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ANALYSIS OF CUTTING SKILLS IN THE 4 TO 6 YEAR POPULATION

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A Dissertation submitted to the Faculty of Medicine, University of the Witwatersrand in partial fulfilment of the Master of Science Degree in Occupational Therapy.

Johannesburg, January 1999

Ethics Clearance Certificate Number: M 940408

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Masters of Science in Occupational Therapy at the University of the Witwatersrand, Johannesburg. it has not been submitted before for any degree or examination in any other University.

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Johannesburg, 15 day of January 199 9.

ABSTRACT

The purpose of this study was to develop some guidelines for cutting skills in the four to six year age group. There are no precise norms available at this stage and these guidelines would be beneficial to occupational therapists and teachers assessing children as they need to compare the children's function to the norm.

14 T.E.D registered nursery schools were selected according to certain criteria, in order for the researcher to get a multiracial sample of 210 four to six year old children.

These children were tested individually with the consent of the parents. Each child was presented with seven shapes and asked to cut them out on the line. The shapes were presented in order of expected difficulty, starting with the straight line and ending with a crown.
The researcher gave the child left or right handed scissors, depending on the dominance of the child.
While the child was cutting out the shapes the researcher filled out an observation sheet which included the scissor grip, as well as the cutting motion. Time was used as a secondary variable.

In the pilot study, three months prior to the study, the researcher examined the line thickness of the assessment shapes for the various age groups, as well as the suitability of the observation sheet. These were then adjusted accordingly.

The results were evaluated by measuring those parts cut off the line, using a line measure. The results were given as a length score, which was then converted to a percentage score. The percentage score was then used for analysis. The aim of the researcher was to analyse cutting skills in the four to six year age group. This included the development of the cutting approach as well as the accuracy

with which children were able to cut. By using the results, the researcher was able to develop specific guidelines for the development of cutting skills which can be used in children's cutting ability.

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1. INTRODUCTION

1.1 Statement of the problem

Occupational therapists rely on formal standardized tests to evaluate children's functioning in all areas including gross and fine motor development and co-ordination as well as perceptual abilities. These tests are used so that children can be evaluated and compared with others of the same age as they allow the therapist to establish whether a child is functioning within the norm, or whether the child functions below the norm for his age group. If there is a group of scores where the child falls below the norm, therapy is recommended.

Cutting is a basic skill used by every child in order to carry out a fine motor activity. It requires the use of both hands, one to hold the pair of scissors and the other to manipulate the paper, and is therefore a fine bilateral motor activity co-ordinating the two sides of the body in a skilled manner (Fisher, Murray and Bundy 1991).
As Williams (1983) has suggested, the ability to use a lead hand and an assistive hand together effectively (functional asymmetry) when acting on objects in the environment (in any spatial orientation with respect to the body) is the culmination of the development of bilateral motor co-ordination. Clearly, the newborn infant, who is unable even to bring his hand reliably or consistently to the midline, must develop considerable ability and skill before we can expect him to draw, cut with a pair of scissors, or open a jar (Fisher, Murray and Bundy 1991). "The normal child passes through stages of both unilateral and bilateral hand use, which prepare him for using both hands separately and together" (Erhardt 1989).

All areas of fine motor co-ordination have been researched, yet there is very little literature available on cutting skills and "little is known about the ages by which the various aspects of bilateral performance are usually mastered" (Fisher, Murray and Bundy 1991). There are no standardized tests for this fine motor skill, which

makes it difficult for occupational therapists, as they are unable to compare and evaluate the child's performance against the performance of other children of the same age group.

The following broad general guide does however exist:

> *"From four years on, arm, and finger control increase and children learn to combine and sequence shoulder, forearm, wrist, and finger movements to cut complex shapes with scissors, draw shapes, and write letters and numbers. The ability to stabilize the arm and wrist and inhibit unnecessary movements, while using finer and more efficient movements of smaller muscles of the hand and fingers, develops progressively into the school years"* (Johnson Levine 1991).

Edwards (1987) broke down the expected levels of functioning as follows:

- 3 years - manipulates scissors correctly, not yet cutting accurately on lines; cuts incisions.
- 3½ years - cuts a circle with a pair of scissors, within 45 seconds - at least 3/4 of the circle is within 1 cm of line. Tries to cut a 9 cm square - the entire length of the line within 15 seconds.
- 4 years - can cut on a line with a pair of scissors; cuts out a square within 5 mm of the line.
- 4½ years - cuts a square fairly accurately on lines within 45 seconds.
- 5½ years - cuts more difficult corners and circles.

So far most standardized tests used by occupational therapists are from America and the United Kingdom. We need to carry out research on South African children in order to develop more relevant and appropriate norms. In order to assist a child with difficulties in the fine motor sphere one needs to know what to expect at the child's chronological age.

Cutting is an important skill that is used by most people and therefore it is necessary to be able to perform this function accurately. Initially the child requires cutting for tasks in school such as sizing the paper to fit into a book; further, a child requires this skill for carrying out creative fine motor tasks. Without the necessary accuracy the child will struggle to complete the task neatly. As an adult one is often exposed to situations where one needs to cut something out, for example on a simple level one would cut open a cereal packet and milk sachet or cut out wrapping paper and on a more complex level one would for instance cut out a circular car licence. This shows that cutting is an essential life skill in the modern world.

Cutting is a basic skill for children in pre-school and thereafter. Due to the lack of detailed guidelines, the researcher decided to investigate this area of function.

1.2 Purpose of the study

The purpose of this study was to analyse cutting skills in children aged four to six years in order to develop some guidelines for the development of this skill. Once the skill required for cutting has been established in the various age groups, one can establish trends in the development of children's cutting skills.

1.3 Importance of the study

Cutting is an essential skill, required in pre-school and in school. During a normal school day, children carry out fine motor activities most of the day. These include writing, colouring in and cutting. Children also need to be able to cut out later in grades 3, 4 etc. Here, very often they are asked to cut out A4 sheets so that they are able to paste them into their books, or they cut out more complex shapes for projects. It may seem like a small task, but if a child struggles with these simple

things, it slows him down in classroom activities.

As there are no norms available for children's ability to cut, therapists are making assumptions on what is expected at a particular age. These assumptions, however, can be misleading. A therapist could recommend treatment for a child who, according to her, was unable to cut at age level and therefore had poor bilateral skills, although not sure what the exact requirements really were. It is very important to work within the normal range, not to expect too much of children as well as not to treat too quickly and unnecessarily.

Cutting was identified as one variable which has not been properly investigated, yet which was often commented on and used in therapy. In order for therapists to be able to use such a skill in therapy it is necessary to understand the development of the cutting approach as well as the accuracy. Once this is clear, the therapist is able to integrate cutting into the treatment programme as she will know cutting expectations and be able to improve the child's cutting skills within age norms.

1.4 Scope and objectives

The study included 167 children from 13 different nursery schools. There were 88 boys and 79 girls. The children were all asked to cut out seven graded shapes on the line.

The objectives of this study were :

- to determine the accuracy with which children cut out some shapes;
- to determine the skills used for cutting;
- to determine the progression of these skills between ages 4 and 6;
- to determine the average speed with which children cut.

1.5 Definition of terms

Fine motor skills

> *"These are patterns that normally rely on both tactile-proprioceptive and visual information for accuracy. However, fine motor skills may be accomplished without visual feedback if somatosensory functions provide adequate information. The patterns include basic reach, grasp, carry, release, and the more complex skills of in-hand manipulation and bilateral hand use.*
>
> *Reach - Movement and stabilisation of the arm and hand for the purpose of contacting an object with the hand.*
>
> *Grasp - Attainment of an object with the hand.*
>
> *Carry - The movement of the arm in space for the purpose of transporting a hand-held object from one place to another.*
>
> *Release - The intentional letting go of a hand-held object at a specific time and place.*
>
> *In-hand manipulation - The adjustment of an object within the hand after grasp.*
>
> *Bilateral hand use/ bilateral integration - The effective use of two hands together to accomplish an activity."*
>
> (Exner, in Pratt & Allen, 1989 : 235)

Hand-arm

The interactive movement and stabilization of different parts of the arm and hand when doing a fine motor task.

Cutting

The ability to manipulate scissors effectively in order to cut out shapes on a predrawn line.

Scissor Grip

This refers to the position in which the scissors are held in the dominant hand of the child.

Forearm in midposition

> *"The neutral or zero position is midway between supination and pronation, that is, from anatomical position with elbow extended the thumb is directed forward; with the elbow bent at right angle, the thumb is directed upward. The normal range of motion is 90 degrees in either direction from zero."* (Kendall & Kendall, 1983 : 24)

Perpendicular to the floor

The scissors are held perpendicular to the floor. This is associated with the forearm that is held in the neutral position and is between pronation and supination.

Supination and Pronation

> *"Supination and pronation are rotation movements of the forearm. In pronation the distal end of the radius moves from a lateral position, as in the anatomical position, to a medial position; in supination, it moves from a medial to a lateral position. The palm of the hand faces anteriorly in supination and posteriorly in pronation."* (Kendall & Kendall, 1983 : 23)

Fixation

> *"In general fixation refers to the firmness or stability of the body necessary to insure an accurate test of any muscle or muscle group...fixation which implies holding firm."* (Kendall & Kendall, 1983 : 6)

Snipping

> *"Cut with scissors etc., especially in small quick strokes."* (Branford, 1994 : 918)

Associated tongue movements

> *"These occur normally throughout life when attempting strenuous activities but are more widespread in central nervous system dysfunction when there is increased tone. These are tonic reactions acting from one extremity to another."* (Trombly,1983 : 51)

Visual skills

These include eye movements, visual fixation on an object and visual tracking using smooth movements of the eye muscles.

Visual perceptual skills

This includes the recognition, discrimination as well as processing of visual information. It includes basic concepts such as colour, shapes and objects as well as spatial relations and position in space.

Norm

"customary behaviour." (Branford, 1994 : 647)

Skill

"ability to do something well." (Branford, 1994 : 907)

1.6 Limitations of the study

The study was limited in the following way:

Area - Gauteng

Schools - T.E.D. registered nursery schools only

Number - 13 different nursery schools from 332 schools in the Gauteng area

Age - 4, 5 and 6 year old children

Race - all races were included, namely white, black, coloured and indian children

Sex - both sexes were included, boys and girls

Children - no children with known disabilities were included in the sample.

2. LITERATURE REVIEW

There are no precise norms available for the development of cutting, as will be discussed in this section. The following areas were identified and will be dealt with in this chapter:

2.1 External factors affecting the development of hand function

2.2 The principles of development

2.3 The development of hand function

2.4 Bilateral integration on a fine motor level

2.5 Cutting skills

2.6 The importance of cutting in the development of children

2.7 The significance of cutting for the child with a learning disability

2.1 External factors affecting the development of hand function

Banus, Kent and Sukiennicky (1979) use the term neuromotor development in preference to motor development as it emphasises the correlation between intrinsic neural organisation, maturation, and visible motor development. Development takes place by the sensory-integrative-motor-sensory-feedback system. This indicates that development is not purely motor but is dependent on various intact sensory systems. For development to take place, a child requires his senses such as vision, touch, hearing and proprioception to feed back to the brain what is happening. The brain therefore does not only rely on the motor feedback but also on the sensory feedback and intact sensory integration in order to achieve a complete picture of a particular task.

Various other external factors also play a role in the development of the hand and the development of fine motor skills. These include culture; social aspects; cognitive function; visual perception; spatial analysis and planning; somatosensory awareness; visual regard; postural control; shoulder stability and

control; forearm, hand and finger control; integrity of the hand; range of joint motion; and muscle tone.

A child can only develop the hand if he is encouraged to do so. Cultural and social aspects can prevent a child from performing fine motor activities which would enable the child to progressively learn various hand grasps. The more a child is exposed to activities involving fine motor control, the more he will have the opportunity to become skilled at these.

Children that are cognitively impaired do not use their hands as much as children of the same age that are not cognitively impaired, as they do not have the understanding of what to use their hands for. The cognitively impaired child thus appears clumsy and is unable to perform various fine motor acts as he does not understand the tasks.

In order to use the hand effectively the child has to have adequate visual perceptual skills. All fine motor tasks require perceptual abilities such as form perception, visual discrimination, spatial relations, figure-ground concept, spatial analysis and planning.

Somatosensory awareness or kinesthetic awareness "*refers to the awareness (without vision) of where the body parts are in space and the position, force, and extent of their movement*" (Johnson Levine, 1991: 303). Without somatosensory awareness it is very difficult to hold a tool such as a pencil or a pair of scissors correctly, or to control the output without constantly visually monitoring this. One requires the sensory feedback in order to know if one is using the tool correctly, eg. pressing too hard or too softly. Somatosensory awareness allows us to develop a 'feel' for the correct output.

Fine motor co-ordination develops as the hand becomes more skilled and is

controlled by visual regard. A child that is unable to focus with his eyes on the activity struggles to perform any skilled hand functions.

Postural control is achieved in various positions such as standing, walking or sitting. It allows the child to work from a stable base, namely the trunk and neck, with the hands free for manipulative activities while the head is maintained in an optimal position for eye contact.

Johnson Levine (1991) states that it is very important to hold the shoulder joint steady so that the arm can be held in various positions while the forearm and hand are involved in activities. Once the child has developed shoulder stability he should be able to hold the arms loosely next to the trunk, without fixation, while performing fine motor activities. The elbow should not be pressed against the trunk for stability as this limits the movement of both hands involved in the activity. The stability should be achieved in the shoulder joint and not compromised and compensated by the elbow joint.

Forearm, hand and finger control and co-ordination can only develop once the child has learnt to stabilize at the shoulder. The child can then move the forearm and fingers and learn to develop skills. Initially the hand moves as a unit until the child has learnt to isolate the tripod fingers, that is the thumb, index and middle fingers, from the last two fingers, which are also known as stabilizers of the hand. These fingers provide the stability required for localized finger movements of the tripod fingers.

The hand can only develop adequately and to the optimum use if all parts of the hand are functioning correctly, including muscle control, range of motion and muscle tone. An imbalance in any of these results in difficulty controlling the motor output in a co-ordinated manner.

As the child matures, he learns to combine visual with fine motor skills; later he combines eye-hand co-ordination with visual perceptual skills and in conjunction with cognitive and social development the child can make use of these skills for complex activities. Refined hand movements are dependent on the combination of patterns of stability and mobility. The child has to learn to stabilize the upper arm including the shoulder, elbow and wrist; this allows him to move the fingers only. Independent movement and stabilization of the hand and fingers develop, which is necessary for complex fine motor tasks. Stability does not include locking of joints, or fixation. Stability includes a balanced control of the muscles around a joint in order to give the joint a stable base to work from.

2.2 The principles of development

Gesell (1950) noted various principles of development. The three principles of interest for this study are:

1. the direction of development
2. neuromotor or reciprocal interweaving
3. laterality or functional asymmetry

1. The direction of development is cephalo-caudal (head to tail) and proximal to distal (close to the body centre, moving outwards). This is also referred to as the gradient of growth.

In fine motor development the proximal-distal progression refers to the fact that scapulo-humeral control develops before fine hand function emerges. There is also a proximal-distal progression of development of skill within the hand. First there occurs palmar holding. This refers to holding objects between the hand and the fingers as a group. Then finer finger control emerges for the various grasps of objects. This includes holding objects using the fingers only, ie the palm is not involved.

Other gradients of growth include the development from mass movement to the

accomplishment of progressively more specific movements.
Finally there is ulnar to medial to radial control of objects in the development of grasp patterns.

2. Neuromotor or reciprocal interweaving
This second principle relates to the resolution of bilaterality. Here the child learns to use the arms symmetrically in an activity. Both arms are used for the same task for example clapping hands or pushing and pulling a toy with both hands.

3. Laterality or functional asymmetry
Once the child has learnt to use the arms symmetrically, he begins to use the arms discriminatively for different parts of an activity, eg. an object is stabilized in the one hand while the other is used to manipulate it.

2.3 The development of hand function

Pratt and Allen (1989) describe the development of the hand as follows: The child brings the hands together in the midline at three months of age and their approach to objects is initially bilateral.

The first grasp to develop is the *primitive squeeze grasp*. This does not involve the palm of the hand; the object may be pressed against the trunk or other hand while the object is being scooped up. The hand does not yet perform a real grasping action.

From here the *palmar grasp* develops at about 5 months. The object is grasped clumsily between the fingers and palm, without involving the thumb.

During the sixth month the *radial-palmar or whole hand grasp* develops. Here the beginning of opposition of the thumb emerges; together, fingers and thumb grasp

the object, ie the thumb is also involved in applying pressure to the object. The toy is approached by one hand and may be transferred to the other.

At 7 months the *manipulative and deliberate phase* begins. This includes picking up objects and altering the grasp within the hand, without dropping the object.

At 8 months the thumb envelopes the object pressing it towards the index finger; this is called the *scissor grasp.*

At 9 to 10 months the infant uses the *pincer grasp* securing the object between the tips of the index finger and the thumb.

Voluntary release begins at about 10 months only. Before this babies "*transfer objects from hand to hand, release them against a table top or inadvertently drop them*" (Gesell,1950 : 82). The baby thus releases the objects accidentally, when loosening the grip, or when the objects become too heavy.

At 12 months the child uses the *opposed or superior forefinger grasp* with the thumb opposed and the index finger predominating. The child involves mainly the thumb and the index fingers when picking up finer or smaller objects. Initially, the child uses a tabletop as point of stabilization. Later, the child no longer requires a surface as a point of stability but is able to control the hand function simply by using the upper limb and shoulder as a point of stability.

The child of one year has not yet established a dominant hand however he may already show a preference for one hand. The establishment of hand dominance takes place much later, when the child enters school at about five to six years of age.

Gesell states that

> *"the first five years of life are largely concerned with the elaboration of native reactions into a large variety of ς s and fine motor skills....Postural skills once acquired and mechanised not only permit greater freedom for adjustments to new situations but serve as an essential preparation for the development of the higher, more refined skills of later years"* (Gesell, 1950 : 65).

Cutting is not an inherent skill but it draws on acquired basic skills which have been learnt and perfected in order to develop this complex task.

2.4 Bilateral integration on a fine motor level

Bilateral activities are important in the development of children, as sensory and motor information is passed from the active hand to the opposite hemisphere of the brain, which assists in the integration of the two sides together. There are various degrees of bilateral integration, starting with symmetrical movements such as pushing or pulling toys. This is further upgraded to reciprocal movements and then to asymmetrical movements or differentiation of function, where the one hand does not do the same movement as the other hand.

> *"From age two years on, increased manipulative skills are seen in each hand (simultaneous manipulation); and although the dominant function may shift from one hand to the other, increased differentiation of function is seen when both hands are used together. The hand assuming the dominant role performs the finer manipulations, and the other hand assists by stabilising, positioning, or moving the object that is being manipulated or worked on. By around 2½ years, preschoolers are developing the ability to accomplish such activities as cutting with scissors and stabilising their paper for colouring, which require different controlled movements of each hand. As children develop, the functions of each hand become more separate and co-ordination becomes more refined, until the hands work together, each performing its part of the activity, to accomplish any bilateral task effectively"* (Johnson Levine, 1991 : 459).

2.5 Cutting skills

Cutting is a complex task and it requires a variety of prerequisite skills in order to carry out the movement. It involves postural control; normal muscle tone; shoulder stability and control; forearm, hand and finger control and co-ordination; kinesthetic awareness; visual perception; visual motor control; bilateral arm and hand use; spatial analysis and planning. These factors were all described in section 2.1 (External factors affecting the development of hand function). These factors therefore also affect the development of fine motor control and apply to cutting, which is a fine motor task.

> *"Scissor manipulation first involves shoulder movement and gross open-and-close hand motions. As children develop, stability increases at the shoulder, elbow, and forearm, until fine movements at the wrist, thumb, index and middle fingers control cutting, while the arm and the last two fingers are primarily held steady. The stability and mobility needed for finer, more efficient movement patterns develop steadily throughout the first four years of life"* (Johnson Levine,1991 : 215).

Johnson Levine (1991) states that if children are exposed to scissors they learn to grasp them, and open and close the whole hand to snip between ages 2 and 3. Looking at the direction of development, which is from proximal to distal, the child initially moves the shoulder to control in this case the positioning of the scissors. The forearm and hand still move as one unit as the child is not yet able to isolate movements.

In 3 to 4 year olds some isolation of movement develops and the child learns to move the wrist independently from the arm. This results in more control over the scissors and the child learns to keep them on the line.

In 4 to 6 year olds there is further isolation of movement; here the child uses finger and wrist movement to control the motor output.

At the age of 5 to 6, most children have developed the prerequisite skills for using fine movements. They can stabilize the upper arm, giving them a stable base from which they are able to work. Many, however, are still learning to move the arm and hand in an efficient way to control scissor movement.

A desired level of skill expected while a child is cutting is described in the following text. Johnson Levine (1991) does not distinguish between various levels of skill for different age groups and only presents the mature skill level. She says that the child should be sitting at a table with both feet on the floor. Scissors are held in the dominant hand which is placed in midposition with the wrist straight or slightly extended. The thumb is placed through the top loop of the scissors and the middle finger is placed through the bottom loop. The index finger helps to hold the scissors steady. The scissors are held loosely at the middle joints of the hand. The non-dominant hand holds the paper with the arm slightly in supination.
The cutting action should be smooth and rhythmical and the child should be able to adjust the speed of the arm movement to the snip size. Further, the child should be able to adjust the wrist to the line/curve that he is cutting. The elbow remains next to the trunk while the hand adjusts to the cutting action.

Johnson Levine (1991) has commented on the correct positioning and cutting action required, once the skill of cutting has developed. The response described above, therefore only applies to children that are able to cut well and that have practised the skill and perfected it. No norms for different ages are given and only the end-product of the perfected action is described, rather than the process of development.

The following description refers to an undesired response and serves to make the observer aware of undeveloped skills:

> *"Child's dominant elbow goes up in the air as the upper arm moves to align scissors with the line direction, while nonpreferred hand holds*

paper without movement. Child does not stabilize the paper, or stabilizes ineffectively with assisting hand" (Johnson Levine, 1991 : 482).

"Child raises elbow or moves wrist during cutting. Child moves paper to avoid forward arm movement. Snipping movement is jerky and snip size varies. Paper rips due to poor control or because child moves arm forward too fast for the size of the snip" (Johnson Levine, 1991 : 290).

Here Johnson Levine (1991) has described responses that are still immature but simply refers to these as poor skills. She does not differentiate between responses for various age groups. As will be seen later, some of these responses are acceptable and normal for certain age groups.

2.6 The importance of cutting in the development of children

Many studies have been carried out on the various stages of human development. These are broad and include the following aspects: Motor, Speech and Language, Social, Psychological and Cognitive development. Motor aspects are generally defined by gross and fine motor co-ordination. Cutting is a bilateral task of the fine motor sphere and should therefore also be studied when considering the motor development of a child.

When looking at the development of babies, it is the whole development one is interested in, not just specific skills. Against this background cutting skills should be viewed and understood. Cutting skills can be used to indicate the level of development of fine motor skills for that particular child. They add to the completeness of a persons fine motor development.

Various studies include looking at the development of hand grasps, especially holding a tool such as a pencil. This can be extended to holding a tool such as a pair of scissors.

2.7 The significance of cutting for the child with a learning disability

Banus states that "standardized tests provide normative data on specific behaviour of a specific population" (Banus 1979 : 175). The occupational therapy treatment begins with the statement of the child's specific difficulties; progress is monitored and finally the discharge is planned.

Children with learning disabilities may have difficulties with gross motor and/or fine motor co-ordination. Impairment in the fine motor sphere is significant as it affects the child's ability to do manipulative hand tasks, which are required in everyday life. Educationally, this impact can clearly be seen in handwriting. The child with fine motor problems often cannot finish his tasks in class. (Fisher, Murray and Bundy 1991)

Poor bilateral integration is evident in the fact that disabled children struggle in the following areas, including co-ordinating the two sides of the body, possibly left-right confusion, avoidance of crossing the midline of the body and failure to develop a more skilled or preferred hand.

Bilateral integration can be tested, looking at for instance ball skills, skipping or jumping jacks in the gross motor sphere. In the fine motor sphere, tasks such as stabilising the paper while drawing or writing on it, or threading beads are used to evaluate bilateral integration. Cutting can also be used as a valuable tool to evaluate bilateral motor co-ordination.

3. RESEARCH METHOD

3.1 Aims of the study

The aim of this study was:

- to analyse cutting skills in South African children aged 4 to 6;
- to establish trends in the development of cutting skills in South African children aged 4 to 6;
- to provide guidelines for therapists to assess children's cutting skills and to evaluate them against the performance of other children in the same age group.

3.2 Study design

A descriptive research study was used in which the ability and quality of cutting at different ages was analysed and described. This included accuracy, speed and motor components of the cutting skills for children aged four, five and six years.

- Accuracy - The accuracy score was given as a percentage score. All the scores of children from the same age group were added together and a Mean and Standard Deviation calculated.
- Speed - The speed was also given as a mean score per shape cut out in each age group.
- Motor components - Motor components were described in the observation sheet (see appendix A1) and a trend established.

This information has practical implementation possibilities as it can be used in the field of paediatric occupational therapy as a tool in the assessment of manual

dexterity in children. Cutting will give an indication as to the development of fine motor control as well as the use of both sides of the body in a co-ordinated manner. The child that is being tested can be compared to other children of the same age group, thereby establishing how accurately the child is cutting, how he approaches the task, that is if he uses the mature or immature approach, and how fast the child is able to work.

3.2.1 Population

The *population* in this case included all normal children between the ages 4 years 0 months (4;0) and 6 years 11 months (6;11), attending any of the 332 T.E.D registered nursery schools in Gauteng. A list of these 332 schools was forwarded to the researcher by the T.E.D. (see appendix A3). The schools were divided into the various regions including the West, South West, Central, South, North East and North West.

From this population a *sample* was selected.

3.2.2 Sample

i) Selection of schools

Firstly, the schools were divided into five categories, namely schools for predominantly black children, coloured children, indian children, white children and mixed groups. The grouping of schools was done according to the area in which the school was situated, in order to increase variation of subjects and to ensure an equal spread over the socio-economic and racial spectrum. Schools in each category were numbered and placed in separate 'hats' from which they were drawn at random by the researcher. In this way there would be an equal number of the various schools in the sample. Three schools were selected out of each category, including the black, coloured, indian and white categories and two schools were selected from the mixed category.

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The schools selected were approached and asked if they would participate in the study. In the case where a particular school refused to participate, another school was drawn at random from the required category.

Fourteen schools were drawn from the 'hat' and were initially approached and planned to be seen within the two-week time period set aside by the researcher. The researcher planned to see 14 schools, testing 15 children in each school. The total of 210 children would make up a large enough sample for statistical purposes. The researcher planned to see 2 schools per day, starting at 8h00 at the first school and assessing until 10h00. Assessment of the second school started at approximately 10h30 until 12h30. This gave the researcher approximately 120 minutes at each school. It was felt that 15 children could be assessed in this time, allowing 8 minutes per child. This assumed that the children assessed would be seen immediately one after each other. One school cancelled on the day of the assessment and therefore only 13 schools participated in the study. When visiting the schools, the following was found:

- 5 of the schools had white children,
- 2 of the schools had indian children,
- 2 of the schools had coloured children and
- 4 of the schools had black children.

After selection, one of the multiracial schools and one school that was classified as a coloured school, turned out to have predominantly white children resulting in a surplus of white children. The other multiracial school turned out to be mainly for black children, resulting in four black schools being included. One of the indian schools cancelled on the day, resulting in only two indian schools being included in the sample data. Due to time limitations, it was not possible to substitute another school in its place.

ii) Selection of children in general

Criteria for the inclusion of children in the study were as follows:

- Age - the three age groups to be considered were 4;0 to 4;11, 5;0 to 5;11 and 6;0 to 6;11.
- School going - children had to attend a T.E.D. registered nursery school in Gauteng.
- No disabilities - children should have no known learning or physical disability.
- Nursery school consent - the principal of each nursery school had to agree to participate (see appendix A6).
- Consent from parents - parents were asked individually for signed consent for their children to participate (see appendix A2).

iii) Selection of children from the class

Class teachers of the selected schools were asked to select the children from their classes according to set rules:

- the children were to be selected according to a prescribed criteria and teachers were asked specifically NOT to choose their own candidates as this would affect the randomness of the study. The researcher was, however, not able to control this and had to rely on the discretion of the various nursery schools;
- the class lists of the three different age groups were to be divided into boys and girls so that an almost equal number of boys and girls could be selected. (As the overall group contained 15 children, it would not be possible to have an equal number of boys and girls from each school);
- every second child on the list of boys and that of the girls

was asked to participate and only up to five children per age group were included. Thus 2 to 3 boys and 2 to 3 girls were asked to participate per age group;

- as not all nursery schools had children in the 6;0 to 6;11 age group at the time of the assessment, teachers were asked to add more children from the 4;0 to 4;11 and 5;0 to 5;11 age groups, so that a total of 15 children could be seen per nursery school;
- once selected, the child's parents were asked for consent and required to complete a consent form. This was done by the principal of each school;
- children whose parents did not consent were excluded from the list and the following child on the class list was then included in the sample, after receiving the parents consent.

3.2.3 Research Tool

The test used for this assessment consisted of various parts:

- Seven shapes (see appendix A4) were graded from shape 1 (easiest) to shape 7 (hardest), starting with the straight line, square, triangle, semi-circle, circle, spiral and finally the crown. Different line thicknesses were used for the different age groups, namely, 3mm for age group 4;0 - 4;11, 2mm for age group 5;0 - 5;11 and 1mm for age group 6;0 - 6;11.

  The line thickness was decided upon before the actual assessment. A small pilot study was carried out in order to establish if these tasks were appropriate for the various age groups (see pilot study).

- One pair of scissors for right-handed children and one for left-handed children were used. The scissor length was 13 centimetres and the loops were ovals, with a length of 2,5 centimetres and a width of 1,8 centimetres.
- An observation sheet or qualitative questionnaire (see appendix A1) was filled out while the child was cutting. Questions were in Yes/No format and included the topics of scissor grip and cutting motion. There were 22 questions in total. The researcher used two different coloured pens (blue and red), in order to answer the questions. Initially the child was observed and the questions were answered as Yes or No. This was done using the blue pen. Once shapes became more complex, it was noted that the child's actual quality of cutting declined and therefore some answers that had previously been answered by a Yes, now were answered by a No.

  As soon as there was a decrease in performance in cutting, the red pen was used on the observation sheet and a note was made from which shape onwards the child used this approach to cutting. A five-year old child, for example, usually was able to place the elbows relaxed next to the trunk while cutting, yet if the task became more complex and required more skill, the same five-year old child would abduct the arms at the shoulder in order to cut out for example the spiral. The same question (i.e. does the elbow remain next to the trunk), therefore initially was answered with a 'Yes', but as the task became more difficult it was answered with a 'No'. From the shape that

was more difficult for that particular child, which required more skill and therefore showed a poorer quality of execution, the red pen was used in order to answer questions.

3.2.4 Measurement

The *measurement* included three parts -

1. Accuracy

   The accuracy with which the child was able to cut on the line was calculated and converted into a percentage score.

   To determine the accuracy of cutting, a line measure was used, which is a tool that is used to measure the length of a curved line. The length that the child cut off the predrawn line was measured. The wheel of the line measure was placed on the black line from where the child stopped cutting on the black line, and then moved along up to where he cut on the line again (i.e. the distance on the black line was measured where the child did not cut on the black line). As the line measure was moved along, the wheel turned, giving an accuracy score in centimetres (cm). If the child cut on the line all of the time, the line measure score was 0 cm, as no part was off the predrawn line and no distance was measured.

   To convert the accuracy score in cm to an accuracy percentage score the following methodology was used:

If the shape to be cut was a 12 cm straight line and the child cut off the line for 4 cm then the accuracy score would be 8 cm (i.e. total length of shape (12cm) minus the line measurement (4cm)). The percentage could then be calculated by dividing the accuracy score (8cm) by the total length (12cm) and then multiplying the result by 100. In this example the percentage score would be 66,6%.
A percentage score of x,5 was rounded down and a percentage score of x,51 was rounded up.
In this example the score would therefore have been noted as 67%.

The percentages of the various children were then compared to each other and a mean percentage per form per age group was established.

If a child stayed on the line all the time, he cut with 100% accuracy. If he cut off the line half the time, his accuracy score was 50%, and if he did not cut on the line at all he scored 0%.

In Summary: The actual shape length minus the length deviated from the line was converted to a percentage score.

See appendix A5 for scoring instructions.

2. Speed

The time required to cut out the individual shapes was taken using a stopwatch from the time the child started

cutting the shape until the child completed the task. Each shape was timed separately. The child was not aware that he was being timed, as the researcher did not want the child to compromise his accuracy due to speed.

3. Motor component

   A qualitative observation form was filled out while the child was cutting out the seven shapes (As discussed earlier).

3.3 Analysis of data

The following methods of data analysis were used namely:

3.3.1 Descriptive statistics

3.3.2 Analysis of cutting skills

3.3.1 Descriptive statistics

Initially results were plotted on graphs, comparing the individual percentage scores of the various age bands. This method, however, proved to be unsatisfactory as the data did not distribute normally on a bell-shaped curve. It had been expected that most children would perform in the average range, and only a few scoring either towards 100% and 0%. This, however, was not the case at all, and often an inverted bell-shaped graph was found. Many children scored either very poorly, or very well. The scores overall seemed to be very scattered. There was no trend that could be established in all shapes for all age groups and therefore this method was abandoned.

Descriptive statistics were then used in this study in order to organize, summarize

and describe quantitative information.

Firstly, the mean, standard deviation, minimum/maximum ranges and percentiles were calculated. The mean is a measure of central tendency and describes where the values of the distribution clusters. The accuracy scores of each shape of all children were converted into percentage scores. The percentage scores were then added together, keeping the three age groups separate, in order to obtain a mean score for each of the seven shapes.

The standard deviation (SD) is a measure of variability. If the distribution is bell-shaped then 68% of the values are within 1 SD of the mean and 95% of the values are within 2 SD from the mean. Even if the distribution is not bell-shaped, these percentages are fairly similar.

The range is the most simple form of variability and gives the difference between the maximum and minimum value.
Further, percentiles were worked out and used in the discussion of the data. Percentiles allow us to describe a given score in relation to other scores; it therefore tells us the relative position of that particular score and indicates the number of scores less than that given score.

Secondly, the time scores in seconds for the various shapes and age groups were added and again the mean and minimum and maximum scores were calculated for the various shapes.

3.3.2 Analysis of cutting skills

The main aim of the study was to determine the method used by different aged children to carry out a cutting task. The observation sheets were completed for

this reason. The approach to cutting was compared for the various age groups. The Yes/No scores were added up and converted into percentages in order to establish a trend for the various motor aspects used in cutting. Once this was established it would be possible to recognize a trend used from 4 years through to 6 years. Further, one would be able to construct a standardized cutting tool for therapists to use in practice.

3.4 Method of collecting the data

Initially the researcher made contact with the various schools, explaining what the study entailed, as well as the possibility of carrying out the research at that school. Appointments were then set up at the various schools ensuring that two different schools were visited per day. The following schedule was set up and adhered to as far as possible.

Table 3.1 Assessment Timetable

Monday 5 June 1995 to Friday 9 June 1995

	Monday	Tuesday	Wednesday	Thursday	Friday
8h00 - 10h00	Roosevelt	Coronationville	Floc Pre-school	Parktown North	Nur-ul-Islam
10h30 - 12h30	Melville	Hamilton	Kiddycare	Parkview	

Monday 12 June 1995 to Wednesday 14 June 1995

	Monday	Tuesday	Wednesday	Thursday	Friday
8h00 - 10h00	JHB Muslim	Kammaland	Jabulile		
10h30 - 12h30	Greenhouse				

In the consent form no indication was given as to what the assessment involved and therefore cutting skills were not practised prior to the date of assessment. Parents were merely asked if their child could participate in a fine motor activity.

Before the evaluation, general information was recorded on the checklist including sex, date, age of the child and the name of the school. Each child was tested individually.

The child was timed while cutting out but no emphasis was placed on timing. While the child was cutting out, the observation sheet was completed by the researcher. This included qualitative statements about how the child was doing the task.

See appendix A7 for standardized words used in the assessment.

3.5 Evaluation instrument

Initially, eight shapes were chosen for children to cut out. These included the straight line, square, triangle, semi-circle, circle, spiral, crown and a bear. The researcher chose these forms for the following reasons:

Firstly, the shapes had to become progressively more difficult, as the aim was to analyse the development of skills used for cutting. Therefore, the child should start off with a task that was simple and then progress to a more complex task, so that the researcher was able to establish the cutting approach used by children. The researcher would be able to observe the mature approach used for simple shapes, as well as a decline in approach for more complex shapes. By using progressively more difficult shapes the researcher would be able to establish which shapes are more difficult for children, just by observing their cutting approach.

Secondly it would also be possible to establish which shapes are easier to cut out. Thus shapes had to include straight lines, corners and curves. The shapes initially were ordered in the expected progressive level of difficulty.

Prior to the research packages were sent to the various schools, including a covering letter for the principal (see appendix A6) as well as the 15 consent forms (see appendix A2).

3.6 Pilot study

The pilot study was carried out three months before the actual study. Five children, not included in the sample, were tested, in order to evaluate the instructions as well as the shapes. All children were given the same shapes to cut out, no matter how old they were; (i.e. the 1 mm line thickness was the same for all of them). This was the thickness that was used in the research assessment for 6 year old children. It was then decided to change the line thickness to 2 mm for 5 year old children and 3 mm for 4 year old children, as it was felt that a line thickness of 1mm would be too difficult for them. This was then again tried on a 4 year old child, to find out if the thickness was appropriate.

During the pilot study, it was decided to leave out the bear, as the crown already represented a shape, which included straight lines, corners and curved lines.

During the pilot study, it was found necessary to fill out the observation sheet with two different coloured pens as it was noted that generally children changed their approach to cutting once the task became more complex. On the observation sheet a blue pen was used to fill out the first few shapes (generally up to shape four or five) and a red pen was used to fill out the more complex shapes. The answer to any question on the observation sheet could therefore be Yes or No, for example "are the elbows placed loosely next ot the trunk" could be Yes when cutting out a simple shape such as the straight line. It could however, also be a

No when cutting out the spiral. It was felt that one needed to differentiate the cutting approach when the task became complex for the child.

4. RESULTS

The results will be discussed under the following headings:

4.1 Statistical analysis of accuracy scores

4.1.1 Descriptive statistics including mean, standard deviation, minimum and maximum scores

4.1.2 Percentiles

4.2 Observation sheets

4.3 Time factor

4.1.1 Descriptive statistics of data collected

The accuracy which was measured in centimetres (cm) was converted to obtain a percentage score. A score of 0 cm line measurement represented a score of 100%, as the child was very accurate and did not miss the line at all while cutting. Tables 4.1, 4.2 and 4.3 below, give an overview of how children performed for cutting out the various shapes. The minimum and maximum range was given for each shape. Further, the mean per shape was calculated as well as the standard deviation. In order to obtain the mean, all the percentages of one particular shape of one age group were added and divided by the number of children participating.

The three age groups were analysed separately as the line thicknesses used in the evaluation were different and scores would therefore not be comparable.

Children were then grouped into the individual schools and results compared in the tables.

Cutting analysis of the three age groups

Age Group 4

The sample size varied for the different shapes, as not all children cut out all seven shapes. All of the children completed Test 1, the straight line. There were 61 children that were tested in this age group. More and more children were not able to participate as the assessment progressed, and only 51 children participated in Test 7, the crown. All children were presented with all the shapes but some did not cut out all of them. Some 4 year old children simply refused to complete tasks or attempt some of them and they were not forced to do so.

Table 4.1 Percentage scores for 4 year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
Sample Size	61	58	58	57	52	51	51
Mean	64	57	58	52	41	43	51
SD	37	35	34	32	31	27	33
Minimum	0	0	0	0	0	0	0
Maximum	100	100	100	100	100	100	100

From the mean the actual order of difficulty of the seven shapes can be established. For the four year age group the straight line was the easiest to cut out. This was followed by the triangle, then the square, the semicircle, the crown, the spiral and finally the circle. The circle (shape 5) seemed to be the most difficult shape for 4 year old children to cut out. The researcher expected the crown to be the most difficult shape to cut out but it appeared that the score improved as the children were able to cut out the straight parts of the crown. In the circle, for example, there is only a curved path, which proved to be more difficult for the children.

The standard deviation was rather high for all of the tests. This was due to the fact

that children were able to score from 0% - 100 %, giving a large range of scores. The minimum score obtained for all tests was 0%. For every single shape there were children that were not able to cut on the line at all. The maximum range obtained was 100% for most shapes, except for the spiral and the crown where it was 93% and 98% respectively. For all of the shapes there were children that were able to stay on the line most or all of the time. This range was rather large, indicating that the ability to do these tasks was variable among the different children.

Age group 5

Here the sample size remained constant at 79. All of the children completed all seven tests.

Table 4.2 Percentage scores for 5 year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
Sample Size	79	79	79	79	79	79	79
Mean	65	58	61	54	37	38	45
SD	36	33	29	27	27	26	28
Minimum	0	0	0	0	0	0	0
Maximum	100	100	100	100	100	100	100

The mean was used to indicate the order of difficulty of the shapes. For the five year age group the straight line was the easiest to cut out. This was followed by the triangle, then the square, the semicircle, the crown, the spiral and finally the circle. The circle (shape 5) appeared to be the most difficult shape for children to cut out. This was the same order as for the four year age group.

The standard deviation was rather high for all of the tests. This was due to the fact that the children involved scored anywhere from 0% - 100 %, giving a large range of scores. The minimum score obtained for all tests was 0%. For every single

shape there were children that were not able to cut on the line at all. The maximum range obtained was 100% for most shapes, except for the spiral where it was 96%. For all of the shapes there were children that were able to stay on the line most or all of the time.

In the five year age group there was again a large range in performance, extending from 0% to 100% for most shapes. Again this indicated a big difference in skill, some children being able to cut accurately, whereas others not being able to do so at all.

Age group 6

Here the sample size remained constant at 27. All of the children completed all seven tests.

Table 4.3 Percentage scores for 6 year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
Sample Size	27	27	27	27	27	27	27
Mean	61	61	59	53	37	42	44
SD	34	26	24	21	23	25	23
Minimum	0	0	0	6	5	5	0
Maximum	100	100	97	87	92	86	97

The mean was used to establish the order of difficulty. For the six year age group the straight line and the square were the easiest to cut out. This was followed by the triangle, then the semicircle, the crown and finally the spiral and then the circle. The circle (shape 5) seemed to be the most difficult shape for children to cut out. The order of difficulty varied slightly from the other two age groups; firstly the square seemed to be as easy to cut out as the straight line, and secondly the triangle seemed to be slightly more difficult than the square.

The standard deviation was rather high for all of the tests. This was due to the fact that the range of scores was between 0% and 100 %, giving a large selection of scores. The minimum score obtained for all tests ranged from 0% to 6%. For most shapes there were children that were not able to cut on the line at all. The maximum range obtained was between 86% and 100%. Children were able to cut on the lines fairly accurately for all shapes.

In the six year age group the range of performance was slightly less than for the other two age groups but at times it still varied from 0% to 100%.

Cutting analysis of the individual schools per age group

In Tables 4.4, 4.5 and 4.6 the children are grouped into the various schools, keeping the age groups separate. The various schools are listed in the first column, using their initial letters and the number of children tested per school are indicated in the second column. Each shape was cut out and a percentage was calculated in order to establish how well the child cut on the line. The mean scores are listed below. A figure of 100% indicated that the child cut on the line all of the time and a figure of 0% indicated that the children did not cut on the line at all.

Age Group 4

Table 4.4 Mean score results of various schools for the 4 Year age group

School	No. of Children	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown	Average
R	5	81.6	82.0	86.6	79.2	71.4	66.4	79.0	78.0
PN	7	91.0	80.3	77.4	76.4	58.6	57.9	84.3	75.1
P	3	97.3	70.7	67.7	50.3	42.0	56.0	61.3	63.6
M	4	88.5	73.5	78.2	54.7	43.5	43.0	55.7	62.4
N	5	77.6	60.8	63.2	50.6	26.2	35.8	51.8	52.3
JHB	5	50.6	59.6	74.0	72.6	15.4	27.2	30.8	47.2
K	6	60.3	42.2	55.3	44.2	44.5	30.2	30.0	43.8
F	6	30.5	48.0	41.2	47.0	32.8	44.8	33.3	39.7
C	4	28.0	50.5	48.5	44.5	36.7	25.7	37.7	38.8
KC	4	64.5	51.0	44.7	31.2	31.5	18.0	25.7	38.1
H	7	82.1	29.7	36.6	24.4	10.6	17.1	19.3	31.4
J	2	37.5	23.0	0	17.0	10.5	35.5	6.5	18.6
G	3	8.3	0	0	0	0	0	0	1.2

At School F, 6 children were tested, however one child did not complete test 6 and 7.

At School G, 3 children were tested; no children did test 2 to 7.

At School M, 4 children were tested, however one child did not do test 5 to 7.

At School KC, 4 children were tested, however one child did not do test 5 to 7.

At School H, 7 children were tested, however one child did not do test 4 to 7 and three children did not do test 5 to 7.

Scores where children had not completed the tests were taken at 0%.

The schools are listed in order, starting with the highest average and ending with the lowest average. The comparison of the mean scores gives an indication of how children from different schools completed the same tasks. When looking at the straight line, children from school P showed very accurate cutting ability (mean = 97,3%), whereas children from school G struggled to cut on the line (mean = 8,3%).

Age Group 5

Table 4.5 Mean score results of various schools for the 5 Year age group

School	No. of Children	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown	Average
R	5	72.4	79.2	87.4	67.8	45.4	48.6	56.6	65.3
N	9	73.7	74.1	81.7	72.0	41.3	51.0	53.4	63.9
JHB	6	76.3	70.0	68.3	62.5	57.0	46.5	63.0	63.4
PN	6	84.0	73.5	78.2	62.8	47.0	37.0	52.0	62.1
C	7	59.6	63.9	72.6	62.3	31.4	38.1	52.9	54.4
P	4	64.2	56.8	58.4	52.1	35.9	38.1	44.0	49.9
KC	6	84.2	55.0	46.0	50.7	37.8	40.5	31.7	49.4
F	3	55.7	79.7	59.7	48.0	23.0	31.3	22.7	45.7
K	4	66.7	56.5	38.2	39.7	24.7	42.5	47.2	45.1
J	7	56.6	48.0	35.7	48.9	29.0	29.7	58.1	43.7
M	7	57.1	42.3	45.0	42.3	41.7	31.9	33.0	41.9
G	8	50.6	33.9	58.4	44.6	22.0	19.5	28.0	36.7
H	7	52.4	30.7	36.9	29.9	17.7	30.0	32.6	32.9

The schools are listed in order, starting with the highest average and ending with the lowest average. The comparison of the mean scores gives an indication of how children from different schools completed the same tasks. When looking at the straight line, children from school KC showed good cutting ability (mean = 84,2%), whereas children from school G struggled to cut on the line for half the length (mean =50,6%).

Age Group 6

Table 4.6 - Mean score results of various schools for the 6 Year age group

School	No. of Children	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown	Average
P	4	97.9	79.0	74.2	77.2	51.0	58.0	58.2	70.7
M	1	100	54	68	69.0	58.0	79.0	66.0	70.6
R	3	69.3	75.0	71.7	71.7	50.0	56.0	48.7	63.2
KC	3	50.0	76.7	53.3	63.7	59.7	70.7	68.3	63.2
J	1	92.0	79.0	74.0	69.0	37.0	61.0	26.0	62.4
JHB	3	62.3	64.7	56.3	44.0	23.0	32.7	41.0	46.3
K	8	49.5	57.4	47.4	42.5	27.2	25.2	40.2	41.3
PN	1	42.0	37.0	55.0	56.0	18.0	18.0	40.0	38.0
C	2	46.0	21.0	43.5	15.5	23.5	20.5	15.5	26.5
F	1	0	0	84	25	11	11	6	19.6
H	0	No 6 year old children							
G	0	No 6 year old children							
N	0	No 6 year old children							

The schools are listed in order, starting with the highest average and ending with the lowest average. The comparison of the mean scores gives an indication of how children from different schools completed the same tasks. When looking at the straight line, children from school M showed 100% accuracy in cutting ability, whereas children from school F struggled to cut on the line (mean =0%). In both cases only one child was tested. When looking at schools with more children, school P scored a mean of 97,9% when cutting the straight line. Children from school K struggled and only achieved a mean of 49.5%.

4.1.2 Percentiles

Further the researcher looked at the results in terms of percentiles (see appendix A8). Tables A8.1, A8.2 and A8.3 in Appendix A8 give the percentile score for each percentage score in the various shapes and age groups.

4.2 Observation sheet

The observation sheet looked at scissor grip as well as the actual cutting motion. It was completed by the researcher while the child was cutting out the various shapes. Two different coloured pens were used to fill out the observation sheet. Initially the child was observed and the questions were answered as Yes/No. However, once the shapes became more difficult for a child, the cutting approach regressed and became more unskilled and therefore some answers that had previously been answered by a Yes, now were answered by a No. This was then noted on the observation sheet using the red pen and a note was made from which shape onwards the child used this approach to cutting. The questions were asked in such a way that the Yes answers represented the positive or mature and desired response.

In table 4.7 the Observation sheet is summarized for all age groups, using percentage scores. This was done in the following way:
The total number of children that participated per test represented a sample of 100%. All the questions on the observation sheet were worded so that a Yes answer described the desired or mature response. If all of the children scored a Yes for one of the questions, then the percentage score for that particular question was 100%. For example, looking at age group 6, the total number of children participating was 27. If all 27 children scored Yes for a question, then the percentage score would be 100%. If only 15 out of the 27 children scored Yes, then the percentage score would be (15 / 27) x 100 = 55,6% or 56 %.

Table 4.7 Numeric Summary of the Observation sheet (given in percentage scores)

	4 Year Old Children			5 Year Old Children			6 Year Old Children		
	Test 1 - 3	*Test 4*	*Test 5 - 7*	*Test 1 - 3*	*Test 4*	*Test 5 - 7*	*Test 1-3*	*Test 4*	*Test 5 -7*
Thumb through top loop	99	100	100	100	100	100	100	100	100
Middle finger through bottom loop	69	72	72	73	73	73	63	63	63
Index finger helps to hold the lower loop steady	18	20	20	21	23	23	19	19	19
Loop rest near middle joints of fingers	52	58	58	53	52	52	44	44	44
Little and ring finger are in the stabilising position	73	78	78	90	86	84	89	89	89
Scissor grip is constant	75	78	78	85	81	81	93	85	81
Fingers are in flexed position	79	84	84	89	86	84	85	85	85
Wrist in slight (45 degrees) extension	11	12	12	25	25	25	26	26	26
Forearm is in midposition	87-90	61	33	92	56	37	93	63	56
Elbow is flexed at 90 degrees	100	100	100	100	100	100	100	100	100
Elbow not fixated against trunk	100	100	94	100	100	99	100	100	100
Scissors are held perpendicular to the floor	82-84	61	39	86	53	37	93	63	56
Non-dominant hand holds the paper in midposition	87-88	80	80	95	87	84	100	100	100
Paper does not tear	89-91	82	78	94	86	85	100	89	81
Cutting is rhythmical and smooth	44-47	29	25	76	53	44	89	59	52
Snip size remains constant	70	70	78	94	92	91	93	93	93
Controlled cutting i.e. no mass flexion or extension of fingers	62	67	67	86	82	82	81	81	81
Child closes scissors properly i.e. not just snipping	38	39	35	22	22	19	26	26	26
Wrist moves (slight adjustment) to maintain scissors on the line	0	0	0	1	1	1	19	19	19
Assistive hand manipulates the paper	81-82	51	42-41	96	62	48	100	67	52
Elbow remains next to trunk	39-41	35	27	39	23	10	56	19	15
No associated movements seen in tongue	64-67	48	48-47	72-73	65	57	81	67	63

The following trends were observed throughout the three different age groups. Specific differences between the various age groups will be looked at and compared in Chapter 5.

Scissor grip:

- 99% - 100% of the children held scissors with the thumb through the top loop.
- 63% - 73% of the children held a pair of scissors with the middle and index fingers through the bottom loop. 18% - 23% of those children held the index finger on the outside of the lower loop. 27% - 37% of the children held the scissors with the index finger in the bottom loop only, and the middle finger outside of the loop.
- 44% - 58% of the children had learnt to hold the scissors near the middle joints of the fingers, rather than close to the metacarpophalangeal joints (knuckles).
- 73% - 90% of the children held the little and ring fingers in a stabilising position. The other children still kept the ring and little fingers in an extended posture, which did not allow for stability of the hand.
- 75% - 93% of the children seemed to use a constant scissor grip, no matter how difficult the shape that they were cutting out.
- 79% - 89% of the children held the tripod fingers in a flexed position. The other children held their tripod fingers in the extended position.
- 11% - 26% of the children only held their wrists in extension. The other children still kept their wrist in neutral or in flexion.
- 87% - 93% of the children kept the forearm in midposition (between pronation and supination) when easier shapes were cut out. When cutting the more complex shapes, only 33% - 56% of the children kept their forearms in midposition. The other children reverted back to pronation of the forearm.
- All children flexed the elbow at 90 degrees.

- 94% - 100% of the children did not fixate the elbow against the trunk.
- 82% - 93% of the children held the scissors perpendicular to the floor, yet only when cutting out the easier shapes. This correlated with the forearm held in midposition. 37% - 56% of the children managed to keep the scissors perpendicular to the floor when cutting out more complex shapes. The other children turned the scissors, so that they were parallel, rather than perpendicular to the floor, .
- The non-dominant hand held the paper in midposition in 80% - 100% of the children. The other children held the paper in pronation, with the fingers at the top of the paper, rather than the thumb.

Cutting motion:

- 78% - 100% of the children managed to cut out shapes, without tearing the paper.
- Cutting was not yet rhythmical and smooth in the 4 year age group, ranging from 25% - 47%, depending on the difficulty of the shape. This improved as the children got older; in the 5 year age group 44% - 76% of the children cut rhythmically and smoothly and in the 6 year age group 52% - 89% of the children were able to cut rhythmically and smoothly.
- 70% - 93% of the children were able to maintain a constant snip size.
- 62% - 86% of the children tended to cut using controlled finger movement, that is no mass finger flexion and extension. This meant that children were able to cut, using the tripod fingers only, separating them from the stabilising fingers or the ring and little fingers.
- 19% - 39% of the children only closed their scissors properly. The others tended to snip, using only the back part of the blade.
- 4 year old children did not involve their wrist when cutting. They did not yet make adjustments at the wrist in order to stay on the line but rather adjusted the forearm. Only 1% of the 5 year old children involved the wrist

when cutting. 19% of the 6 year age group involved the wrist when cutting.

- 81% - 100% of the children manipulated the paper with the assistive hand when cutting out simple shapes. Only 41% - 52% of the children manipulated the paper with the assistive hand when cutting out more complex shapes. The approach became more static and children tended to move the 'scissor hand' in order to stay on the line rather than adjusting the paper.
- 27% -56% of the children had the elbow next to the trunk; the others still tended to abduct the arm at the shoulder so that the elbow remained in the air.
- 47% - 81% of the children did not show associated tongue movements. In all three age groups there was an increase in associated tongue reactions as the shapes became more complex to cut out.

4.3 Time factor

Table 4.8 Time scores in seconds for four year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
Minimum	6	12	16	9	5	6	14
Maximum	213	167	150	129	92	127	169
Mean	35	62	50	41	43	53	79

Table 4.9 Time scores in seconds for five year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
Minimum	6	7	17	14	16	22	26
Maximum	61	192	249	112	183	266	320
Mean	23	65	50	44	47	57	90

Table 4.10 Time scores in seconds for four year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
Minimum	10	25	19	15	13	24	24
Maximum	90	165	99	90	78	157	191
Mean	26	62	46	40	44	64	99

It should be noted that the seven shapes that were cut out were not all the same length; the difficulty between the shapes as well as the actual shape length varied. The child was timed while cutting, although no emphasis was placed on this aspect. For school children, accuracy is only of benefit if it is performed in a reasonable amount of time. This means that a child has to perform a task within the allocated time given in a class; this depends on the activity and the teacher generally uses the norm of the class as the time limit. That is, when most children have completed the task, that would be considered as the norm. A child therefore that can cut with 100% accuracy still struggles with cutting tasks, if he takes three times longer than a child that is able to cut with the same accuracy in a shorter time period.

It should be noted that the time scores for the three age groups cannot be compared as the children were cutting different line thicknesses.

In the following chapter the results will be discussed.

5. DISCUSSION

The results varied greatly and it was difficult to interpret them together. Variables included the home and the school environment. It was questionable at some schools whether children had actually held scissors in their hands before and whether they were exposed to cutting on lines. It was felt that some children did not understand the task of cutting on a line as they seemed to cut accurately next to it. If a child did this, cutting on a line was reinforced and the child was shown how to do this. This meant, that often the child did worse for the straight line than for the next shapes, which should definitely not be the case, as the straight line is the easier shape to cut.

The results will be looked at in two different ways. Firstly, each child will be looked at as an individual, and compared with all the other children in that age group. Secondly, the child will be looked at as part of a group, with the other children of the same school within the same age group, and compared to other schools. It is felt that cutting skills were affected by the exposure of the child to these skills, and therefore the children were also grouped, according to the school they were attending.

5.1 Comparison of individuals per age group

Children found the test more difficult than the candidate expected before start of the research project. The mean percentage accuracy when cutting out shapes was 60% or less most of the time; this included all age groups that were tested.

Comparing the guidelines available by Edwards (1987):

"3 years - manipulates scissors correctly, not yet cutting accurately on lines; cuts incisions."

The line thickness is not stated. 3 year old children were not tested in the study. It was, however, found that even older children such as 4-, 5- and 6-year olds did not always manipulate the scissors correctly, as will be discussed under the observation sheet.

"3½ years - cuts a circle with a pair of scissors, within 45 seconds - at least 3/4 of the circle is within 1 cm of line. Tries to cut a 9 cm square - the entire length of the line within 15 seconds."

Again the line thickness is not stated. It is also not clear, whether the child actually cuts on the line at all or just cuts next to the line. Even 4 year old children were found to struggle cutting out a square or a circle. The cutting time on average for the 4 year old child was 62 seconds for the square (24 cm) and 43 seconds for the circle (19cm).

Age group 4

Looking at the mean for shapes 1 to 7, the highest mean score obtained was 64% for the straight line. The lowest mean score was for the circle at 41%. The mean was certainly lower than expected, indicating that the skill needed for this task was not as well developed as one would have expected. The standard deviation was rather high for all of the tests, due to the fact that the scores ranged from 0% to 100%, which is a large range. '*The standard deviation indicates the spread of the scores that might be expected to encompass all the scores*' (Barrow & McGee 1971 : 79) for cutting performed by this group.

Comparing the guidelines available by Edwards (1987):

"4 years - can cut on a line with a pair of scissors; cuts out a square within 5 mm of the line."

The line thickness was not stated. Further, it was found that 4 year old children were not able to stay on a straight line (12cm) all of the time. Cutting out a square within 5mm of the line does not indicate whether the child cuts on the line at all, or

whether it constantly deviates. In the 4 year age group it was found that children were able to cut out squares (24cm) with 57% accuracy. This clearly states that a 4 year old child was able to stay on a 3mm line for 57% of the time.

"4½ years - cuts a square fairly accurately on lines within 45 seconds."

Again the line thickness was not stated, nor was the size of the square. It is also not very clear what 'fairly accurately' means. In the study it was found that the 4 year old child was able to stay on the square (3 mm line thickness and each side 6 cm length) for 57% of the time. On average the 4 year old child took 62 seconds in order to cut out the square.

Age group 5

Looking at the mean for shapes 1 to 7, the highest mean score obtained was 65% for the straight line. The lowest mean score was for the circle at 37%. The mean was certainly lower than expected, indicating that this task was not as well developed as one would have expected. The standard deviation was rather high for all of the tests. This was due to the fact that the scores ranged from 0% to 100%.

As the shapes were 3mm in thickness for the 4 year age group and 2mm in thickness for the 5 year age group, the results are not directly comparable. The line thickness was decreased for the 5 year age group. Looking at the mean, however, this seemed to be very similar for all of the shapes of the two age groups. One could, therefore assume that the level of difficulty of the cutting task was increased and correlated to the increased level of skill from one age group to the next. This meant that the shapes that were cut out in age group 5 appeared to be as difficult for the 5 year old child as the shapes of the 4 year age group were for the four year old child.

Comparing the guidelines available by Edwards (1987):

"5½ years - cuts more difficult corners and circles."

It does not clearly state what is meant by 'more difficult corners'. The shapes with corners that were used in the study included the square (24cm), triangle (19 cm) and crown (31cm). It was found that the 5 year olds cut with 58% accuracy on the square, 61% accuracy on the triangle and only 45% accuracy on the crown. The line thickness for the 5 year age group was 2 mm for all shapes. The semicircle (16cm), circle (19cm) and spiral (28cm) were also used in this study; here the 5 year olds were found to cut with 54% accuracy for the semicircle, 37% accuracy for the circle and 38% accuracy for the spiral.

These shapes were also used for the 4 year old population, yet with slightly thicker lines (3mm as compared to 2mm) and it was noted that the 4 year olds coped fairly similarly with these shapes when looking at the percentage accuracy.

Age group 6

Looking at the mean for shapes 1 to 7, the highest mean score obtained was 61% for the straight line and the square. The lowest mean score was for the circle at 37%. The mean was certainly lower than expected, indicating that this task was not as well developed as one would have thought. The standard deviation was rather high for all of the tests. This was due to the fact that the scores ranged from 0% to 100%.

Again, one cannot directly compare the results to age group 4 and 5, as the line thickness was further decreased for this age group. Looking at the mean scores for these seven shapes, it became evident that they were very similar to the mean scores of the other two age bands. Again, it could be assumed that the increased level of difficulty was absorbed by the increase in age. The task therefore was as difficult for the six year old child, as the tasks were for the four- and five year old children.

Had the line thickness not been adjusted and simply been left the same, one

would have expected an increase in performance from the four- to the five- to the six year age group.

5.2 Comparison of schools per age group

There was a big range of scores obtained within the various age groups. It was felt that cutting was not an inherent skill and the ability to carry out cutting seemed to be dependent on the exposure to this task. So, although some children may have learnt other bilateral tasks such as dressing, eating with knife and fork, stabilising the paper with one hand while working on it with the other, they may not have been exposed to cutting. This seemed to be a learnt skill and can only be perfected if exposed to it and practised. Looking at the factors described in the literature review, there were various external forces that affect the development of the hand, for example culture or social aspects. Although all of the children that were tested were going to nursery school, they were still very much affected by their home environments. Some children may not have a pair of scissors and paper readily available to them and are unable to experiment with these. Scissors may only be used at school. Yet at school, there were also different expectations and different schools spent different amounts of times on cutting. Further, some schools may just do cutting around the picture whereas others actually reinforce cutting on a line. Other factors mentioned in the literature review included cognitive function, visual perception, spatial analysis and planning, somatosensory awareness, visual regard, hand and finger control, integrity of the hand, range of motion and muscle tone. These factors were not considered further and it was assumed to be similar for all of the children. For the purpose of this study, the researcher did not take these factors into account. Children that were tested had, however, no obvious physical disabilities or poor cognitive functioning.

Age group 4

The minimum range of each cut out shape was 0 %. The maximum score varied from 93% for the spiral, to 98% for the crown to 100% for all other shapes including the straight line, square, triangle, semicircle and circle.
Throughout testing it was felt that the average was lowered by those children that did not seem to have handled scissors before. Scores were therefore also looked at separately, grouping the children of each school together.

When looking at these results it became apparent that some schools did not seem to use scissors in their curriculum. The school with the best average of all seven shapes was school R, then school PN, followed by School P. The schools with the weakest scores were school G, J and H. School G and H also obtained the lowest score for age group 5. In school G for example, the children did not seem to know how to operate the scissors and therefore tasks were not completed and children scored 0%. Further, children may also have been exposed to cutting around a picture rather than cutting on a line, which would decrease their understanding as well as their ability to do so.

Depending on the exposure of a child to cutting as well as readily using this skill, the results varied greatly. If a child had been exposed to cutting, his ability could be compared to that of school R, PN or P. If a child was not exposed to scissors at home, his ability could be compared to schools G, J and H.

The range of all the mean scores varied from 1.2% to 78.0%. This was a large difference in skill and it appeared to make a great difference, how much the child practised cutting skills at home and in school.

The researcher expected a decrease in performance over the seven shapes, with the best score expected with the straight line, followed by the square, triangle,

semi-circle, circle, spiral and finally the crown.

Improvement from cutting a straight line to cutting a square and/or triangle, as seen in four schools, could be due to initial anxiety, as the straight line was the first that was cut out. Often, however, the task of cutting on the line needed to be explained again once the child had cut out the straight line, to make sure that he understood the task correctly.

Six of the schools performed better when cutting out the triangle, whereas six schools performed better when cutting out the square. This meant that these tasks were equal in terms of level of difficulty. In eight schools, the level of difficulty of cutting out the square and triangle were in second and third positions. The next shape in the level of difficulty seemed to be the semicircle, followed by the crown.
Last, the circle and spiral, seemed to be at the same level of difficulty.

When looking at results per age group, rather than grouped into schools, the following order of difficulty was found:
The straight line was cut out best with an average of 64%, followed by the triangle with 55%, the square with 54%, the semi-circle with 49%, the crown with 42%, the spiral with 36% and finally the circle with 31%.

Age group 5

The three best schools were School R, N and JHB. The three schools with the weakest scores were School H, G and M. In the 4 year age group school R also had the best results. School, P and PN were second and third best in the 4 year age group. Of note is the fact that the averages of the various schools were closer together than in the 4 year age group, with a range from 32.9% to 65.3%. Compared to the 4 year age group, children now seemed to be functioning at a

more constant level. This could be due to the fact that by the age of 5 more nursery schools had included cutting skills in their programme. It could also just be the normal development of bilateral tasks and the ability of children to be able to use a pair of scissors.
There were five schools, where the results of the square and/or triangle were better than the straight line. In eight schools, the performance of cutting the triangle was better than the square. It seemed that for this age group the task of cutting out a triangle was done better than cutting out the square.

The next shape in the level of difficulty was the semi-circle, followed by the crown, as in the four year age group. In this age group, performance was better for cutting out the spiral when compared to the circle. The circle, thus seemed to be the most difficult shape.

When looking at results per age group, rather than grouped into schools, the following order of difficulty was found:
The straight line was cut out best with an average of 66%, followed by the triangle with 62%, the square with 59%, the semi-circle with 55%, the crown with 46%, the spiral with 39% and finally the circle with 37%. These are in the same order as for the four year age group.

Age group 6

Schools with the three best results included School P, M and R/KC. School F, C, and PN did not do that well. One should, however, take into consideration the number of children tested. In School PN for example only one child of this age group was seen, which therefore was not representative of the ability of cutting skills at that school. In fact, School PN did well for the 4- and 5-year age group. This child could therefore have been one of the weaker children at that school. As the 4 and 5 year age groups did well, it can be assumed that School PN did cutting

in its curriculum and that generally the children learnt this and carried it out competently.

If one disregarded those schools where only one child was tested, then the school with the best results was P and the school with the weakest results was C. Schools H, G and N did not participate as they had no six year old children.

The range of mean scores of all tests varied from 19.6% to 70.7%. At age group 6 one would expect mean scores to fall within a smaller range, the reason being that by age 6 the children should have been exposed to the skill of cutting for a longer time period. The variation in this skill should thus decrease.

In six schools, the performance was better for either the square and/or the triangle as compared to the straight line.
Six schools performed better when cutting out the square, whereas only four schools performed better when cutting out the triangle. For the six year age group, the square seemed to be easier. The next shape in the order of difficulty was the semicircle, followed by the spiral, the crown and finally the circle.

When looking at results per age group, rather than grouped into schools, the following order of difficulty was found:
The straight line and the square were cut out best with an average of 61%, followed by the triangle with 59%, the semi-circle with 53%, the crown with 44%, the spiral with 42% and finally the circle with 37%. These were similar to the four and five year age groups, except that the square was cut out better than the triangle and was on a par with the straight line.

When comparing the schools of all three age groups to one another, it is clear that school R on a whole did very well in all three age groups. Twice, [illegible] from

school R performed the best and in one age group they were third best. Other schools that did well and were represented at least twice in all three age groups within the first five schools included school P, school M, school PN and school N. Schools that generally did not do that well included school G, H, J, C and K.

5.3 Observation sheet

It was felt that the observation sheet was necessary as not only the end result was important but also the quality of execution of the task. This also gave an indication of the way in which cutting skills developed as children seemed to use a varying approach to cutting; the approach seemed to be more mature when the task was easier and more unskilled when cutting out a complicated shape.

The development of the cutting execution was looked at during the assessment of the children. It became evident that children did not only use one style of cutting but tended to revert back to more immature cutting skills as the task became more demanding. All of the children used a more mature cutting approach for shape 1 (straight line) as compared to shape 5 (circle).

It was also noted that not all skills were fully integrated by the time the child was 6 years of age. It was felt that cutting skills were fully integrated when the child did not revert to a more immature method of cutting, even when the shape became more complex to cut out. Further, it should be noted that not all children necessarily needed to go through the same steps of development but that this was simply a trend that one could observe in the normal population.

The results of the observation sheet, which included Yes/No answers were added up and converted to percentage scores. For the four year age group the range of participants decreased from 61 to 51 children.

Not all four year olds completed all tests, as some of them refused to carry on

cutting after a while. Children that refused to carry on were not pressured into doing the tasks. They were asked to watch another child, in the hope that they might carry on participating, but this was not the case. 61 children started off with the tests, 58 children completed test two and three; 57 children completed test 4; 52 children completed test 5 and 51 children completed test 6 and 7.
In the 5 year age group 79 children participated in all 7 tests and in the 6 year age group 27 children completed all 7 tests.

The following is a summary of the development of the cutting skills that were observed in the children.

Age group 4

In the four year age group there was an improvement in percentage for many aspects on the observation sheet when comparing test 1-3, 4 and 5-7. Generally one expected a drop in percentage as the approach became more unskilled as the shapes became complex. In the four year age group, however, not all of the children participated in all of the tests. Those children that struggled to cut, dropped out and therefore one could see an improvement in the cutting approach in some of the aspects.

Scissor grip:

99-100% of the children placed their thumbs through the top loops. 69 - 72% of the children placed their middle fingers in the bottom loop, joined by the index finger. Only 18 - 20% of the children kept the index finger out of the loop. Just over half of the children (52 - 58%) held the scissors near the middle joints, compared to the others that held them close to the metacarpophalangeal joints. 73 - 78% of the children held the ring and little fingers in a stabilising position. The scissor grip seemed to be constant in 75 - 78% of children. 79 - 84% of the children held their fingers in the flexed position while cutting out shapes. Only 11 - 12 % of the four year old children held their wrist in extension while cutting out

shapes. The forearm was held in midposition by 87 - 90% of the children when cutting simple shapes. As the shapes became more complex, the forearm seemed to go into pronation for most children. For shape 4 only 61% of the children held the forearm in midposition and for shapes 5 - 7 only 33% of the children still held the forearm in midposition. All of the children flexed the elbow at 90 degrees. All children did not fixate their elbows against the trunk for shapes 1 - 4. From shapes 5 - 7, 94% of the children did not fixate their elbows against the trunk. 82 - 84% of the children held the scissors perpendicular to the floor for cutting simple shapes. As shapes became more complex only 61% for shape 4 and 39% for shapes 5 - 7 still held the scissors perpendicular to the floor. The other children tended to hold the scissors sideways, with the forearm in pronation. 87 - 88% of the children held the paper with the assistive hand in midposition. This decreased slightly for shapes 4 - 7 where 80% of the children held the paper in midposition. The paper usually did not tear when cutting. This was the case for 89 - 91% for shape 1-3, 82% for shape 4 and 78% for shape 5-7. For 44 - 47% of the children cutting was not yet rhythmical and smooth; this also decreased as the shapes became more complex so that 29% of the children for shape 4 and only 25% of the children for shape 5-7 were able to cut rhythmically and smoothly. 70% of the children were able to maintain a constant snip size. This increased to 78% for test 5-7; as explained earlier, this was probably due to the fact that many of the children with weaker skills did not complete all of the tests. 62% of the children used controlled cutting, ie no mass flexion and extension of the fingers. Again this increased to 67% for tests 4-7. About 62% of the children tended to snip rather than cut. No children used the wrists in order to stay on the line when cutting out shapes but tended to adjust the paper, so that they could cut on the line. 81 -82% of the children manipulated the paper with the assistive hand; this decreased as the shapes became more complex, until only 41 - 42% of the children manipulated the paper with the assistive hand. 39 - 41% of the children kept their elbows next to the trunk while cutting; they kept their arms in abduction

at the shoulder joint. This decreased further for shapes 4 (35%) and shapes 5-7 where only 27% of the children were able to maintain their elbows next to their trunk. In 33 - 36% of the children associated tongue reactions were noted when cutting simple shapes but they became more evident when cutting more complex shapes and were seen in 53% of the children.

Age group 5

The scissor grip was very similar to that of the four year old children. In the five-year age group, however, there seemed to be an increase in the percentage of children that achieved the desirable response. In table 4.7 the exact percentage could be compared between four and five year old children.

There seemed to be a slight decrease in percentage for resting the loop of the scissors near the middle joints of the fingers when cutting the more complex shapes 4 - 7. (58% in 4 year olds and 52% in 5 year olds). In actual fact, one would have expected this to improve as the children got older. Again, one should remember that the line thickness decreased and therefore the task became more difficult.

The five-year olds also achieved a slightly lower percentage for test 4 when looking at the position of the forearm. Only 56% of 5 year olds were able to keep their forearms in midposition, yet 61% of 4 year olds achieved this. This could also be seen when looking at the score of holding the scissors in the perpendicular position, which was linked to the forearm position. (61% of 4 year olds and only 53% of 5 year olds managed this).

The five year age group tended to snip more than the four year age group.

The five year age group did not keep the elbow next to the trunk as often as the four year olds did for test 4 to 7.

Age group 6

The scissor grip was very similar to that of the four and five year old children. In the six-year age group, however, there seemed to be an increase in the percentage of children that achieved the desirable response. In table 4.7 the exact percentage could be compared between four, five and six year old children. An improvement in the percentage score thus indicated an increase in desirable response, whereas a decrease in percentage score indicated a more unskilled response.

There seemed to be a slight drop in percentage when looking at the placement of the middle finger. Less six year old children had their middle fingers in the lower loop. By the age of six, generally the children had to decide which finger to place in the lower loop, either the index or the middle finger. Only 63% of the children had the middle fingers in the loop; the others placed the index finger in the loop only.

There also seemed to be a slight decrease in percentage for resting the loop of the scissors near the middle joints of the fingers. In actual fact, one would have expected this to improve as the children got older. It was felt that with the inclusion of a greater number of 6 year old children, the result would have been different.

85% of 5 year olds were able to cut without tearing the paper, yet only 81% of 6 year olds achieved this. Again it was felt that this could be related to the number of children that were tested.

The six year age group tended to snip more than the four year age group, but slightly less than the 5 year age group.

The six year age group did not keep the elbow next to the trunk as often as the four year olds did for test 4 to 7, or the five year olds for test 4.

5.4 Overall picture of executing cutting in the four to six year age group

In all children there was a decrease in the quality of execution as the shapes became more complex. This seemed to be part of normal development.

There were only a few factors that seemed to be related to an increase in cutting complexity, resulting in a decreased quality of execution. In all three age groups it became evident that the decrease in quality of the execution of the task was related mainly to the cutting motion rather than the scissor grip. Factors that were influenced included the forearm position, which was initially held in midposition and then tended to move into pronation. With this the scissors changed from a perpendicular position to the floor, to a more parallel position. Other factors where the quality seemed to decrease included the paper tearing more often; cutting becoming less rhythmical and smooth; less manipulation of the assistive hand and therefore more manoeuvring with the scissors; more associated tongue reactions; and the elbow not remaining next to the trunk, but the arm abducting at the shoulder.

One could assume the following development of scissor grip and cutting action:

A child, four years of age, seemed to know how to hold a pair of scissors correctly, that is, thumb through the top loop and the middle finger with the index finger through the bottom loop. This meant that most children did not yet place the middle finger only through the bottom loop. It was felt that this was also probably due to the fact that children's fingers were still a lot smaller and both fitted easily into the loops. Once they did not fit through the loop together, they would have to decide on one finger only to go through, that is the index or the middle finger. It was expected that most of the children would place their middle fingers through the loop. The four year old child was just beginning to learn to hold the loop near the middle joints of the fingers, rather than at the knuckles. In the 4 to 6 year population many children still rested the scissors at the base of the fingers. From

here this seemed to progress to the middle joints. While the scissors were still at the base of the fingers, it was very difficult to use controlled finger extension and flexion and therefore children often seemed to use mass finger movements when the scissors were placed at the base of the fingers. In four year olds, the little and ring fingers were already in the stabilising position. Before this they were used in the mass action pattern of the hand.

When cutting, fingers were flexed, as was the wrist, and the forearm tended to vary from being in midposition to being in pronation. By six years of age, the child seemed to be able to maintain the midposition of the forearm. The wrist, however, was still not in extension. This skill seemed to be developed only later. Initially the wrist was very static but later it was involved in maintaining the scissors on the line. This meant that not only the non-dominant hand was very important in aligning the paper correctly so that the scissors could cut on them; the 'scissor-hand' was just as important in making finer adjustments so that this actually became a very involved bilateral fine motor skill. Both hands were used to the same extent, each performing different functions. The elbow was flexed at 90 degrees and the scissors were held perpendicular to the floor, although at times they still tended to cut with them parallel to the floor. By six years of age, the child was mostly able to maintain the scissors in the perpendicular position. Initially the shoulder was often abducted, so that the child cut while the elbow was in the air. At six years of age the child held the elbow next to the trunk. When cutting difficult shapes, however, the arms still went into abduction.

Children initially fixated their elbows against the trunk but this soon became loose and they were able to work without fixating their arms.

Initially the non-dominant/assistive hand held the paper in pronation but this changed to midposition or slight supination by the time the child was 4 years old. Initially the child would simply hold the paper in order to cut it with the other hand but this changed and the child learned to manipulate the paper with the assistive

hand. This went in varying degrees and the child initially learnt to operate corners as in a square or triangle. Here the child simply turned the paper once it reached the corner. But in a shape such as the circle, this needed to be done constantly and the degree to which the paper needed to be turned needed to be monitored and adjusted constantly, depending on the shape as well as on the speed with which a child cut. It was felt at even at 6 years of age the child had not mastered this skill of manipulating the paper for curves. When looking at the shape that had been cut out, one would find that children tended to make small straight cuts in order to get around a curve but that they were not yet able to synchronize the right and left hands effectively in order to achieve a smooth curve. When the child started learning to manipulate the scissors, the paper often teared but again this changed rapidly. Cutting seemed to be uncontrolled for a while and it took time to develop smooth and rhythmical cutting. Even in the 6 year age group this only happened when cutting out easy shapes. Children tended to snip, rather than close scissors properly.

Children learned to control their snip size, so that it became constant.
Initially children showed some associated tongue and mouth reactions but by the time they were six years old this had decreased and generally was not observed.

6. CONCLUSION

It was felt that the standard of cutting ability varied between those children who were able to cut on a line and those children who were not. The children who were unable to cut on a line, either, had not been exposed to the skill of cutting, or were at schools where little or no emphasis was placed on cutting. Clearly, it is not possible to base a norm on children whose cutting ability falls into the aforementioned category, as cutting is not an inherent skill but one which is acquired and mastered by practise.

The norm should be set at a standard that is being achieved by children who are exposed to and use cutting skills on a regular basis, rather than accepting the overall mean as a norm, as this would result in a false indication of cutting ability.

One should strive to expose young children to the fine motor task of cutting. Exposure to this skill should be set to a standard that is accepted nationally in order to achieve a norm. The goal of every school should be to achieve this standard, so that all children can be measured and compared with their peers from other schools. This is the only way, that differences can be eliminated, irrespective of their background and opportunity. One should not underestimate the support in the home environment and the importance this has on the development of the child's cutting ability. Standards that are used in school should be assisted and encouraged at home.

In order for children to achieve a norm, it is recommended that cutting be integrated into daily fine motor tasks. Children should be encouraged to cut out various shapes, including straight lines, corners and curves. Initially this can be done separately and then in combination. Further, the line thickness can be increased or decreased, making the task easier or more difficult respectively.

The observation sheets clearly reflect the development of the cutting approach in the three age groups in this study. The difference between a mature and an undesired or unskilled approach is evident. It is also clear, which approach the child should be striving towards. When a child uses an unskilled approach, he should be shown how to improve on this, using the guidelines drawn up for the different ages.

A cutting assessment should be developed, which can be used by therapists and teachers in order to ascertain a child's cutting skill level.
The researcher feels that such a test should include the straight line, the square and the circle only, as this gives an indication if the child has mastered a straight line, a change of direction in cutting as seen in corners and a circle. All shapes should have the same line thickness, in order to establish the improvement of cutting accuracy for the various age groups, and to compare the separate age groups to one another.

The researcher feels that 7 and 8 year old children's cutting ability should also be studied. During this study it has become evident that some skills only develop after 6 years of age. So far, the researcher has seen that a 6 year old child is able to stay on the line in order to cut out a circle. However, it was noticed that this is not yet a smooth bilateral task, where the one hand manipulates the paper while the other is cutting on the line simultaneously. A 6 year old child still tends to snip around the circle, that is, he uses straight short snips to get around the line, rather than a true bilateral approach. Therefore, this skill only develops later, possibly in the 7 or 8 year old child.

The ability to cut including the accuracy as well as the approach of mastering this skill should be incorporated in nursery school activities nation wide. This would allow to strive towards a more controlled standard in the education process. Further, an improvement in cutting would influence the bilateral co-ordination of a

child, as well as the general fine motor skill. This in turn impacts on the overall development of a child.

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APPENDIX A1 - OBSERVATION SHEET

Date of assesment				
Birth date				
Current age				
Sex				
School				
Dominance	Left		Right	

Scissor Grip	YES	NO
Thumb through top loop		
Middle finger through bottom loop		
Index finger helps to hold the lower loop steady		
Loops rest near middle joints of the fingers		
Little and ring finger are in stabilising position		
Scissor grip is constant		
Fingers are in flexed position		
Wrist is in slight (45 degrees) extention		
Forearm is in mid position		
Elbow is flexed at 90 degrees		
Elbow not fixated against trunk		
Scissors are held perpendicular to the floor		
Non-dominant hand holds the paper in midposition		

Cutting motion	YES	NO
Paper does not tear		
Cutting is rhythmical and smooth		
Snip size remains constant		
Controlled cutting i.e. no mass flexion and extension of fingers		
Child closes scissor properly i.e. not just snipping		
Wrist moves (slight adjustment) to maintain the scissors on the line		
Assistive hand manipulates the paper		
Elbow remains next to the trunk		
No associated movements seen in the tongue		

Comments

Time taken

Picture one (straight line)		Picture five (circle)	
Pitcure two (square)		Picture six (spiral)	
Picture three (triangle)		Picture seven (crown)	
Picture four (semi-circle)		Overall time	

APPENDIX A2 - INFORMATION AND CONSENT FORM

15 Kingston
Kings Street
Windsor East
2194

Tel: (011) 678-7090

12 September 1994

Dear Parents

I am an Occupational Therapist in the process of completing my Masters Degree. In order for me to complete my Masters Degree I am required to do a research project, for which I need consent from you as the parents of your child. Your child has been randomly chosen to participate.

The objective of my study is to evaluate some fine motor skills in normal children aged 4-6 years to provide information on what normal children do.

This research involves taking the child out of the classroom situation for about 10 to 15 minutes to complete various fine motor tasks. There are no costs or risks involved.

Please confirm your consent for this research as detailed below.

Yours sincerely

Ingrid Gutmayer

Researcher : Ingrid Gutmayer - Occupational Therapist

I / we the undersigned allow / do not allow my son / daughter to take part in this research project.

_____ _____

(Signature) (Date)

APPENDIX A3 - LETTER TO THE T.E.D.

ingrid • gutmayer • occupational • therapist

43 Sycamore Street Weltevreden Park P O Box 9135 Devon Valley 1709 Tel : (011) 678-2429 Fax : (011) 646-1580

BSc OT (Witwatersrand) Diploma in Advanced OT (Witwatersrand) OTR Private Practice Number 6607772

19 February 1995

Dear Miss Katz

I am an Occupational Therapist doing my Masters Degree in Occupational Therapy at the University of the Witwatersrand.

My study involves setting up norms for children in the 4 to 6 year age group for fine motor skills. The protocol was submitted in November 1994 and it was accepted by the Medical Board. Their suggestion was that I should select my sample for the study by using a comprehensive list of Primary and Nursery Schools in the Johannesburg area and randomly choosing children from those schools.

In order for me to select the schools I would require a comprehensive list from you. The schools should include all Primary and Nursery Schools, government and private.

I thank you for your help.

Ingrid Gutmayer

ingrid • gutmayer • occupational • therapist
43 Sycamore Street Weltevreden Park P O Box 9135 Devon Valley 1709 Tel : (011) 678-2429 Fax : (011) 646-1580
BSc OT (Witwatersrand) Diploma in Advanced OT (Witwatersrand) OTR Private Practice Number 6607772

12 March 1995

Dear Miss Katz

Thank you for your comprehensive list of Nursery Schools. I do, however, have some questions about the list. Does it not include Nursery Schools for black children? Further, could you let me know where I could get hold of a list of private Nursery and Primary schools. And lastly, could you also please supply me with a list of Primary Schools.

I thank you for your help.

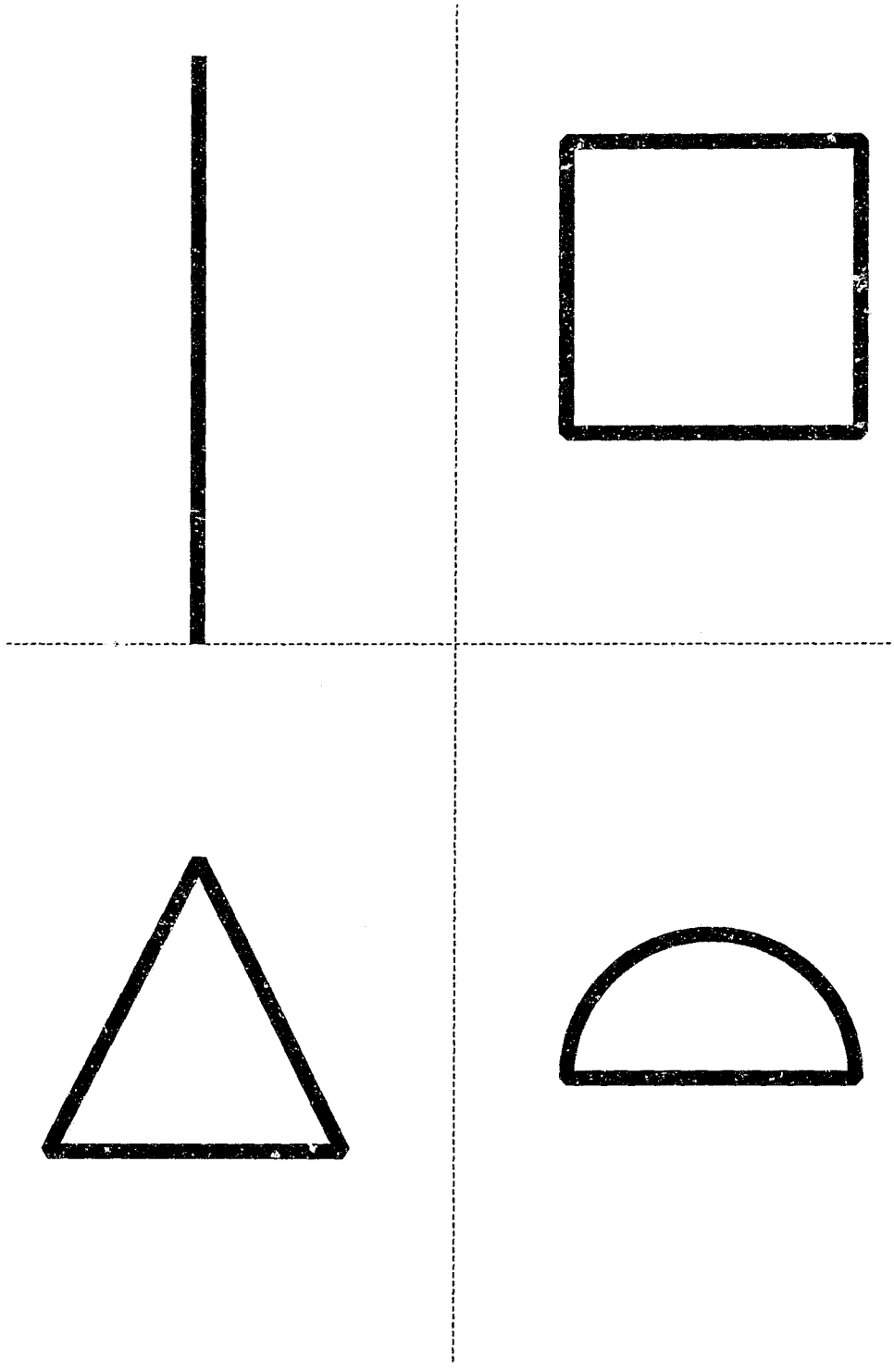
Ingrid Gutmayer

APPENDIX A4 - TEST

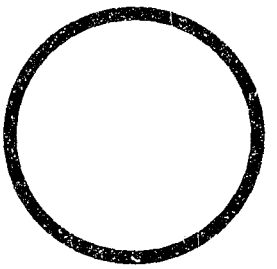
There are seven shapes per age group. Age group 4 has a line thickness of 3 mm, age group 5 has a line thickness of 2 mm and age group 6 has a line thickness of 1 mm.

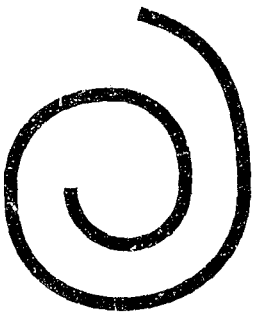
The seven shapes are presented at 85%; the total length of the shapes as well as the line thicknesshave therefore decreased.

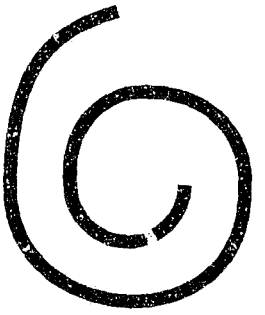
4 year age group : shapes 1 - 4

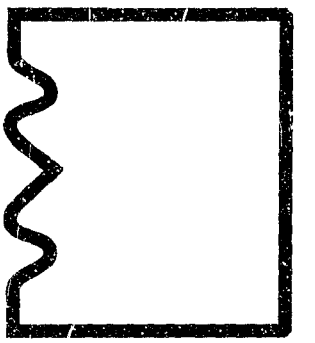


4 year age group : shapes 5 - 7



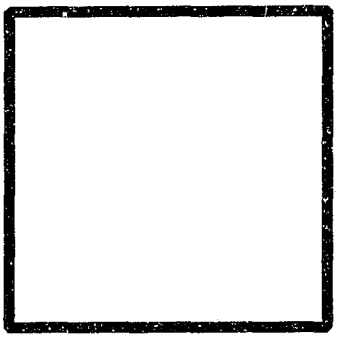


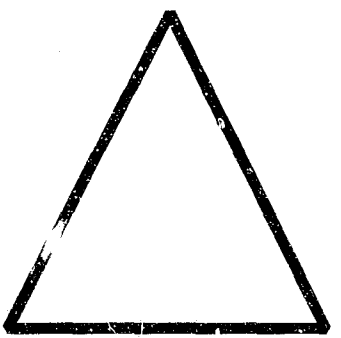


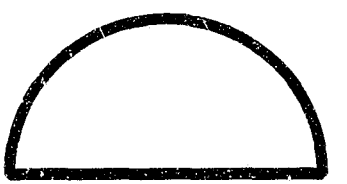


5 year age group : shapes 1 - 4

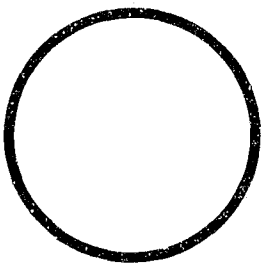


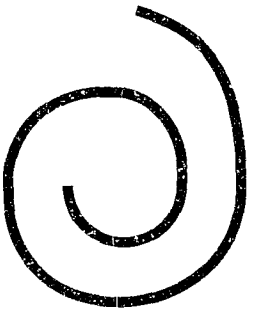


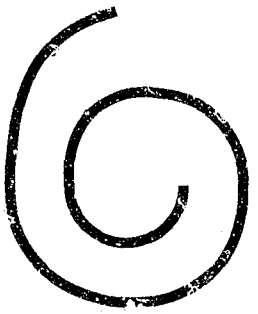


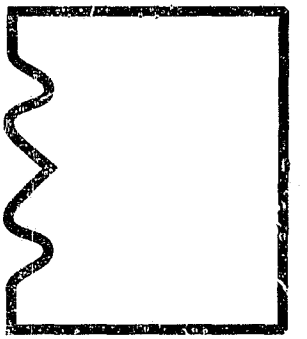


5 year age group : shapes 5 - 7

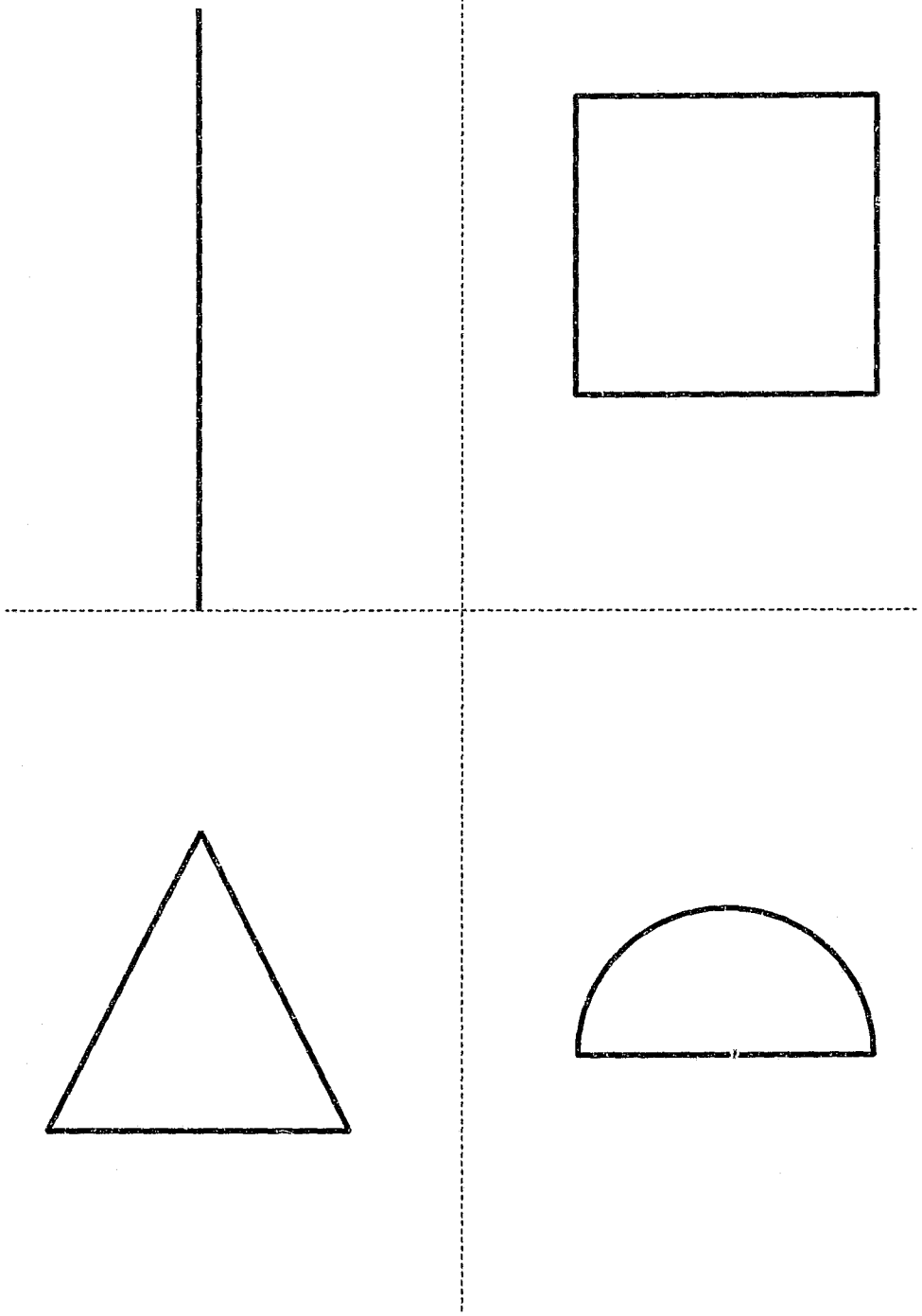




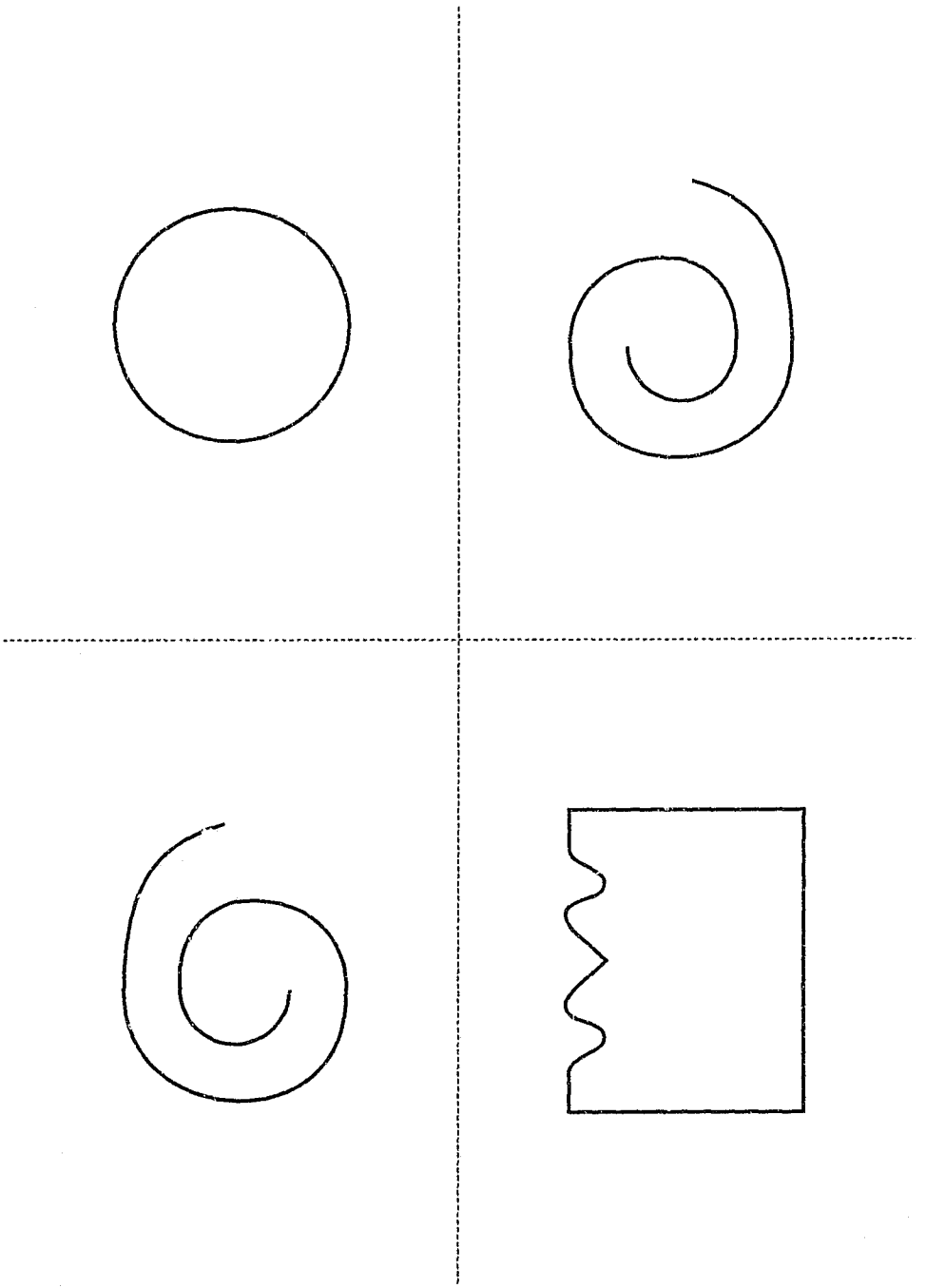




6 year age group : shapes 1 - 4



6 year age group : shapes 5 - 7



APPENDIX A5 - SCORING INSTRUCTIONS

Actual length of the various shapes are as follows:

Straight line - 12 cm

Square - 24 cm

Triangle - 19 cm

Semicircle - 16 cm

Circle - 19 cm

Spiral - 28 cm

Crown - 31 cm

A line measurement of 0 cm indicated that the child cut on the line all of the time and therefore obtained a percentage of 100%. A child that cut off the line a lot of the time, close to the actual lenght of the individual shapes would therefore have a poor percentage score eg. between 0 and 10%.

accuracy(cm) = shape length (cm) - amount cut off the line (cm)
Accuracy Score (%) = [accuracy (cm) : shape length(cm)] x100

Formula used

The length of the shape (in cm) minus the amount cut off the line (in cm) equalled the accuracy of the cutting (in cm). This accuracy in cm was then divided by the shape length (in cm) and multiplied by 100 in order to obtain the accuracy score, given as a percentage.

Example Triangle:

shape length = 19 cm

The child cut off the line for 10 cm, ie slightly more than half of the time, therefore one would expect less than 50 %.

accuracy (cm) = 19 cm - 10 cm (line measurement)

accuracy (cm) = 9 cm

Accuracy score (%) = [9 cm : 19 cm] x100

Accuracy score (%) = 47%

APPENDIX A6 - LETTER TO THE PRINCINPAL

ingrid • gutmayer • occupational • therapist

43 Sycamore Street Weltevreden Park P O Box 9135 Devon Valley 1709 Tel : (011) 678-2429 Fax : (011) 646-1580
BSc OT (Witwatersrand) Diploma in Advanced OT (Witwatersrand) OTR Private Practice Number 6607772

12 May 1995

Dear

Thank you for allowing me to use your school as a sample for my study.
Enclosed, please find the information and consent forms. Please hand these out to the children randomly selected for this study and then return them to me on the day that I do the evaluations.

Random selection:
Select every second child on your class list for

- 4 year olds - 5 children
- 5 year olds - 5 children
- 6 year olds - 5 children

that is, 15 children in total.

Please only include _____ children from your school.

Should the parents not allow the child to participate, just add the next child on the class list to the study group. Please do not choose the children, since this would affect the randomness of the study.

If you do not have e.g. 6 year olds, please just add more 4 or 5 year old children to the sample, so that I have a total of 15 children.

Once my study has been completed, I will inform you of the results which will hopefully benefit you and can also be used as a guideline as to what is expected at the different age groups.

I hereby confirm my appointment with you :
Date: _____
Time: _____

Should there be any queries, please do not hesitate to contact me on 678-2429.
Thank you

Ingrid Gutmayer

APPENDIX A7 - STANDARDISED WORDS

A pair of scissors was placed in front of each child; it was assumed that children are right dominant. If this was not the case, the scissors were changed to left-handed scissors, before the child started to cut. Standardised words (see appendix) were used so that all children were exposed to the same amount of information. The child was asked to cut out seven different shapes, starting with the simplest shape (straight line) and ending with the most complex shape (crown).

Picture one - (straight line) - *cut on this line. Try to stay on the line.*

Picture two - (square) - *cut out this square. Start here and try to stay on the line.*

Picture three - (triangle) - *cut out this triangle. Start here and try to stay on the line.*

Picture four - (semicircle) - *cut out this half-circle. Start here and try to stay on the line.*

Picture five - (circle) - *cut out this circle. Start here and try to stay on the line.*

Picture six - (spiral) - *cut out this spiral. Start here and try to stay on the line.*

Picture seven - (crown) - *cut out this crown. Start here and try to stay on the line*

APPENDIX A8 - PERCENTILE SCORES

A8.1 Table of percentile scores versus cutting accuracy for 4 year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
99	100	100	100	100	100	93	98
95	100	98	97	100	89	82	95
90	100	96	97	94	82	79	90
85	100	92	92	91	74	71	90
80	100	90	89	84	74	68	90
75	100	83	84	81	69.5	68	84
70	100	83	84	72	63	64	74
65	96	81	82	69	58	54	71
60	87	79	79	66	53	52	60
55	83	73	74	56	47	50	55
50	75	71	68.5	53	39.5	48	53
45	67	65	63	50	34	45	52
40	58	52	58	44	26	43	45
35	58	46	55	37	21	29	39
30	54	33	47	37	11	29	29
25	37	25	26	31	9.5	20	23
24	33	25	26	25	8	20	23
23	29	25	26	25	8	18	13
22	25	21	21	19	8	18	13
21	21	21	21	19	8	14	13
20	17	17	21	19	8	14	13
19	15	17	21	19	5	11	11
18	13	12	13	19	5	11	11
15	8	0	0	12	5	4	6
10	0	0	0	0	0	2	3
5	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0

A8.2 Table of percentile scores versus cutting accuracy for 5 year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
99	100	100	100	100	100	96	100
95	100	100	100	100	92	89	87
90	100	100	95	94	79	73	77
85	100	94	89	84	63	68	76
80	100	87	87	81	58	57	71
75	100	87	84	75	55	55	68
70	100	83	82	72	53	52	65
65	92	79	79	62	45	50	63
60	92	77	74	62	37	45	61
55	83	75	71	59	37	43	58
50	71	71	66	56	32	39	48
45	67	56	63	53	26	36	42
40	58	50	63	50	24	29	35
35	58	42	55	41	21	23	32
30	50	37	47	37	18	21	27
25	42	33	37	37	16	18	23
24	42	33	37	34	16	18	19
23	42	33	37	34	16	18	19
22	42	29	37	31	16	16	19
21	33	25	34	31	13	12	15
20	25	25	34	28	11	11	13
19	25	25	34	28	11	11	13
18	21	23	32	28	11	11	13
15	0	17	26	25	8	9	10
10	0	2	8	19	3	5	3
5	0	0	3	0	0	0	0
4	0	0	3	0	0	0	0
3	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0

A8.3 Table of percentile scores versus cutting accuracy for 6 year old children

	Straight Line	Square	Triangle	Semi-Circle	Circle	Spiral	Crown
99	100	100	97	87	92	86	79
95	100	96	87	87	79	82	77
90	100	92	84	81	68	79	77
85	100	85	84	75	63	71	68
80	92	85	84	72	58	68	68
75	92	79	79	72	55	68	68
70	83	73	74	69	42	61	58
65	83	71	71	66	42	61	52
60	75	71	68	66	42	50	52
55	71	67	61	53	37	32	45
50	67	67	58	53	34	30	42
45	62	62	58	44	32	30	42
40	54	58	55	44	26	30	40
35	50	58	53	44	26	29	32
30	42	54	50	44	24	25	31
25	42	42	47	37	18	20	26
24	42	42	47	37	18	20	26
23	42	42	47	37	18	20	26
22	37	37	42	37	13	18	26
21	37	37	42	37	13	18	26
20	37	37	42	37	13	18	26
19	37	37	42	37	13	18	26
18	17	33	37	37	11	14	26
15	17	33	37	37	11	14	26
10	0	21	21	25	8	11	6
5	0	17	18	25	5	11	3
4	0	17	18	25	5	11	3
3	0	0	0	6	5	5	0
2	0	0	0	6	5	5	0
1	0	0	0	6	5	5	0

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