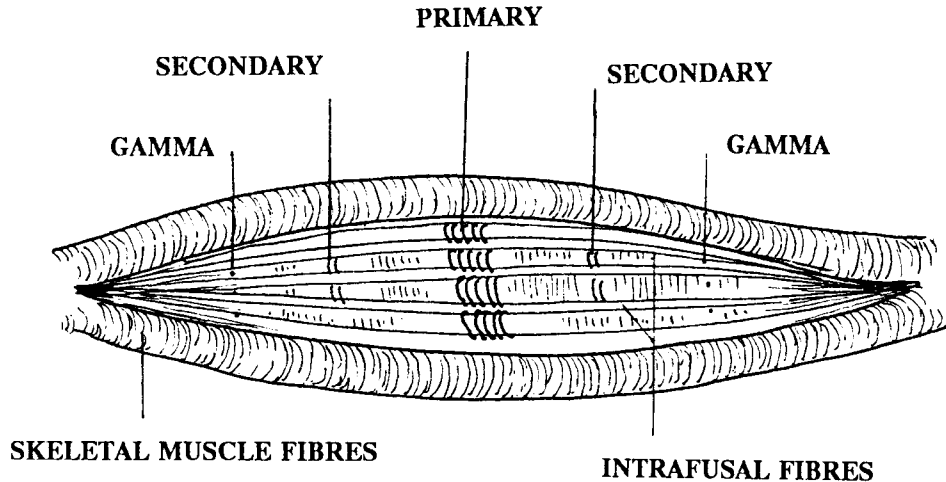


**FIGURE 1.8:** Golgi tendon organ (Redrawn with slight changes from Moore, 1984)

The Golgi Tendon Organs have afferent connections with the central nervous system but no efferent fibres. The Golgi Tendon Organs do not monitor tension in the muscle spindles, but only that of the extrafusal muscle fibres to which they are attached. The Golgi Tendon Organs are found at both the proximal and distal musculotendinous junctions of extrafusal muscle fibre as well as along intramuscular septa of muscles (Moore, 1974).

- Muscle Spindles:

The muscle spindle consists of muscle fibres enclosed in a connective tissue capsule (figure 1.9). Two types of intrafusal fibres are identified in muscle spindles, i.e. nuclear bag fibre and nuclear chain fibre. The nuclear bag contains many nuclei in a dilated central area. The nuclear chain fibre is thinner and shorter and lacks a definite bag. The ends of the nuclear chain fibres connect to the sides of the nuclear bag fibres. The ends of the intrafusal fibres are contractile but the central parts are not. Two types of nerve endings are found in the spindle. Firstly, the annulospiral (primary) endings that wrap around the centre of the nuclear bag and the nuclear chain fibres. These are rapidly conducting fibres. Secondly there are the flower spray (secondary) endings located nearer the ends of the intrafusal fibres and occur only in the nuclear chain fibres.



**FIGURE 1.9: Muscle spindle (Redrawn from Guyton, 1972)**

5.1.2 Ascending pathways of the somatosensory system

Afferent impulses that arise from mechanical deformation of the

receptors in the skin, from the joints, muscles and tendons, have similar central pathways. These impulses travel centrally through the afferent sensory fibres and have their cell bodies in the spinal ganglia. The fibres vary in thickness, ranging from very fine unmyelinated to thick myelinated fibres. The fibres of particular sizes are related to various kinds of receptors. The velocity with which the impulse is conducted is directly relative to the thickness of the fibre - the thicker the fibre, the faster the conduction velocity.

The somatic afferent fibres that convey impulses from the skin, muscles, tendons, joints, etc., enter the spinal cord in the dorsal (posterior) root. There is also evidence that some of the unmyelinated fibres enter the spinal cord through the ventral roots. The fibres composing the dorsal roots vary in thickness, from thick myelinated fibres (up to 20 microns) to very fine unmyelinated fibres (some less than 2 microns). In the spinal cord fibres with more or less the same function group together in fibre tracts to the higher centres.

Upon entering the cord the nerve fibres separate into two major groups, i.e. the dorsal lemniscal system and the anterolateral spinothalamic system. The dorsal lemniscal system is located in the dorsolateral columns and include the dorsal columns and the spinocervical tracts. The anterolateral spinothalamic system is located in the anterior and lateral columns (figure 1. ).

The main difference between the dorsal lemniscus system and the anterolateral spinothalamic system is that the dorsal lemniscal system comprises mainly large myelinated nerve fibres that transmit signals at a velocity of up to 30 to 110 metres per second while the anterolateral spinothalamic system comprises much thinner myelinated fibres that conduct signals at a much slower rate, between 10 to 60 metres per second. Another difference is that the dorsal lemniscal system has a high degree of spatial orientation of nerve fibres with respect to their origin in the body, whereas the anterolateral spinothalamic

system has very little spatial orientation with some fibres seeming to have no orientation at all.

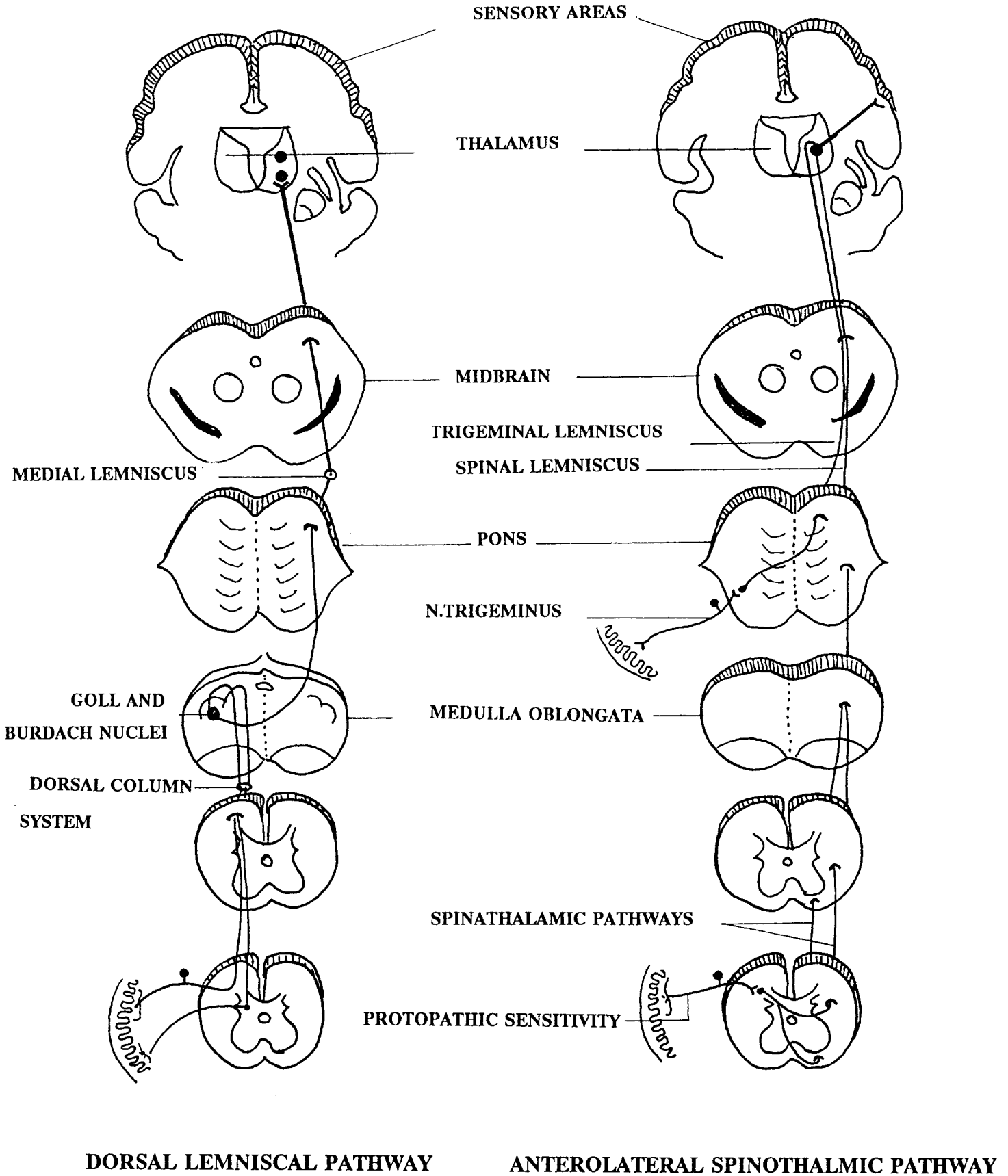
These differences allow for different types of sensory information to be transmitted by the two systems. The sensory information that needs to be transmitted rapidly and spatially accurately is transmitted in the dorsal lemniscal system. The sensory information that does not need to be transmitted rapidly is transmitted by the anterolateral spinothalamic system. Those sensations that detect fine gradations of intensity are transmitted by the dorsal lemniscal system, while those that lack fine gradations are transmitted by the anterolateral spinothalamic system. Furthermore, sensations that are localized to exact points in the body are transmitted by the dorsal system whereas those that are not localized as accurately are transmitted by the spinothalamic system. Despite the non-specificity and relative slower transmission of signals of the spinothalamic system, it has the ability to a broader spectrum of sensory modalities (pain, temperature and crude touch). The dorsal system does not have this ability as it is restricted to mechanoreceptive sensations alone.

#### 5.1.2.1 The dorsal-lemniscal system

Sensory signals are transmitted to the brain by two major pathway of this system, i.e. (i) the dorsal column pathway and (ii) the spinocervical pathway (figure 1.10).

##### (i) The dorsal column pathway:

The nerves entering the dorsal columns pass up in these columns to the dorsal column nuclei (the cuneate and gracilis nuclei, also known as nuclei of Goll and Burdach). Here the second order neuron cross over to the opposite side and then passes upward to the thalamus through the medial lemnisci. The medial lemniscus terminates in the ventrobasal complex of nuclei in the thalamus. Here it is joined by additional fibres from



**FIGURE 1.10:** Dorsal lemniscal and spinothalamic pathways (Redrawn from Meij, 1988)

the main sensory nucleus of the trigeminal nerve and from the upper portion of its descending nuclei. From here the third order neurons project mainly to the postcentral gyrus of the cerebral cortex which is known as the somatic sensory area I. Some neurons also project to the associated areas of the cortex behind and in front of the postcentral gyrus. A few fibres also project to the somatic area II in the lowermost lateral portion of the parietal lobe.

(ii) The spinocervical pathway:

The large sensory fibres that enter the spine in the dorsal root synapse mainly in laminae IV and to a certain extent in laminae V and VI as well. The second order fibres enter the dorsolateral white columns and ascend in the spinocervical tract to the cervical region and also to the medulla. Synaptic connections are made either in the dorsal horn of the spinal cord or the medullary nuclei which is either adjacent to or part of the dorsal column nuclei. Here the third order neurons cross and ascend to the thalamus through the medial lemnisci. From here the two tracts of the Spinocervical and Dorsal Column pathways ascend in parallel to somatic sensory area in the cortex (figure 1.10).

#### 5.1.2.2 The Anterolateral Spinothalamic system

As this system is responsible for some transmission of somatosensory associated with mechanoreceptors i.e. crude touch, the pathway will be discussed here briefly (figure 1.10).

The fibres of the anterolateral spinothalamic pathway synapse mainly in the laminae I, IV, V for pain and thermal sensations and in VII and VIII for the crude tactile sensations. Some of the fibres cross to the anterolateral white column and ascend upward to the brain in the ventral spinothalamic and lateral spinothalamic tracts. The tract terminates in two locations: in the reticular nuclei of the brain stem and in the thalamus. In

the thalamus the termination is in the ventrobasal complex and the intralaminar nuclei. The tactile sensations are transmitted mainly into the ventrobasal complex.

#### 5.1.2.3 Other influences from the spinal cord

The spinoreticular-, spinotectal- and paleospinothalamic pathways are closely associated with the anterolateral spinothalamic pathway (Guyton, 1986). These form extensive connections with the anterolateral spinothalamic pathway and their function is related to the transmission of crude tactile signals (also thermal and pain signals). It is also postulated that these tracts play a role in controlling the neural functions of the brainstem (Guyton, 1986).

#### 5.1.2.4 Spatial organisation of fibres in the dorsal lemniscal system

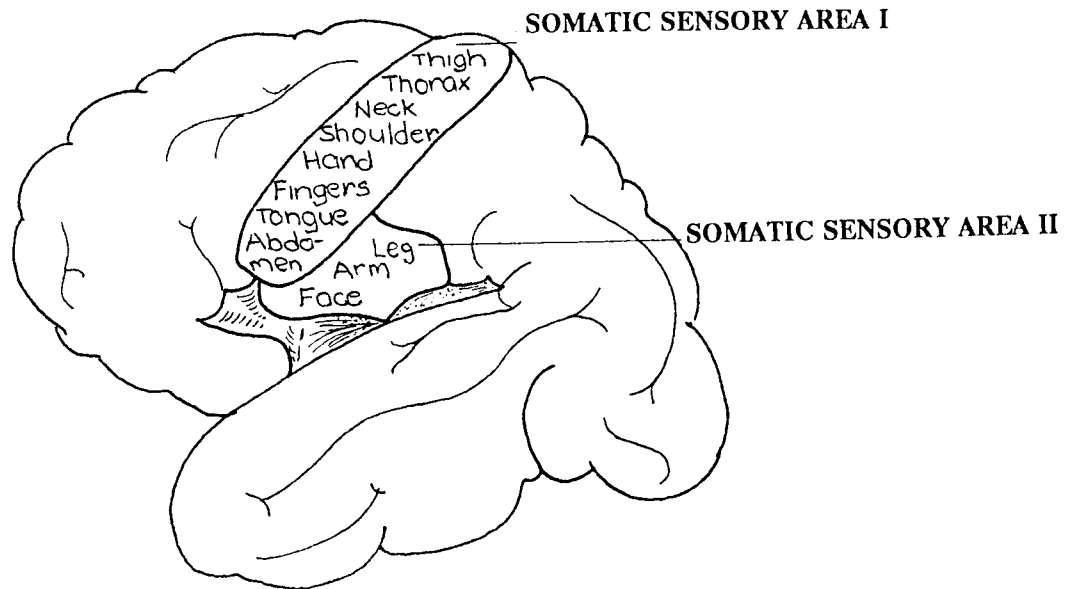
The fibres from the lower parts of the body lie towards the centre while those fibres that enter the cord at higher levels lie more laterally. This distinct spatial orientation is maintained in the thalamus. In the same way the fibres that reach the cortex are also spatially oriented so that a specific area of the cortex receive signals from a specific part of the body.

#### 5.1.3 The somatic sensory area in the cortex

There are two distinct somatic sensory areas in the cortex, i.e. somatic sensory area I and II. As the somatic sensory area I is much more important than area II, often when referring to the somatic sensory cortex, reference is made only to somatic area I (figure 1.11).

##### 5.1.3.1 Somatic sensory area I

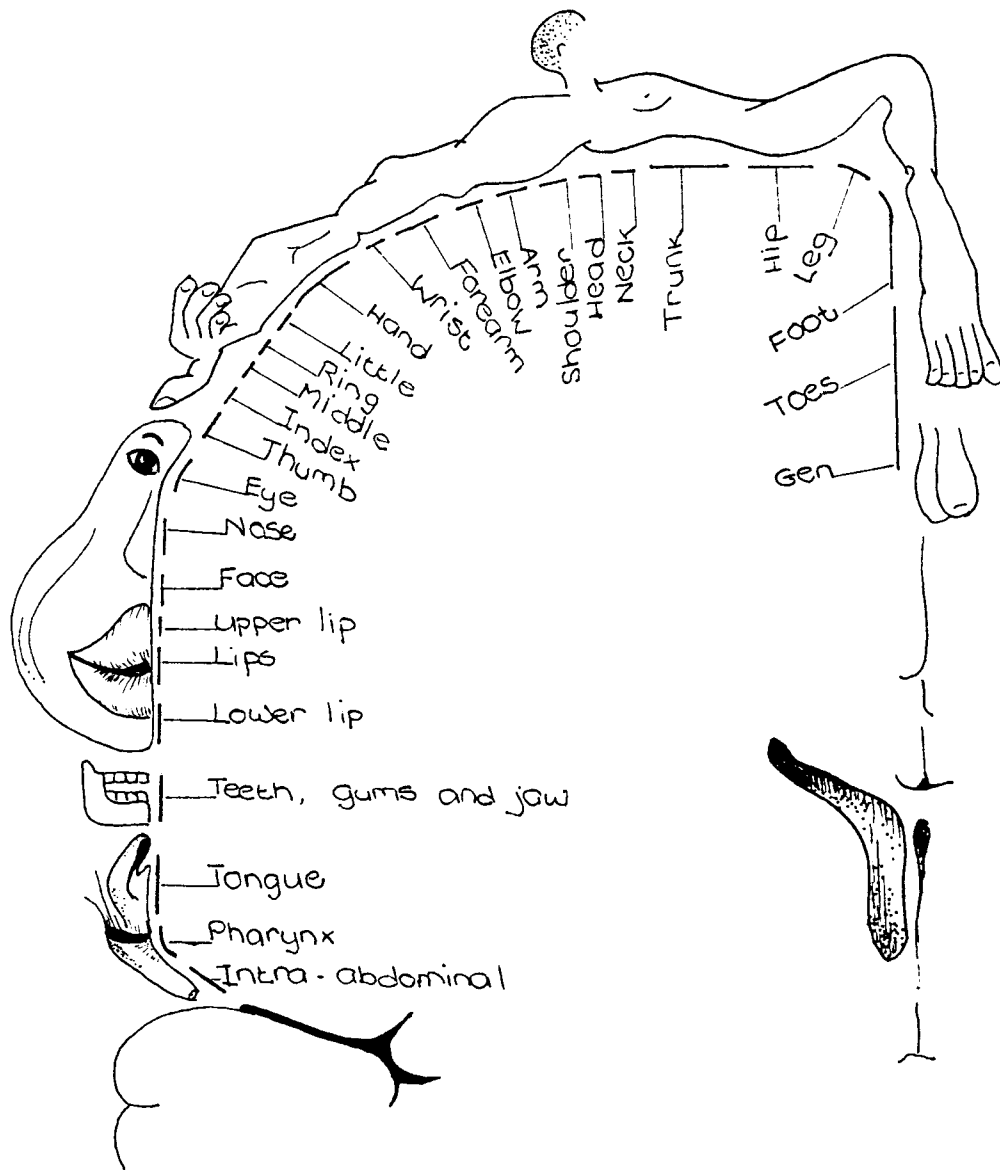
Somatic sensory area I lies in the postcentral gyrus of the cerebral cortex. The different parts of the body are distinctly



**FIGURE 1.11:** Somatic sensory areas (Redrawn from Guyton, 1972)

represented in this area as seen in the homunculus (figure 1.12). Each side of the cortex receives sensory information from the opposite side of the body (except for some from the same side of the face). As can be seen in the homunculus the representation of parts of the body differ in size. The size of representation does not correlate with the size of the body part but is directly proportional to the number of specialized sensory receptors in each respective peripheral area of the body.

Apart from the spatial organisation of the representation of the body parts in the somatic sensory area I, there is also modality separation of different types of mechanoreceptor signals. Tactile signals stimulate the central and anterior portions of the postcentral gyrus, whilst the joint receptors stimulate the posterior portion and the anterior portion is stimulated mainly by signals from the muscle spindles. This separation of modalities is important for the function of sorting the different types of incoming sensory signals.



**FIGURE 1.12:** Representation of the different areas of the body in the somatic area I of the cortex (Redrawn from Guyton, 1972)

#### 5.1.3.2 Somatic sensory area II

Somatic sensory area II lies posterior and inferior to the lower end of the postcentral gyrus and on the upper wall of the lateral fissure. Localization of the different parts of the body is poor compared to somatic sensory area I. The face is represented anteriorly, the arms centrally and the legs posteriorly.

### 5.1.3.3 Somatic association areas

The Brodman areas 5 and 7 are located in the parietal cortex immediately behind somatic sensory area I and above somatic sensory area II. This area plays an important role in deciphering the incoming sensory information and is therefore called the somatic association area. This area combines information from multiple points in the somatic sensory area to decipher its meaning. It receives signals from the primary somatic areas, the ventrobasal complex of the thalamus and the adjacent areas of the thalamus which receive input from the ventrobasal complex.

## 5.2 PHYSIOLOGY OF THE SOMATOSENSORY SYSTEM

This section of the literature deals with the function of the sensory receptors in the skin, joints, muscles and tendons, their connections in the central nervous system and the interpretation of these sensations in the cortex. The following works were consulted in this regard: Brodal (1981), Fisher et al (1991), Garoute (1981), Guyton (1986), Harper (19 ), Heiniger & Randolph (1981), Iggo (1973) & Meyer et al (1988).

### 5.2.1 Some general principles on the neural function of receptors

#### 5.2.1.1 Specificity versus non-specificity of receptors

Traditionally the law of adequate stimulus is accepted. Because receptors probably have a low threshold for a certain form of energy, that particular receptor will easily be stimulated by a weak stimulus of the correct form of energy. There is not total clarity about the degree of specificity of receptors and there are indications that at least some receptors can be stimulated by more than one form of energy if the stimulus is strong enough.

In 1850 Muller, as cited by Meij (Meyer et al, 1988), formulated the law of specific neural energy by which it is stated that a

sensation that travels along a specific tract will always be the same, irrespective of the type of stimulus applied. According to this law the sensation is totally dependent upon the type of receptor that is stimulated. In contrast to this a theory was formulated whereby spatial patterns of fibres and temporal frequency patterns of impulses determine the quality of sensation. This was supported particularly by Weddell, as cited by Brodal (1981). Currently the opinion is that despite anatomical differences, little functional differences can be detected. It is generally accepted that some receptors are very specific whereas others are less specific.

#### 5.2.1.2 Potentials

A common feature of all sensory receptors is that, whatever the stimulus, the immediate effect is that the potential changes across the receptor membrane which is called the receptor potential.

Different receptors can be stimulated in different ways, i.e.:

- mechanical deformation stretches the membrane and opens the pores
- chemical application to the membrane opens the pores
- change of temperature of membrane alters the permeability of the membrane
- effects of electromagnetic radiation eg. light, changes the membrane characteristics and allows ions to flow through membrane pores.

The basic cause of change in the membrane potential is a change in the permeability which allows ions to diffuse more or less readily through the membrane and thereby change the transmembrane potentials.

- Generator potentials: In the nerve endings of the receptors, it is the receptor potential that causes the generation of action potential in the nerve fibres. The potential that actually causes generation of action potentials, is called the generator potential. In nerve endings the generator potential is the same as the action potential, but in the specialized receptor cells the generator potential is only that part of the receptor potential that is transferred to the nerve endings.

#### 5.2.1.3 Receptor function

As the Pacinian corpuscle is the most easily studied because of its relatively larger size, their well-defined capsule and the ease with which mechanical stimuli can be quantified, it will be used as an example for describing the function of receptors in general.

The central non-myelinated tip of the nerve fibre extends to the core of the corpuscle that is surrounded by many concentric capsule layers so that compression on the outside of the corpuscle tends to elongate, shorten, indent or otherwise deform the central core of the fibre depending on the compression applied. This deformation causes a sudden change in membrane potential, which is the receptor potential and in this case the generator potential that causes the generation of action potentials. The receptor potential thus is believed to be caused by the stretching of the nerve fibre membrane, resulting in its increased permeability and thus allowing positively charged sodium ions to leak into the interior of the fibre. This change in local potential causes a circuit of current to flow that spreads along the nerve fibre to its myelinated portion.

At the first node of Ranvier, which is still inside the capsule, the local current flow initiates action potentials in the nerve fibre. The flow through the node depolarizes it and sets off a typical saltatory transmission of an action potential along the

nerve fibre towards the central nervous system.

#### 5.2.1.4 Stimulus strength

The more intense a sensory stimulus, the higher the frequency of afferent action potentials. There are two mechanisms by which this occurs: Through increased frequency of potentials from a single ending (temporal summation) and through increased numbers of activated endings (multiple fibre summation). This enables the stimulus strength to be interpreted accurately over a large range of intensity and also allows the receptors to operate in the correct range. (Guyton, 1986).

- Judgement of stimulus strength: The two principles widely used in the discussion of sensory interpretation, i.e. The Weber-Fechner Principle and The Power Law (Guyton, 1986). The Weber-Fechner Principle states that the greater the background sensory stimulus, the greater must be the additional change in stimulus strength for the psyche to detect the change. The Power Law states that the greater the stimulus, the greater the difference needed to interpret the change. This however does not hold true for very low or very high intensities.

#### 5.2.1.5 Adaptation of receptors

All sensory receptors adapt either partially or completely to a stimulus after a period of time. When the stimulus is initially applied, the receptors respond at a very high impulse rate. If the stimulus persists the receptors respond progressively less rapidly until finally in many cases they do not respond at all.

Some receptors adapt very rapidly whilst others adapt very slowly. Some receptors adapt to such an extent that the stimulus becomes extinct. It is postulated (Guyton, 1986) that all mechanoreceptors eventually adapt completely but require a long time - probably hours or days. These receptors are frequently

called non-adapting receptors.

- Mechanisms of adaptation: Adaptation occurs in the receptor as well as in the nerve fibre itself. The adaptation within the receptor is an individual property of the specific type of receptor.

Using the Pacinian corpuscle as example, it can be explained as follows: When a force is suddenly applied to one side of the structure, it is transmitted by the viscous component directly to the same side of the central core of the corpuscle thus eliciting a receptor potential. Within a very short while the fluid redistributes itself so that the pressure becomes equal all through the corpuscle. This results in even pressure being exercised again on all sides of the central core and thus the receptor potential is no longer elicited. Receptor potential therefore appears at the onset of compression but then disappears after a very short time (a fraction of a second).

When the force is removed, the reverse occurs. Sudden removal of the distorting force from one side of the corpuscle, allows rapid expansion on that side, resulting in a corresponding distortion of the central core once more. Here again the pressure becomes equalized within a fraction of a second and the stimulus is lost. The receptor thus signals the onset as well as the offset of the stimulus.

Slower adaptation of the Pacinian corpuscle takes place through the accommodation of the nerve fibre itself. With continuous stimulation the nerve fibre accommodates itself to the stimuli. This results from the redistribution of ions across the nerve fibre membrane. It is presumed that the two mechanisms of adaptation apply to the other types of mechanoreceptors as well i.e. readjustments in the structure of the receptor and accommodation within the terminal nerve fibril.

### 5.2.2 The function of slowly adapting and non-adapting receptors

These receptors are often also called the tonic receptors as they continue to transmit impulses to the brain for as long as the stimulus is present. These receptors keep the brain continually informed of the status of the body and its relationship to the surroundings, eg. the slowly adapting joint receptors allow the person to know at all times the degree of to which the joint is bent and therefore gives information about the position of body parts. The impulses from the muscle spindle and Golgi tendon organs allow the central nervous system to know the status of muscle contraction and the load on the muscle tendon. Some tactile receptors such as Ruffini endings and Merkel's disks are also slowly adapting receptors. Guyton (1986) proposes that many of these slowly adapting receptors could adapt to extinction eventually but because of the continually changing bodily state this almost never happens.

### 5.2.3 Function of rapidly adapting receptors

The rapidly adapting receptors are of no use for transmitting a continuous signal as they are only stimulated when the stimulus strength is changed. They react strongly when the change is taking place and the number of impulses are directly related to the rate at which the change takes place. They are therefore often called the rate receptors.

This is a very important mechanism for transmitting information about rapid changes in pressure against the body, but useless for transmitting information about constant pressure applied to the body.

### 5.2.4 Predictive function of rate receptors

By knowing the rate at which some changes take place in the body, one can predict ahead of time the state of the body a few seconds later. For example, the Pacinian corpuscle located in or near the

joint capsule helps to detect the rate of movement of any part of the body. When a person is walking, information from these receptors allows the central nervous system to predict ahead of time where the feet will be during the movement. Appropriate motor signals can thus be transmitted to the muscles of the legs to make any necessary anticipatory correction in the limb position so that the person will not fall. Loss of this predictive function will make it impossible for the person to walk.

#### 5.2.5 Classification of nerve fibres

Not all sensory signals need to reach the central nervous system at the same speed. Those sensory signals that inform the brain of the momentary positions of the limbs at each fraction of second, need to reach the brain very rapidly. It is therefore important that these signals are transmitted by very rapidly conducting fibres. Other signals do not need to be transmitted so rapidly, eg. interpreting a prolonged aching pain and therefore slowly conducting fibres will suffice.

The larger the diameter of the fibre, the faster the transmission. The sizes of nerve fibres vary from 0,2 microns to 20 microns with conduction velocities that vary from 0,5 to 120 meters per second.

Generally nerve fibres are classified as A and C fibres (Brodal, 1986). The type A fibres are typical myelinated fibres of spinal nerves whereas the type C fibres are small unmyelinated nerve fibres. More than 66% of all nerve fibres in peripheral nerves are type C fibres and because of the great number of fibres they transmit tremendous amounts of information from the surface of the body even though the velocity of transmission is low.

An alternate classification is as follows (Guyton, 1986):

- **Group Ia:** These fibres originate from the annulospiral

endings of the muscle spindles and average 17 microns in diameter. They correspond to A-Alpha fibres.

- **Group Ib:** These are from the Golgi tendon organ, averaging 16 microns and also correspond to A-Alpha fibres.
- **Group II:** These fibres originate from the discrete cutaneous tactile receptors and flower spray endings of muscle spindles. They average 3 microns and correspond to A-Beta and A-Gamma fibres.

**Group III:** These fibres relay temperature, crude touch and pricking pain, averaging 3 microns and correspond A-Delta fibres.

- **Group IV:** These are unmyelinated fibres carrying pain, itch, temperature and crude touch. They average 0.5-2 microns in diameter and correspond with the C type fibres.

The more critical types of sensory signals such as those that determine localization on the skin, minute gradations of intensity or rapid changes in intensity, are transmitted in rapidly conducting nerve fibres. Cruder types of signals are transmitted via much slower conducting fibres - fibres that require much less space.

Almost all specialized sensory receptors transmit their signals through A-Beta nerve fibres at a velocity of between 30 and 70 meters per second. Free nerve endings transmit via A-Delta myelinated fibres at a velocity of 5-30 meters per second. Some tactile free nerve endings conduct via type C unmyelinated fibres at about 2 meters per second.

### 5.3 THE TRANSMISSION OF MECHANORECEPTORS' SOMATIC SENSORY SIGNALS INTO THE CENTRAL NERVOUS SYSTEM

The sensory information enters the spinal cord through the dorsal

roots. Upon entering the cord, the nerve fibres separate into two main groups: the dorsal lemniscal system (which includes the dorsal columns and the spinothalamic tracts) and the anterolateral spinothalamic system. There is a close association of the dorsal-lemniscal system with the dorsal and ventral spinocerebellar tracts which operate at a subconscious level and submit information to the cerebellum.

**TABLE 1.1: DIFFERENCES BETWEEN THE DORSAL-LEMNISCAL SYSTEM AND THE ANTEROLATERAL SPINOTHALAMIC SYSTEM**

Dorsal-lemniscal	Anterolateral spinothalamic
1. Large myelinated fibres	1. Smaller myelinated fibres
2. Velocity of 30-100m p.s.	2. Velocity of 10-60m p.s.
3. High degree of spatial orientation	3. Very little spatial orientation
4. Sensory information that needs rapid transmission	4. Sensory information that doesn't need rapid transmission
5. Information with temporal accuracy	5. Information with very little temporal accuracy
6. Sensation that detect fine gradation of intensity	6. Sensations that lack fine gradation of intensity
7. Sensation specifically localized to an exact point on body	7. Sensations not localized exactly
8. Not a very broad spectrum of sensory modalities	8. Broad spectrum of sensory modalities
9. Can transmit phasic sensations, i.e.vibration	9. Cannot transmit phasic sensations
10. Can transmit movement sensation against skin	10. Cannot transmit movement sensation against skin
11. Can transmit position sensations of body parts	11. Cannot transmit position sensations of body parts
12. Can transmit pressure sensations	12. Cannot transmit pressure sensations

## 5.4 TRANSMISSION IN THE DORSAL-LEMNISCAL SYSTEM

### 5.4.1 Two main pathways

The two main pathways in the dorsal lemniscal system are the dorsal column pathway and spinocervical pathway. There is a separation of sensory modalities between these two pathways which begins in the spinal cord. The dorsal column pathway transmits signals mainly from rapidly adapting receptors whereas the signals from the more slowly adapting receptors are transmitted through the spinocervical pathway. This separation of modalities is also found in the somatic sensory area I which means that these modalities remain separated throughout their entire pathway from the spinal cord to the cortex.

### 5.4.2 Spatial orientation of fibres

The spatial orientation of fibres in the dorsal lemniscal system is as follows: In the dorsal column the fibres from the lower parts of the body lie towards the centre while those that enter the cord at progressively higher levels form successive layers laterally. The spatial orientation in the spinocervical pathway is less well known but there is some experimental evidence of this orientation (Guyton 1986). This spatial orientation continues as the tracts reach the thalamus, however, because of the crossing of the medial lemnisci in the medulla, the left side of the body is represented in the right side of the thalamus and vice versa. Similarly this spatial orientation continues to the cortex so that a single part of the cortex receives signals from a specific part of the body (see homunculus figure 1. ).

### 5.4.3 Accuracy of transmission

The most important feature of the dorsal-lemniscal system is its faithfulness of transmission. It accurately transmits the signal in terms of its localization of origin and intensity. The information carried by this system is not altered significantly

by stimuli from other areas of the nervous system. Although divergence takes place at each synaptic stage, a single stimulus does not cause all the cortical neurons with which that receptor connects to discharge at the same rate. The cortical neurons that discharge most are those in the central part of the cortical field for the specific receptor. Thus, a weak stimulus will cause only the most central neurons to fire, but a stronger stimulus will cause more neurons to fire and the central neurons will fire at a more rapid rate.

#### 5.4.4 Lateral inhibition

When a receptor is excited, signals are not only transmitted to the somatosensory cortex, but also laterally to adjacent fibre pathways. These signals are inhibitory in nature and help to block the lateral spread of the signal. This is called lateral inhibition or surround inhibition. As a result the essential stimulus stands out and much of the surrounding diffuse stimulation is blocked. This mechanism greatly increases the contrast of the perceived spatial pattern.

#### 5.4.5 Rapidly changing peripheral conditions

Rapidly changing peripheral conditions are effectively transmitted by the dorsal column system as it can follow changing stimuli to the skin at up to 400 cycles per second and also detect changes as high as 700 cycles per second. Vibratory signals, which are rapidly repetitive, can therefore only be transmitted through the dorsal column pathway.

#### 5.4.6 Static position sense and kinaesthesia

These sensations are transmitted mainly through the dorsal-lemniscal system. Information from many different types of receptors is used to determine both static position sense and kinaesthesia, especially the extensive sensory endings in the joint capsules, ligaments and deep tissues near the joints.

The Ruffini endings are stimulated strongly when the joint is suddenly moved. They adapt slightly at first and then send a steady signal thereafter. The Golgi tendon organ has much the same response properties. The Pacinian corpuscle found in the tissues around the joints adapt very rapidly and are postulated to detect rate of rotation of the joint (Guyton, 1986). Various receptors are stimulated in turn when a joint is rotated and from this the brain knows to what extent it is rotated.

A great many of the position sense signals are transmitted by the dorsal column, but animal studies have led to the belief that many signals are also transmitted by the spinocervical pathway (Gardner, 1967). These are probably mostly the static position signals that are slowly adapting and transmit information about the relative positions of different parts of the body when a person is not actively moving. Within the dorsal-lemniscal pathway, the signal pattern from the static position receptors changes as it progresses up the dorsal column. At the thalamic level there are two types of neurons that respond to joint rotation, i.e. those that are maximally stimulated when the joint is at full rotation and those that are maximally stimulated when the joint is at minimal rotation. Thus the rate of stimulation of the neuron increases or decreases depending on the direction in which the joint is being rotated. This integration of stimuli at the thalamic level gives a progressively stronger signal as the joint moves in only one direction rather than giving a peaked signal as in the case of stimulation of one individual receptor.

#### 5.4.7 Rate of movement

Ruffini and Golgi endings are stimulated very strongly at first when the joint is moved, but this strong level fades to a lower steady rate within a fraction of a second. This early "overshoot" in stimulation is proportional to the rate of movement and is believed to be the signal used by the brain to interpret the rate of movement. It is suggested that the Pacinian corpuscles may also play a role in this process.

### 5.5 TRANSMISSION IN THE ANTEROLATERAL SPINOTHALAMIC SYSTEM

This system transmits sensory signals which do not require a high degree of localization and also do not require discrimination of fine gradations of intensity. For the purpose of this study, attention will only be given to the transmission of tactile stimuli by this system (excluding the other sensations of pain, temperature, etc.).

Closely associated with the anterolateral spinothalamic pathway are the spinoreticular, spinotectal and paleospinothalamic pathways. Little is known about the specific function of these pathways, but they are probably related to the transmission of crude tactile signals and control of the neural functions of the brain stem.

Upon entering the ventrobasal complex of the thalamus the spinothalamic signals (in association with those from the dorsal-lemniscal system) are relayed mainly to somatosensory area I but to a lesser extent also to somatosensory area II.

In general the transmission of signals through the anterolateral spinothalamic system follow the same principles as those transmitted through the dorsal lemniscal system. The differences being: the velocity of transmission is much slower, the degree of spatial localization of signals is poor, the gradations of intensities are far less acute and the ability to transmit rapidly repetitive sensations is poor. It can thus be said that the anterolateral spinothalamic system is a cruder transmission system than the dorsal lemniscal system.

### 5.6 FUNCTION OF THE THALAMUS IN SOMATIC SENSATION

Almost all sensory information that enters the cerebrum, is relayed through one or other of the thalamic nuclei. The thalamus has a slight ability to discriminate tactile sensation but its main function is to relay this information to the cortex.

### 5.7 CORTICAL CONTROL OF SENSORY SENSITIVITY

The conscious brain is capable of directing its attention to different segments of the sensory system. This is mainly as a result of facilitation and inhibition of the cortical receptive areas. Corticofugal signals are also transmitted to lower relay stations to inhibit transmission. Sensitivity to stimuli is controlled at all levels of the sensory pathway, i.e. thalamus, reticular nuclei of the brain stem, dorsal column nuclei and the dorsal horn relay station of the spino-reticulo-thalamic system. These corticofugal pathways begin in the cortex where the sensory pathway that is controlled, ends. A feedback control loop exists for each sensory pathway. This control allows the cerebral cortex to alter the threshold for different sensory signals as well as focussing the attention on specific types of information. This process is also important in automatic gain control and enhancement of contrast. When excess sensory signals pass to the brain, recurrent inhibition to the spinal cord decreases the sensitivity of the sensory pathway. This prevents overloading of the pathway with signals. This also helps to maintain the contrast in the perception of sensory signals.

APPENDIX 8  
REVISED TEST MANUAL

## GENERAL INSTRUCTIONS FOR ADMINISTERING THE SOMATOSENSORY TESTS

The test consists of five subtests, ie Kinesthesia, Finger Recognition, Form Recognition, Two Point Discrimination and Tactile Stimuli Placement Test. Each of these tests have specific instructions pertaining to that test alone.

Here are some general instructions that pertain to all the subtests:

The arrangement of the room should be complete before the child enters the room. The room should have adequate lighting, heating and ventilation. Distractions such as wall posters, toys, etc should be kept to a minimum.

Furniture should consist of a table and two chairs.

The child should be seated comfortably at the table with ankles, knees, hips and elbows (when resting on the table) at 90° angles. It may be necessary to use an adjustable table and have chairs of varying heights available.

The tester sits directly opposite the child. The screen is attached to the table in such a way that it can be easily positioned in front of the child, approximately 15cm from his/her face.

It is suggested that a quick screening of postural control mechanisms be done beforehand to prepare the tester for responses such as poor postural background movements. General information is obtained from the child (name, age, address, school, etc., depending on the child's age) as to introduce the child to the situation and to reassure him/her.

After the final test a reward is given. Check with the caretaker of the child whether he/she may have a chocolate. If not a star/sticker is offered.

## OPERATING INSTRUCTIONS FOR KINESTHESIA TEST

Apparatus: Adapted "mouse", screen, red fine-liner, scoring sheet, ruler, masking tape, table and chair.

### General instructions:

The child should be seated comfortably at the table. The tester sits directly opposite the child. The tester should check the positioning of the screen before commencement and adjustments should be made if necessary.

The Kinesthesia measurement chart should be taped to the table 5cm from the edge of the table prior to commencement of test.

The tester's hand may touch the child's hand whilst moving the mouse if necessary (e.g. child withdrawing hand), but in the stabilizing period of 3 seconds the tester may not touch the child's hand, only stabilizing by holding onto the mouse. The tester should use his/her non-dominant hand for moving of the mouse and the dominant hand for marking.

Special attention should be given to the timing of movement on the various items. Items 3, 4, 6 and 7 should be timed for one second. Trial items and items 2, 5, 8 and 9 should be timed at two seconds and items 1 and 10 should be timed at three seconds. Tester should practice this timing with the help of a stop watch before commencement of test.

Specific instructions: (Verbal instructions appear in bold print. Afrikaans instructions follow directly and are underlined).

Trial:

Say to the child:

**We are going to play a mouse game. Here is the mouse. Here are his ears. You must hold him between his ears.**

Ons gaan 'n muisspeletjie speel. Hier is die muis en hier is sy ore. Jy moet hom tussen sy ore vashou.

Place the child's fingers of his right hand between the ears of mouse. Say:

**That's right.**

Dis reg.

Make sure at this stage that the hand is correctly positioned. Additional help and/or verbal instructions can be given to ensure that the positioning is correct. Say:

**We are going to show the mouse where to find some cheese. This is where we start from, the nest of the mouse.**

Ons gaan nou vir die muis wys waar hy kaas kan kry. Ons begin hier waar sy nes is.

Place the mouse with the child's hand on it on position T1 so that pencil point will be in the small circle when put through the guide.

This trial part is executed with full vision of the child. Before moving the child's hand to position T2, say:

**We will take the mouse to where the cheese is, here.**

Ons gaan nou die muis neem na waar die kaas is, hierso.

Move the child's hand to position T2. Allow 3 seconds whilst holding the mouse in a stationary position and making a dot through the guide. The tester's hand should not touch that of the child whilst in the stationary position. Now say:

**We will now take the mouse back to his nest, here.**

Ons neem nou die muis terug na sy nes, hierso.

The tester moves the mouse back to position T1 and checks position by inserting pen through guide into the small circle. Say to the child:

**Now you must take the mouse to fetch the cheese.**

Jy moet nou die muis neem om die kaas te gaan haal.

Let the child move to the required position. Immediately when the child's hand stops the tester should again stabilize the mouse to prevent the child from moving it any further, whilst saying:

**That's right.**

Dis reg

Again make a mark through the guide. Draw a line between two red dots for future measurement.

Say to the child:

**Now we will use the other hand. Put your other hand here between the mouse's ears. That's right.**

Ons gaan nou jou ander hand gebruik. Sit jou ander hand tussen die muis ore. Dis reg.

Make sure that the hand is again comfortable on the mouse in the correct position. Move the child's hand to T2.

**Here is where the mouse has his nest now.**

Die muis se nes is nou hier.

Move the mouse so that the pen can be placed on the small circle when placed through the guide. Say:

**We will again show the mouse where to find the cheese, here.**

Ons sal die muis wys waar die kaas is, hierso.

Move the mouse to position T1 and make a mark through the guide with the pen. Wait 3 seconds whilst holding the mouse stable and then say:

**We will take the mouse back to his nest.**

Ons neem nou die muis terug na sy nes.

Move the mouse back to position T2 and place correctly by using the pen through the guide. Say:

**Now you must take the mouse to fetch the cheese.**

Jy moet nou die muis neem om sie kaas te kry.

Again, stabilize the mouse as soon as movement has stopped and mark through the guide and connect the two dots. Say:

**That's right.**

Dis reg.

Test items:

Say to the child:

We will now play this game without your eyes helping you.  
That's why we pull this screen down in front of your face.

Ons sal nou hierdie speletjie speel sonder dat jou oë jou help,  
daarom plaas ons hierdie skerm voor jou gesig, so.

Pull screen down in front of the child's face so that hands are  
obscured. Say:

This is where the mouse has his nest now.

Hier is die muis se nes nou.

Move the child's hand to position 1a. Say:

I will show you where the mouse can find the cheese.

Ek sal jou wys waar die muis die kaas kan kry.

Move the mouse to position 1b. Say:

Here is the cheese.

Hier is die kaas.

Wait 3 seconds whilst stabilizing the mouse and marking through  
the guide. Say:

Now we take him back to his nest

Ons neem hom nou terug na sy nes.

Move the mouse back to position 1a. Say:

Now you take the mouse to fetch the cheese.

Neem jy nou die muis om die kaas te gaan haal.

Again stabilize the mouse once movement has stopped and mark through the guide and connect the two dots.

Continue in the same way for items 2 to 12. Verbal instructions can be shortened once the tester is confident the the child understands what is expected of him. Shortened instructions are:

**Here is the mouse's nest. Here is the cheese. Here is the nest.  
Now you go to the cheese.**

Hier die die muis se nes. Hier is die kaas. Hier is die nes.  
Gaan jy nou na die kaas toe.

After all the items have been completed remove the measurement sheet before removing the screen and then say:

**Thank you, that was good,**

Dankie dit was goed,

indicating that the test has been completed.

Scoring: For each of the items 1 to 12 the distance between the two dots are measured and recorded in the recording blocks on the measurement sheet. The total is subtracted from 50 to calculate a raw score for each hand. The total of both hand's scores are subtracted from 100 to calculate a total raw score.

## OPERATING INSTRUCTIONS FOR FINGER RECOGNITION TEST

Apparatus: Rubber thimbles to fit snugly on the thumb and index fingers of the testers dominant hand when turned inside out, screen, placement sheet, masking tape and scoring sheet (on the back of the Kinesthesia measurement chart).

### General instructions:

The child is seated in the same way as for the Kinesthesia test. This test should follow immediately after the Kinesthesia test. It is suggested that the thimbles be warmed to approximate body heat in cold weather. This can be done by placing the thimbles in a trouser/skirt or breast pocket 30 minutes prior to testing. It is advisable to practice the pressure of touching to make sure that the correct pressure is used, approximately 10 - 15 milligrams of pressure.

Tape the placement sheet onto table, approximately 5cm from the edge of the table.

### Trials:

Say to the child:

**Place your hands in front of you on these hands like this.**

Plaas jou hande voor jou op hierdie hande ,so.

Point briefly to the placement sheet and place own hands on table with fingers spread out as on placement chart. If the child has difficulty in understanding these instructions, the hands may be lifted and placed in position. Say:

**Touch this finger.**

Raak aan hierdie vinger.

Tester touches the right index finger on the middle phalanx. Pointing to the left index finger, say:

**Touch with this finger.**

Raak met hierdie vinger.

Wait for the child's response before proceeding to the next trial item. If the child does not point to the indicated finger spontaneously, his left index finger may be lifted and brought to touch the indicated finger. Proceed in the same the same way for the other two trial items.

Test items:

Say:

**Let us see if you can tell which finger I am touching if you can't see where I'm touching. We will again pull this screen down in front of your face.**

Kom ons kyk of jy vir my kan sê aan watter vinger ek raak sonder dat jy sien waar ek raak. Ons sal weer hierdie skerm voor jou gesig sit.

Pull screen down in position. Say:

**Which finger am I touching now? Thank you.**

Aan watter vinger raak ek nou? Dankie.

Proceed through all items in the same way. When the child has completed all the items, say:

**Thank you, that was good**

Dankie dit was goed.

to indicate the end of the test. Replace thimbles in pocket for further use in Two-Point Discrimination Test.

Scoring: Score two points for each item correct on the first try. Score one point if the child touches the wrong finger at first and then corrects himself spontaneously. This is not encouraged during the test items. The total score obtained is the raw score for this test.

INSTRUCTIONS FOR FORM RECOGNITION TEST

Apparatus: Selection of wooden and metal shapes, screen, stopwatch and scoring sheet (on back of Kinesthesia measuring chart).

General instructions: The child is seated in the same way as for the previous two tests. This test should follow directly upon the Finger Recognition Test. The tester should acquaint her/himself with the sequence in which the forms are presented so as to make the presentation fluent.

Specific instructions:

Say:

I have some shapes/forms here.

Ek het 'n aantal/klomp vormpies hier.

Show the child the first set of four forms. Place stimulus shape in child's right hand, saying:

Feel this shape. Does it feel like this one,

Voel aan hierdie vormpie. Voel dit soos hierdie een,

placing the first of the distractor items in the left hand for 3 seconds. Retrieve the shape and replace it with the second distractor and say:

Or this one.

Of hierdie een,

Again wait 3 seconds, retrieve it and replace it with the third item, saying:

Or this one.

Of hierdie een?

Allow the child to manipulate and look at the shapes.

If the child was correct the tester says:

**Yes, that is right. They feel the same and they look the same.**  
Ja, dis reg. Hulle voel dieselfde en hulle lyk dieselde.

If he was incorrect the differences and similarities should be pointed out by saying:

**Look, here these two are the same, but these two are different.**

Kyk hierdie twee is dieselfde, maar hierdie twee is verskillend/anders.

Allow the child then to hold the two matching items in each hand and say:

**Can you feel that they feel the same?**

Kan jy voel hulle voel dieselfde?

Make sure at this stage that the child has felt the difference between the items. Additional instruction can be given.

The second trial item is administered in the same way with the stimulus form placed in the left hand and the distractor items in the right hand.

Test items:

Say:

We will use this screen again to see if you can tell which forms feel the same, without your eyes helping you.

Ons sal weer hierdie skerm gebruik om te sien of jy vir my kan kan sê watter vormpies dieselfde voel sonder dat jou oë jou help.

Draw the screen in front of the child's face. Say:

We will put the first shape in this hand.

Ons sal die eerste vormpie in hierdie hand sit

Lightly touch the right hand,

and the other shapes in this hand,

en die ander in hierdie hand

touching the left hand. Place the first test shape in the right hand and say:

Here, feel this shape. Does it feel like this one

Voel aan hierdie vormpie. Voel dit soos hierdie een

Place first distractor item in left hand and start the stopwatch. Wait 3 seconds and retrieve shape from left hand replacing it with with the second distractor item saying:

Or this one.

of hierdie een

Wait 3 seconds and retrieve the shape replacing it with the third distractor, saying:

Or this one?

of hierdie een?

The time is recorded when the child chooses the correct item. It is advisable to keep the stopwatch running in case the child chooses an additional shape.

If the child chooses more than one shape or the incorrect shape, the shapes are again presented in reverse order, saying:

Let's feel them again. Is it this one, this one or this one?,

Kom ons voel hulle weer. Is dit hierdie een, hierdie een of hierdie een?

pausing for 3 seconds between presentations. If the child still is unable to choose the correct item, proceed to the next item and score that item as incorrect and give no time score for that item.

Mark the appropriate letter, R, Y or B, for the response of either red, yellow or blue. (The correct response is always red).

#### Scoring:

Score all responses on red as 1 point, other responses as 0. The correct items are calculated for the total item score. The time taken for each response is recorded on the record sheet. Any item requiring more than 30 seconds is scored as incorrect and that time is not calculated in the time score. Total time is calculated and one point is deducted for each 30 seconds. This adjusted total is the raw score for this test.

## INSTRUCTIONS FOR THE TWO-POINT DISCRIMINATION TEST

Apparatus: Two rubber thimbles as used in the Finger Recognition Test, screen, placement sheet, score sheet (on back of Kinesthesia Measuring Chart) and splint to be used between thumb and index finger in order to keep them at a constant distance apart.

### General instructions:

Child and tester are again seated as in previous tests. This test should follow immediately after the Form Recognition Test

### Specific instructions:

The placement sheet is taped to the table so that the full forearm of the child rests on the table when hands placed in position. Say:

Place your hands on these hands.

Sit jou hand op hierdie hande, so

Indicate the hands on the placement sheet and place own hands on table as in placement sheet.

### Trial items:

Say:

I am now going to touch you either with one or two fingers like this.

Ek gaan nou aan jou raak .f met een .f met twee vingers, so.

First touch the dorsum of the child's right hand with thimble and index finger. Say:

See, I touched you with one finger. Now I'm touching you with two fingers.

Sien ek het jou nou met een vinger geraak. Nou raak ek jou met twee vingers.

Touch the dorsum of the right hand with thimble index finger and thumb horizontally next to each other.

**See, I touched you with two fingers.**

Kyk ek het jou met twee vingers geraak.

Say:

**Now you tell me whether I'm touching with one or two fingers.**

Sê nou vir my of ek met een of twee vingers raak.

Touch the left hand with the index finger, whilst the child's arms and hands are still in his visual field. If the child responds correctly, say:

**That is right.**

Dis reg.

If he responds incorrectly touch him again and say:

**See, I'm touching you with one finger.**

Kyk, ek raak aan jou met een vinger.

Wait for a response. If the child is unable to indicate that he was touched by one finger only, discontinue this test.

When the child has responded correctly on the third trial item, say:

**Am I now touching with one or two fingers?**

Raak ek nou aan jou met een of twee vingers?

whilst touching the dorsum of the left hand with thumb and index finger horizontally next to each other. Wait for a response and confirm a correct response by saying:

**Yes, that is right.**

Ja, dis reg.

If the child still responds incorrectly discontinue this test by saying:

**Let's play another game.**

Kom ons speel 'n ander speletjie.

If the child has clearly indicated that he understands what is expected of him, continue with the test items.

Test items:

Say:

**Now you must tell me if I use one or two fingers without your eyes helping you. That is why I will pull this screen down in front of your face like this.**

Nou moet jy vir my sê of ek aan een of twee vingers raak sonder dat jou oë jou help. Daarom sit ek weer hierdie skerm voor jou oë, so.

Draw screen down into position. Say:

**Tell me if I'm touching with one finger or two fingers.**

Sê vir my of ek met een of twee vingers aan jou raak.

Continue with items 1 to 16 in the same way as for the trials.  
On each item, when the child has responded, say:

Yes,

Ja

indicating that you are satisfied with his response regardless of whether he was correct or not.

Scoring: Both double and single stimuli are scored. Each correct response is scored two points. If the child spontaneously changes his mind, the item is scored one point. This is not encouraged during the test items. The total score for each side is calculated as well as a combined total score. These are the raw scores for this test.

## INSTRUCTIONS FOR THE TACTILE STIMULI PLACEMENT TEST

Apparatus: Pre-inked X-Stamper with written part masked out in such a manner that spring is kept in position, surgical spirits and wad of cotton wool, brown square Carioca koki pen, a clean stamp pad that has been "inked" with surgical spirits, a clean sheet of white paper, screen and measuring tape.

### General Instructions:

Child and tester are again seated as in previous tests. This test should follow immediately after the Two Point Discrimination Test.

### Specific instructions:

The clean white sheet of paper is placed in front of the child (not taped down). Say:

**This is our last game for now. We will take a pretend child to eat a pretend piece of chocolate. Before we do this we first have to clean our fingers like this.**

Ons gaan hierdie kamma kind neem om 'n kamma stukkie sjokolade te eet. Voor ons dit doen, moet ons eers ons vingers skoonmaak, so.

First wipe your own index fingers with some surgical spirits on a piece of cotton wool. Then wipe the child's index fingers in the same way. If the child shows reluctance to having his fingers cleaned, encouragement can be given eg. explaining that one always has to clean up before eating for higienic reasons.

**This is the chocolate**

Hierdie is die sjokolade

show the child the brown marker whilst making a mark on the paper,

**and this is the child**

en hier is die kind

making an imprint of the face on the paper with your own index finger.

We will try to get him/her to eat the chocolate by putting his/her face on the chocolate, like this.

Ons gaan probeer om die kind te kry om die sjokolade te eet deur sy/haar gesiggie bo-op die sjokolade te sit, so.

Make an imprint of the face on the brown mark on the paper. Say:

Now it is your turn to take him/her to get the chocolate. I will put a piece of chocolate here

Nou is dit jou beurt om hom/haar te neem om die sjokolade te kry. Ek sit 'n stukkie sjokolade hier.

Make a new brown mark on the page. Say:

Put your finger on his/her face

sit jou vinger hier op sy/haar gesig

indicating the face on the stamper

and take him/her to eat the chocolate. Yes, that is right.

en neem hom/haar om die sjokolade te eet. Ja, dis reg.

Make sure at this stage that the child understands that he has to make an imprint on the brown mark. Extra instructions are allowed here. If the child still does not grasp the instructions, you can move his/her finger by holding it between your thumb and index finger on the distal phalanx and placing it on the brown marker.

The child's finger should be cleaned after each mark has been made. Use the stamp pad that has been "inked" with surgical spirits for this purpose. Say to the child:

Let's clean your finger again by wiping it on this pad  
Kom ons maak jou vinger weer skoon. Vee dit af op hierdie  
kussinkie.

Wipe your own finger on stamp pad as demonstration. Remember to  
do this after each item.

Remove the sheet of paper and say:

We are now going to play this game on you. Put your hands down  
on the table like this.

Ons gaan nou hierdie speletjie op jou speel. Sit jou hande voor  
jou neer, so.

Place your hands in front of you, palms down, indicating to the  
child that he/she should do the same. Say:

I'm going to put a piece of chocolate on your hand like this.

Ek gaan 'n stukkie sjokolade op jou hand sit, so.

Make a mark with the marker on the dorsum of the child's right  
hand and say:

Now, put your finger on the child's face and take him to get  
the chocolate. Don't move your finger once you've got chocolate  
otherwise his/her face will smudge. Yes that is right.

Sit nou jou vinger hier op die gesiggie en neem die kind om die  
sjokolade te kry. Moenie jou vinger beweeg as jy die sjokolade  
gekry het nie, want anders sal sy/haar gesiggie klad. Ja, dis  
reg.

Make sure that the child grasps the idea of making an imprint on  
the brown mark before continuing with the test part of the test.

Test items:

Place the X-stamper to the right of the child so that it will be in the visual field of the child when the screen is in position. Stabilize the X-stamper with your own hand.

Say to the child:

**We are again going to use this screen to see if the child can find the chocolate without your eyes helping him. Put this finger on the little face and keep this hand flat down on the table.**

Ons gaan nou weer hierdie skerm gebruik om te sien of kind self die sjokolade kan kry sonder dat jou oë help. Sit hierdie vinger op die gesiggie en hou jou ander hand plat op die tafel.

Indicate the child's right index finger and also the face on the stamper and then pull the screen down into position. If the child does not place his finger correctly he/she may be prompted or otherwise his/her finger may be lifted, holding it between thumb and index finger on the distal phalanx and placed on the face of the X-stamper

Say to the child:

**Here is the chocolate**

Hier is die sjokolade

whilst touching the child's forearm on position 1 with the marker. Say:

**That's right**

Dis reg

Continue in the same way for all the items from 2 to 6. Ask the child to turn arms over with palm facing up whilst demonstrating and saying:

Turn your hands over like this.

Draai nou jou hande om, so.

Continue with items 7 to 12. Once all the items have been completed, remove the screen and say to the child:

Thank you. We have now come to the end of our games. I have a little reward here for you for your hard work.

Dankie. Ons is nou klaar met hierdie speletjies. Ek het iets hier vir jou om dankie te sê.

Indicate the chocolate or star/sticker as appropriate.

Say to the child:

Before I give you the chocolate/star, I would like you to help me measure how close the child got to the chocolates. Please put your arms on the table for me again, like this.

Voor ek vir jou die sjokolade/sterretjie gee, wil ek hê dat jy vir my moet help om te meet hoe naby die kind aan die sjokolade gekom het. Sit weer vir my jou arms op die tafel, so.

Demonstrate to the child by placing own arms on the table as previously.

Proceed to measure the distances between the brown pen-mark and the centre of each face (approximately the nose position) for each test item. Calculate the the total for the left and right sides. These are the raw scores for the left and right sides. Calculate left and right totals for the total raw score.