WISC-R CODING INCIDENTAL RECALL, DIGIT SPAN AND SUPRASPAN TEST PERFORMANCE IN CHILDREN AGED 6 AND 7

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DECLARATION

I declare that *WISC-R Coding Incidental Recall, Digit Span and Supraspan Test Performance in Children aged 6 and 7* is my own work and that all sources of information used or quoted have been appropriately referenced or acknowledged.

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ABSTRACT

The primary aim of this study was to develop age-related normative data for the WISC-R Digits Forward, Digits Backward, Digits Difference, Digit Supraspan, and Coding Incidental Recall (Immediate and 30' Delayed) tests for a non-clinical population of South African school children aged 6 and 7. The effects of sex, English versus Xhosa language, and white versus black race groups, were additional investigations. Subjects were randomly selected from three English speaking Grahamstown schools; level of education ranged from pre-school to Sub Standard B; English speaking subjects included predominantly white children, with a small proportion of coloured, Chinese and Indian children; Xhosa speaking children were all black. Interim normative data on all tests across two age groups (6 and 7) are presented, and are considered reliable and diagnostically useful in clinical neuropsychological assessment. There were no significant effects for age, sex, English versus Xhosa language or white versus black race groups, on any of the tests with the exception of Digits Backward which yielded marginally lower scores for black subjects. Although the mean IQ estimate based on the Draw-A-Person test was equivalent across age, sex, English versus Xhosa language and white versus black race groups, an intelligence rating of subjects by teachers revealed that black subjects were evaluated significantly lower than white subjects. This suggests the presence of prejudicial racial attitudes amongst educators in these predominantly English speaking white schools.

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CHAPTER 1 : INTRODUCTION

The aim of this study was to extend the Wechsler Intelligence Scale for Children - Revised (WISC-R) Coding and Digit Span Subtests, in order to enhance their diagnostic potential in neuropsychological assessment, and to provide normative data on these subtests and their extensions, for 6 and 7 year old South African children.

1.1 Clinical Neuropsychology and Deficit Pattern Analysis

The approach adopted by many of today's prominent neuropsychologists is to integrate the techniques and theoretical contributions of the quantitative and qualitative approaches (Lezak, 1983, p 4). Thus, whilst the actuarial system, which exemplifies the quantitative method, does not constitute the entire scope of neuropsychological assessment, it is nevertheless of considerable importance in the discipline (Adams, Rennick & Rosenbaum, 1975; Reitan & Davison, 1974; Russell, Neuringer & Goldstein, 1970; Swiercinsky, 1978). More specifically, researchers are all in agreement that the most common approach to the initial detection and evaluation of cerebral pathology is through knowledge of, and analysis of, both intra-test and inter-test score scatters (McFie, 1975; Reitan & Davison, 1974; Russell, 1979). In this way, a clinician may attempt to match variations of test scores with likely neuropsychological events (Lezak, 1983, p 155).

Lezak (1983) argues that scatter analysis is possible as intellectual functions are expressed consistently and cerebral damage sustained to a specific area, may often be pinpointed by a corresponding change in the expression of the specific function. For example, a clinician would attempt to identify any functions which are repeatedly associated with lowered test scores. Thus, commonality of dysfunction is analyzed via patterns of lowered test performance in terms of whether or not neurological sense can be made of the evident pattern (Goldstein, 1974; Lezak, 1983; Walsh 1987). Clearly, where score discrepancies fit known neuroanatomically probable behaviour patterns, cerebral pathology is strongly suspected. Where the pattern of lowered scores cannot be linked in this manner, alternative possibilities need to be considered. For example, problems of a developmental or functional nature; or chance variations (Lezak, 1983). Thus, Walsh (1987) notes that utilising the neuropsychological implications of score patterns of routine cognitive tests, is a valuable and quick technique in the initial identification of cerebral pathology.

The usefulness of this model of deficit pattern analysis in neuropsychological assessment is now generally recognised in clinical practice. In this respect, it is especially useful with the Wechsler batteries as the relevant subtests thereof are statistically comparable and variations in the subtest scores are therefore helpful in providing clues with regard to the presence of cerebral pathology, generally and specifically in some cases (Lezak, 1983; Matthews, Guertin & Reitan, 1962; McFie, 1975; Simpson & Vega, 1971). The utility of the model has also recently been acknowledged in the medical management of cerebral pathology. In this regard, a case study by Maertens, Cohen & Krawiecki (1987) on a child (aged 13) with subdural empyema, found that this approach to neuropsychological evaluation was clinically more useful in assessing changes in cortical integrity during recovery than pure neurological assessment.

The efficacy of deficit pattern analysis largely depends upon valid normative comparison standards being set. This involves studying the cognitive abilities of normal populations who are unlikely to have impairment in the functions examined by the tests (Hitch, 1990). In order to set valid normative comparison standards in children's tests, cognisance needs to be taken of abilities or traits that change with age (Lezak, 1983). In addition, the differential development rate of boys and girls needs to be taken into account. (Lezak, 1983). Separate norms are also necessary for children's tests of attention, memory, and learning, as these are functions which develop throughout childhood and are not very closely linked to tests of general intelligence (Lezak, 1983). Thus, a general intelligence scale for children, like the WISC-R, is likely to be more effective where subtests are included which examine these functions directly.

1.2 Wechsler Intelligence Scale for Children - Revised

The Wechsler Intelligence Scale for Children - Revised (WISC-R) (Wechsler, 1974), is one of the four best known children's tests and is used routinely in clinical practice throughout the world (Lezak, 1983, p 156). The WISC-R is recognised as a useful clinical and diagnostic tool in the areas of neuropsychological and educational assessment (Lezak, 1983). In this respect, the WISC-R Digit Span and Coding Subtests are especially useful as lowered scores on either or both of these subtests, interpreted together with other normative test data, provide the clinician with invaluable diagnostic information. However, Lezak (1983) cautions that the relevance of a lowered score depends largely upon what goes with it. Thus, A low Digit Span score together with depressed scores on all other tests administered, may merely confirm a diagnosis of mental deficiency; while a low Digit span score together with fairly high scores on most other subtests (especially Vocabulary and Information), may be indicative of anxiety (Lezak, 1983). A description of the Digit Span and Coding Subtests, their administration, the functions they examine, and their diagnostic usefulness follows. First the subtests will be considered separately, followed by an examination of their diagnostic usefulness when used together.

1.2.1 Digit Span

Digit Span, a supplementary verbal subtest of the WISC-R, consists of two parts. Digits Forward with two trials of items 1 to 7, representing a forwards span of 3 to 9 respectively; and Digits Backward with two trials of items 1 to 7, representing a backwards span of 2 to 8 respectively (Wechsler, 1974). Both parts are administered separately with each item scoring 2, 1 or 0 where both trials are passed, one trial is passed, or both trials are failed. The maximum score on this subtest is 28 which represents the combined scores for Digits Forward and Digits Backward.

Digit Span appears to examine attention, concentration, immediate memory and working memory (Lezak, 1983; Russell, 1972). Spafford (1989) contends that the Digit Span Subtest may be useful in screening and diagnosing dyslexic readers. Similary, other studies suggest a significant correlation between Digit Span performance and reading ability (Das, 1986; Kobus, Zino, Lewandowski & Sturr, 1986; McManis, *et al.*, 1978). It is reported that Digit Span is also effective in differentiating between severe, moderate, and mild Mental Retardation as MacKenzie & Hulme (1987) found that Digit Span scores were lower than expected in severely retarded children. They established that the severely retarded child's span for digits failed to develop as mental age increased. Further, it is suggested that the utility of Digit Span would be additionally enhanced by the separate reporting of it's two parts, Digits Forward and Digits Backward. These are actually two different cognitive tasks as the functions they examine differ, as do the effects of cerebral impairment (Black, 1986; Black & Strub, 1979; Costa, 1975; Lezak, 1983; Richardson, 1977; Shuttleworth-Jordan, 1992; Weinberg, Diller, Gerstman, & Shulman, 1972). These researchers argue that Digits Forward primarily measures passive immediate attention span, while Digits Backward primarily measures working memory which involves mental double-tracking, as both the storing of data, and the mental manipulation of juggling them around, must proceed simultaneously (Lezak, 1983; Shuttleworth-Jordan, 1992). This argument is further supported by Schofield & Ashman (1986) who suggest that Digits Backward has a serial processing character. Similarly, Takeuchi (1987) posits that Digits Backward examines a subject's ability to transform information. Weinberg, *et al.* (1972) have proposed that the double-tracking operation of Digits Backward, depends upon internal visual scanning.

Accordingly, the effects of cerebral impairment on Digits Forward and Digits Backward also differ. Digits Forward is usually most affected by left hemisphere involvement, while Digits Backward is sensitive to diffuse brain damage, and is equally affected by left and right hemisphere involvement (Lezak, 1983; Newcombe, 1969). A study by Dennis, Spiegler, Fitz & Hoffman (1991) suggests that Digits Backward may be affected by impairment of the pineal-habenlar region and the anterior and medial thalamic nuclei, as they found that auditory-verbal working memory appears to involve these regions of the brain. Lezak

(1983) notes that Digits Backward appears to be sensitive to visual field defects, and to diffuse damage of dementia, although she warns that this test may not be affected by Korsakoff's psychosis. Dennis & Barnes (1990) suggest that a closed head injury may lead to a working memory deficit, and hence, to a depressed Digits Backward score. However, it appears that although Digits Forward is often depressed following head injury, it is also resilient as subjects scores often return to normal levels in the years following the trauma (Lezak, 1979; Scherer, Klett & Winne, 1957). Digits Backward, however, rarely returns to a normal level in the years following a head injury (Lezak, 1983). In addition to being diagnostically useful in the assessment of cerebral pathology, it is suggested that Digits Forward and Digits Backward scores are also moderate predictors of competence in reading (Jackson, Donaldson & Cleland, 1988).

In summary, Digits Forward (i) measures passive immediate attention span, (ii) is more sensitive to left hemisphere brain damage than right or diffuse brain damage; Digits Backward (i) measures auditory-verbal working memory (the simultaneous storage and mental manipulation of information) which appears to involve the pineal-habenlar region and the anterior and medial thalamic nuclei, (ii) measures the ability to transform information, (iii) depends upon internal visual scanning, (iv) has a serial processing character, (v) is sensitive to left, right and diffuse brain damage and visual field defects, but may not be affected by Korsakoff's psychosis.

1.2.2 Coding

Coding, a performance subtest of the WISC-R, is made up of two separate tests. Coding A for children under eight years, and Coding B for children eight years and older. Coding A, which requires the pairing of five symbols, consists of five sample blocks and forty-five test blocks. The maximum score is 50 which represents a perfect score of 45 plus up to 5 points for time bonuses. Coding B, which requires the paring of nine symbols, consists of seven sample blocks and ninety-three test blocks. The maximum score is 93 and, unlike Coding A, there are no time bonuses.

Like Digit Span, Coding is a complex subtest as it also examines a number of different cognitive functions. McManis, Figley, Richert & Fabre (1978) suggest that a rapid response in Coding requires short-term storage of associations between numbers and symbols which is dependent upon short-term visual memory and visual perceptual ability. It is arguable that Coding A has the additional potential to indirectly tap short-term verbal memory. According to Buffery (1974), before one can automatically classify symbols or wordless stimuli as non-verbal, one needs to assess whether it is possible to verbalize the stimuli in any way. Thus, it may be easy enough for a bright, very verbal subject to translate the paired symbols of Coding A into a type of verbal code. For example, Star + One; Circle + Equals; Triangle + Minus; Cross + Circle; Square + Eleven. However, it appears relatively difficult to do this for the nine numbers with their paired symbols in the Coding B test. Therefore, only Coding A appears to possess the potential to examine both short-term visual and verbal memory. According to Kail (1991) a central mechanism, which regulates speed performance, is involved in Coding. Thus, he suggests that age is a significant variable in Coding test performance as processing time in children is dependent upon this central mechanism which changes with age.

Low Coding scores also provide diagnostically useful information. According to Holland (1989) depressed Coding scores have assisted in identifying reading delayed children, as the subtest examines cognitive abilities which assist in the process of reading. Share, Silva & Adler's (1987) study in children (aged 3 to 11 years) revealed that depressed Coding scores were associated with specific spelling retardation when linked with depressed WISC-R Arithmetic scores, low attentiveness, and poor writing and mathematical achievement. Matthews' (1988) work proposed that difficulties on Coding may be suggestive of Tourette Syndrome where, in addition to a depressed Coding score, the subject scores two years below expectation on the Bender Visual Gestalt Test and on the Wide Range Achievement Test - Revised. Zur and Yule's (1990) study suggested that South African adolescent males (aged 12 to 20), with a history of chronic solvent abuse, carry an increased risk of cognitive impairment compared to their British counterparts. It was found that South African subjects scored significantly lower on tests involving visual processing, especially the Symbol Digit Coding Test. As this test examines similar functions to the Coding test of the WISC-R, the possibility of solvent abuse is yet another parameter that needs to be considered by a clinician when faced with a child's depressed Coding score. Finally, Braden (1990) posits that deaf persons score consistently lower on Coding. Thus, depressed Coding scores may alert the clinician to possible problems with hearing. Together these studies suggest that Coding is useful in the assessment of reading and spelling delayed children, hearing problems, and cerebral pathology.

However, additional valuable diagnostic information is available, if the research literature on Digit Symbol, a similar performance subtest for adults, is briefly reviewed. In this respect, Digit Symbol is noted to examine sustained attention and response speed (Lezak, 1983; Russell, 1972). Visuo-motor coordination, motor speed and perceptual-cognitive ability also play important roles in this subtest (Lezak, 1983; Storandt, 1976). Digit Symbol is a particularly useful neuropsychological screening tool, as it is especially sensitive to minimal cerebral damage because of the high number of functions it examines (Fleischmann, 1991; Joy, Fein, & Kaplan, 1992; Kaufman, Mclean, & Reynolds, 1988; Lezak, 1983; Russell 1972; Salthouse, 1978; Shuttleworth-Jordan & Bode, in press; Storandt, 1976). Similarly, Russell (1986) reports that cerebrally impaired subjects perform most poorly on this test irrespective of the type of cerebral impairment involved. However, Lezak (1983) cautions that this is not a good test for predicting the laterality of lesions, as depressed Digit Symbol scores may be a result of various factors, or a combination thereof. Nevertheless, she acknowledges that orientation errors are often displayed on this test by subjects with right hemisphere damage.

In the above sections (1.1 and 1.2) the diagnostic usefulness of Digit Span and Coding when used alone have been reviewed. A wealth of recent information suggests that Digit Span and Coding are clinically useful when considered together in the identification and screening of numerous disorders and problems.

1.3 Diagnostic Usefulness of the WISC-R Digit Span and Coding Subtests

1.3.1 Academic Skills Disorders

Digit Span and Coding Subtests have been found to be useful in the identification of learning disabilities, language learning problems, and spelling retardation.

1.3.1.1 Learning Disabilities

Digit Span and Coding have been extensively used in assessment of children referred for learning disabilities (Strom, Mason & Williams, 1988). In Sandoval, Sassenrath & Penaloza's (1988) research it was noted that the ACID (Arithmetic, Coding, Information, and Digit Span) pattern of deficit was generally found in Learning Disabled subjects. They established that this pattern emerged on the Wechsler Adult Intelligence Scale - Revised (WAIS-R) as well as on the WISC-R. More recently, however, Greenblatt, Mattis & Trad's (1991) study on 526 psychiatric children (mean age 10.6 years) revealed that very few subjects actually had ACID profiles. Rather, they identified an alternative pattern of deficit which they suggested is more likely in learning disabled children. They noted that this pattern of deficit (an impairment in the Freedom From Distractibility factor), required Digit Span, Coding and Arithmetic to be lower than the mean Performance and Verbal IQ scores. In addition, higher Verbal and Full Scale IQ scores compared to Performance IQ scores were required. Wielkiewicz (1990) proposed a similar case for an impairment in the Freedom From Distractibility factor, which he suggests may be as a result of difficulties with executive and short-term memory processes, rather than pure distractibility.

1.3.1.2 Language Learning Problems

Digit Span and Coding have also proved to be effective in screening for language learning problems. More specifically, inclusion of the WISC-R Digit Span, Coding and Block Design Subtests were found to increase the accuracy of identifying normal hearing children (aged 6 to 11) who exhibited language learning problems (Elliot, Hammer & Scholl, 1989). It is argued that children with language learning problems will be more easily identified by clinicians if these subtests are administered in addition to the usual auditory tasks.

1.3.1.3 Spelling Retardation

The results of Newman, Fields & Wright's (1993) research suggested that children (aged 6 years 9 months to 12 years), who were specifically spelling disabled or spelling and reading disabled, all performed more poorly on Digit Span and Coding. However, only the children with a specific spelling disability also showed superiority in Verbal IQ subtests.

1.3.2 Developmental Disorders

Digit Span and Coding have been found to be discriminating aids in the diagnosis of Attention Deficit Hyperactivity Disorder (ADHD). A study undertaken by Loge, Staton & Beatty (1990) on 20 children with ADHD and 20 matched normal controls (aged 6 to 12) suggested that depressed scores on Digit Span, Arithmetic, Information, Block Design and Coding, together with impaired functioning in reading comprehension, verbal learning and memory, was strongly indicative of an ADHD. Conversely, Massman, Nussbaum & Bigler (1988) found that for 90 young children (aged 6 to 8 years), there was no significant association between hyperactivity or attention problems, as measured by the Hyperactivity scale of the Child Behaviour Checklist, and performance on the WISC-R Digit Span, Arithmetic and Coding tests; Wide

Range Achievement Test Arithmetic; and the Benton Visual Retention Test. However, for 92 older children (aged 9 to 12 years), there were significantly large negative correlations between their Hyperactivity scores and Coding, Wide Range Achievement Test Arithmetic and Benton Visual Retention Test scores.

1.3.3 Cerebral Pathology

Various patterns which include lowered Digit Span and Coding Subtest scores, yield useful information in the neuropsychological assessment of cerebral pathology. In this respect, an impaired Third Factor score (lowered Digit Span, Coding and Arithmetic scores relative to the mean Performance and Verbal IQ scores) was found to useful in identifying children with left and right lesions (Aram, & Ekelman, 1986). Gaggero, Cirrincione, Zanotto and de-Negri (1992) suggested that lowered Digit Span and Coding scores together with poor test performance of the Draw-A-Man test, is a common test profile in children with epilepsy. Digit Span, Coding and Information Subtests of the WISC-R are considered useful in distinguishing between subjects with epilepsy and those who are mentally retarded (Forceville, Dekker, Aldenkamp, & Alpherts 1992). They found that epileptics tended to have difficulty with Digit Span, Coding and Information, in contrast to mentally retarded subjects who experience difficulty with Arithmetic, Vocabulary and Information. However, mentally retarded subjects **with** epilepsy, experienced the most difficulty on Digit Span and Coding. Similarly, these subtests were found to be useful aids in the hemispheric screening of epileptics (Muszkat, de-Vincenzo, Reami, & de-Almeida (1991). Many researchers argue that lowered Digit Span and Coding scores may be indicative of diffuse cerebral pathology as the various functions (working memory and short-term memory) examined indirectly by these tests are sensitive to this type of brain damage (Lezak, 1983; Shuttleworth-Jordan, 1992; Shuttleworth-Jordan & Bode, in press).

In summary, when Digit Span and Coding scores are considered together, they have been found to be very sensitive to a wide range of disorders (academic skills disorders, developmental disorders, and cerebral pathology). It appears that the functions of attention, short-term memory and learning which are tapped by both these tasks, account for their extreme sensitivity to problems of these natures. However, specific problems with short-term memory and learning may still go undetected because these functions are only indirectly examined by these two subtests. Nor is there any direct examination of short-term memory and learning on any other test of the WISC-R.

1.4 Redressing the Deficit Screening Capacity of the WISC-R by Extending its Digit Span and Coding Subtests

It is acknowledged that the WISC-R is popular in clinical practice and is a powerful diagnostic tool, particularly when administered together with other cognitive tests, and interpreted according to pattern deficit analysis. However, although short-term memory is particularly sensitive to brain damage (Lezak, 1983; Walsh, 1991), the WISC-R only examines short-term memory indirectly in the Arithmetic, Digits Backward and Coding Subtests (Banken, 1985; Black, 1983; Mishra, Ferguson & King, 1985; Shuttleworth-Jordan, 1992). It is therefore suggested that the deficit screening potential of this intelligence battery would be additionally enhanced by the inclusion of direct tests of short-term memory.

Short-term memory, is particularly valuable in the assessment of cerebral pathology as it is often the first presenting problem in any pathology with raised intracranial pressure which may result from closed head injuries, haematomas or space occupying lesions (Aronson, 1994; Lezak, 1983; Lishman, 1987; Shuttleworth-Jordan & Bode, in press; Walsh, 1991). Hence, they note short-term memory is very sensitive to the effects of diffuse cerebral damage. In addition, numerous researchers report that impaired recent memory is the most common initial presenting symptom of a progressive or degenerative dementia (Lezak, 1983; Lishman, 1987; Walsh, 1991). Although dementia is generally found in the elderly, it is arguable that the following etiologic factors may cause Dementia at any age: neurological disease (eg. cerebral hypoxia, encephalitis, brain tumours, subdural haematomas, normal-pressure hydrocephalus);

metabolic disorders (eg. hypothyroidism); infectious diseases (eg. tertiary neurosyphilis). Hence, it is vital to be able to distinguish between dementias and depressive pseudodementia in children as well as adults. Finally, depressed scores on tests of sequencing short-term visual memory ability, are found more frequently in autistic than non-autistic populations (Plenkovic, 1988).

Due to their sensitivity to brain pathology, recommendations have been made for the extension of the Digit Span, Coding and Digit Symbol (the adult equivalent of Coding) Subtests in order to examine working memory, verbal new learning and short-term recall in children and adults, more directly (Black, 1983 & 1986; Collaer & Evans, 1982; Hart, Kwentus, Wade, & Hamer, 1987; Imm, Foster, Belter & Finch, 1991; Joy, *et al.*, 1992; Lezak, 1983; Murdoch, Fleming, Skuy, Painter, Schmidt & Schutte, 1994; Shuttleworth-Jordan, 1992; Shuttleworth-Jordan & Bode, in press).

1.4.1 The Separate Reporting of Digits Forward, Backward and Difference and the Extension of Digit Span

Numerous arguments have been proposed for the separate reporting of Digits Forward and Digits Backward, given the different functions they examine and the varying effects of cerebral pathology on each. In this respect, Shuttleworth-Jordan (1992) suggests it is more useful to consider the raw scores of Digits Forward and Digits Backward separately, than to combine these scores. Unlike the individual or combined scaled scores, these separate raw scores are directly comparable to the subject's digits forward and backward spans. Digits Difference, the difference between the two raw scores of Digits Forward and Digits Backward, is also useful in measuring cerebral pathology. In children, as well as in adults, is argued that a three point Digits Difference score occurs more frequently in brain damaged, than in non-brain damaged populations (Black, 1983 & 1986; Black & Strub, 1979; Lezak, 1983). Thus, inflated Digits Difference scores may alert the clinician to the possibility of cerebral impairment.

In addition, the separate reporting of Digits Forward and Digits Backward raw scores, may assist in the identification of the learning disabled. In this regard, Hulme & Mackenzie (1992) note that children with severe learning difficulties experience profound difficulties with verbal working memory tasks. It is also suggested that children who experience comprehension difficulties appear to have a working memory impairment (Oakhill, 1993; Swanson, 1991; Yuill & Oakhill, 1991). Others have found working memory problems in reading-disabled subjects (Beale, Matthew, Oliver & Corballis 1987; Siegel, 1988 & 1992; & Smith, Mann & Shankweiler, 1986). Therefore, it is proposed that because Digits Backward examines working memory, the separate reporting of this raw score may be useful in the identification of the learning/reading disabled child, in addition to being useful in assessing cerebral pathology.

Research in this area has revealed that the average range of normative data for children and adults on Digits Forward is 6 +/- 1; and on Digits Backward varies from 4 to 6 (Black, 1983 & 1986; Black & Strub, 1979; Botwinick & Storandt, 1974; Lezak, 1983; Shuttleworth-Jordan, 1992; Spitz, 1972). Normative data for Digits Difference scores in children, are reported as 1 to 2 (Black, 1983). However, no normative data have been published on South African children for Digits Forward, Digits Backward and Digits Difference.

The expansion of Digit Span into a test of new learning ability (Digit Supraspan) is a recommendation which has been made because the verbal scale of the WISC-R does not examine this function. The rationale for the extension of the Digits Forward Subtest, appears to be based on the premise that rote repetition of meaningless information can lead to learning (Baddeley, 1978; Lezak, 1983). Further, like memory, this is a function that is very sensitive to numerous kinds of cerebral pathology involving both localized and/or diffuse damage (Shuttleworth-Jordan, 1992). As learning is dependent upon short-term memory, inclusion of a test which taps short-term auditory-verbal memory, may assist in identifying the laterality of lesions, because an impairment in this function is often the sequelae of left hemisphere damage, in the posterior parietal region (Vallar & Shallice, 1990). In addition, it may also aid clinicians in the identification of learning disabled children as these children appear to have an impairment in this function (Waldron & Saphire, 1992). In this respect, Douglas & Benezra (1990) researched hyperactive, normal and reading-disabled boys (aged 7 to 12) on Supraspan verbal tests. Results revealed that, across all verbal tasks, subjects with ADHD performed significantly more poorly than the others, on any tasks requiring organized, deliberate rehearsal strategies, sustained strategic effort, and careful consideration of alternative responses. Similarly, Morgan, Dawson & Kerby (1992) identified auditory-verbal memory deficits in children (aged 4 to 6 years) with speech/language difficulties. Carpentier & Mulhern (1993) posit that a verbal memory impairment is likely in children who have received radiation treatment for cerebral tumours. Finally, Gathercole & Adams (1993) suggest that serial span and repetition procedures can be used reliably to assess phonologic memory skills in the very young (below 4 years). Together, these studies therefore suggest that Digit Supraspan is useful in the assessment of cerebral pathology, in the identification of children suspected of ADHD and speech/language disorders, in screening for deficits in short-term auditory-verbal and phonologic memory of the learning disabled.

Shuttleworth-Jordan (1992) outlines the procedure for the Digit Supraspan Test, which she notes has already been described by Zangwill (1943) and McFie (1975). They argue that Digit Supraspan is an easy extension of the existing WAIS Digits Forward Subtest. In order to administer Digit Supraspan, the subjects' normal memory span for Digits Forward needs to be established according to Wechsler's standard procedure. The researcher then ascertains the number of trials required to correctly recall the sequence of digits which exceeds the subjects' normal memory span. As the Digits Forward Subtest of the WAIS is equitable to the Digits Forward Subtest of the WISC-R, the procedure suggested for Digit Supraspan, may be duplicated for the WISC-R.

Normative data have been established for adults on Digit Supraspan. Most normal adult subjects recall this sequence of digits, which is one digit above their normal immediate memory span, in 2 to 3 repetitions (McFie, 1975; Shuttleworth-Jordan, 1992). However, Shuttleworth-Jordan's (1992) research shows that Digit Supraspan is sensitive to the effects of aging and that inflated scores for the elderly (70 to 80 year olds) are more frequently obtained than in the younger age groups. For these latter older groups she suggests a normative range of 2 to 4 repetitions.

No normative data for Digit Supraspan in children have been published to date. Further, the relevant studies in adults were limited to establishing the number of repetitions needed to correctly recall a sequence of digits which is one digit above the normal immediate memory span. Thus, no research appears to have examined how many repetitions, of this same series of digits, it would take to sustain this learning, that is, to store the new information beyond the limits of working memory or rehearsal. The usefulness of making this distinction is noted by Erickson & Scott (1977). It is suggested that a subject's sustained learning ability may be examined by continuing to repeat the same sequence of digits as administered in Digit Supraspan, until this sequence is recalled correctly on two consecutive trials. In order to distinguish between the tests of verbal new learning and sustained learning, it is recommended that the former be referred to as Digit Supraspan A, and the latter as Digit Supraspan B. Clearly, normative data are required on both these tests in children.

1.4.2 The Extension of Coding

The method for extending the WAIS-R Digit Symbol (the adult equivalent of Coding), was first described by Edith Kaplan (Lezak, 1983; Shuttleworth-Jordan, 1992). More recently, Shuttleworth-Jordan & Bode (in press) conducted a study on the extension of the South African Wechsler Adult Intelligence Scale (SAWAIS) Digit Symbol Subtest into a test of short-term visual memory (Digit Symbol Incidental Recall). While Lezak (1983) reports that normal Digit Symbol Recall scores in adults are 7 out of 9, she gives no age references. It appears that only Joy, Fein & Kaplan (1992) and Shuttleworth-Jordan & Bode (in press) have presented age-differentiated normative data for this test. Based on these two studies, normative score guidelines on the Digit Symbol Incidental Recall test are as follows: Age 20-39 = 7; Age 40-59 = 5-6; Age 60-69 = 5-6; Age 70-79 = 4-5; Age 80-89 = 3-4 (Shuttleworth-Jordan & Bode, in press).

Hart, *et al.* (1987) report that Digit Symbol Incidental Recall is useful in identifying Alzheimer's Dementia and discriminating effectively between depression and this disease. They found that depressed patients scores (4.3) were lower than scores of normal patients (6.4), while those suffering from mild dementia of the Alzheimer's type were significantly lower (0.7) than the scores of both depressed and normal patients.

With respect to Coding, a limited number or research studies on extending this subtest into a test of incidental recall have appeared. These studies are outlined in detail. Firstly, Collaer & Evans (1982) incorporated a measure of incidental visual memory in the WISC-R by using a variation of the basic Coding test which they called Coding Recall. They administered the Coding B test of the WISC-R to 305 third, fourth, fifth and sixth grade children from two elementary schools of an army base in the United States of America. Subjects included both white and non-white race groups and were representative of the general population in terms of intelligence. Wechsler's (1974) standard instructions were adapted for group administration. Each subject was provided with a standard WISC-R Coding booklet (see Appendix II), and a separate sheet for Coding Recall. Collaer & Evans (1982) did not mention that a recall test would be administered later. After the two minute Coding test, all booklets were collected. Coding Recall was immediately administered. Collaer & Evans (1982) note that the format of Coding Recall was similar to an enlarged Coding key, except the blocks below each number were left blank. Subjects were requested to insert the appropriate symbols in the blocks. About one to 1 1/2 minutes were required to complete this test. Maximum score on this test is 9, with one point being given for each accurately drawn and associated symbol, and 1/2 point for any accurately drawn, but misassociated symbol. Mean scores and standard deviations (S.D.) were presented by the study as follows: Age 8, males 5.3 (S.D. 2.3), females 6.3 (S.D. 1.8); Age 9, males 6.2 (S.D. 1.5), females 6.1 (S.D. 1.8); Age 10, males 6.3 (S.D. 1.6), females 6.2 (S.D. 2.2); Age 11, males 6.5 (S.D. 1.7), females 7.1 (S.D. 1.6); Age 12, males 7.2 (S.D. 1.6), females 7.7 (S.D. 1.1). Collaer & Evans (1982) found that, although Coding Recall has face validity, its validity as a measure of incidental visual memory is low compared to the Bender Recall test. Therefore, they caution clinicians not to rely solely upon Coding Recall as a generalised measure of visual memory.

In a more recent study on Coding Recall, Imm, Foster, Belter & Finch (1991) examined 216 children and adolescent psychiatric inpatients (aged 8 to 16 years) at the Medical University of South Carolina, USA. Coding B of the WISC-R was administered according to standard instruction (Wechsler, 1974). Upon completion thereof, a folded blank piece of paper was placed over the key covering the symbols, so that only the numbers were visible. The subjects were instructed to complete as many symbols as they could remember. Scores ranged from 0 to 9 with only the correct associations being credited. Mean scores and standard deviations were presented as follows: Age 8-9, 3.1 (S.D. 2.0); Age 10-11, 4.1 (S.D. 1.9); Age 12-13, 4.9 (S.D. 2.2); Age 14-16, 5.6 (S.D. 2.5). Imm *et al.* (1991) found that Coding Recall correlated positively with the Bender Recall test and that age effect for the number of symbols recalled was significant. They suggest that although the nine Coding symbols are less complex than the nine Bender designs, the Coding Recall task is the more difficult task, as subjects scored slightly higher on Bender Recall compared to Coding Recall. They believe that the longer exposure time to items on the Bender (approx. 6 minutes), gave the subjects 3 times the amount of exposure than Coding which is limited to 2 minutes. Further, they also found that subjects with IQ scores less than 80, recalled significantly less symbols than those with higher IQs. They concluded that Coding Recall is a useful test of short-term visual memory as it is quickly and easily administered during the standard administration of the WISC-R.

Finally, another study by Murdoch, Fleming, Skuy, Painter, Schmidt & Schutte's (1994) of 46 asymptomatic, black South African children (aged 11 to 16 years) also included tests on Coding Recall, at three and thirty minutes. They reported that, at the time of testing, all subjects were in their first year of high school (although some were repeating the standard); were of relatively high socio-economic status; were Zulu (18), Tswana (9), Xhosa (2), Sotho (16) and English (1) speaking; were estimated to have mean FSIQ scores ranging from 80 to 101; reported mo major attention, concentration or learning problems. Mean scores and standard deviations were presented as follows: Coding Recall (3 min.): Age 11-15, males, 7.4 (S.D. 1.9), Age 11-16, females, 6.0 (S.D. 2.1); Coding Recall (30 min.): Age 11-15, males, 6.4 (S.D. 2.7), Age 11-16, females, 6.1 (S.D. 1.9).

1.4.2.1 Problematic Areas in Previous Research on Coding Recall

A number of problematic areas are evident in the Coding Recall studies reported above. In the Collaer & Evans (1982) study, subjects did not receive equal practice of pairing symbols and numbers prior to the administration of Coding Recall due to variable performance on the 2 minute Coding test; the standardized administration instructions of the WISC-R manual were altered in order to administer the Coding test to small groups as opposed to individuals; only Coding B was dealt with; and Coding Recall was limited to an immediate trial of visual memory. In the Imm *et al.* (1991) study, normative data for both Coding and Bender Recall tests are based on a psychiatric population. It is uncertain whether these data are valid for non-clinical populations. Further, subjects' educational levels were not given. Like the previous study, subjects did not receive equal practice of pairing symbols and numbers prior to the administration of Coding Recall; only Coding B was administered; and Coding Recall was limited to a test of immediate incidental recall. Finally, the Murdoch *et al.* (1994) study was methodologically extremely problematic for the following reasons: The research sample included 11 subjects who had histories of head injury, motor vehicle accident injury or assault and some who had previously failed a standard at school (number not specified); subjects' FSIQ scores, estimated according to the point score of the D-A-P test, ranged from 54 (Mild Mental Retardation) to 123 (Superior); no detailed administration procedures were given, nor was the language in which the tests were administered specified; mean age per educational standard was not held constant for comparison purposes; and only normative data for Coding B Recall were presented which were not age-graded.

Taken together, three important points emerge. Firstly, all previous studies on the WISC-R Coding Recall test appear to be limited to ages 8 to 16. Thus, there is no published normative data for ages 6 and 7. For this reason, the scope of the present study was restricted to the collection of normative data on non-clinical South African school children aged 6 to 7 for all tests administered. Secondly, there were no consistencies across the three studies with respect to practice of pairing symbols on the Coding task, prior to being examined on recall. Given that Lezak (1983) and Schachter (1980) point out that rehearsal facilitates memory, it is recommended that each subject be given equal opportunity to practice pairing symbols and numbers, prior to being examined on Coding Recall. This can easily be done by allowing the subject to finish the test after completion of the standard 2 minute administration of Coding. Thirdly, except for the most recent study by Murdoch *et al.* (1994), previous studies on Coding Recall have only administered tests of immediate visual recall which are unable to clearly distinguish between subjects with right and left cerebral involvement while tests of delayed visual recall have been found to be sensitive to lateralized cerebral damage (Delaney, Rosen, Mattson & Novelly, 1980; Lezak, 1983). As numerous researchers advocate administering both immediate and delayed trials of recall, it is suggested that this recommendation be adhered to when administering Coding Recall (Joy, *et al.*, 1992; Lezak, 1983; Mills & Burkhart, 1980; Russell, 1975). In this respect, Donders (1993) examination of immediate and delayed recall of a complex geometric figure in children (aged 10 to 16 years) with traumative brain injury, suggested that the severely impaired children tended to show depressed visual recall scores more consistently than the mild or moderately injured children. Hence, it appears that a delayed administration of Coding Recall may be useful in assessing the laterality and severity of brain damage in children.

It is therefore suggested that Coding Recall (Immediate) is more a test of rehearsal, than pure immediate memory; while the Coding Recall (Delayed) test is somewhat more difficult to classify because recall may vary from subject to subject, given that the duration of short-term storage varies from approximately 30 seconds to one hour (Lezak, 1983; Watkins, 1974), and may even last for a day or two before dissipating (Rosenzweig & Leiman, 1968; Thatcher & John, 1977). At the same time, however, the duration of long-term storage varies from as short a time as needed for consolidation (the process of storing information in long-term memory), which may be anytime from a half a second onwards after the information entered short-term storage (Baddeley, 1978). This argument is supported by the Wilson, Scott & Power (1987) study, the results of which suggest that the system for pattern representation is shared by short- and long-term visual memory. Thus, this delayed trial may also be examining long-term memory.

1.5 Factors Affecting Test Performance

1.5.1 Age

The importance of presenting age-differentiated normative data for children cannot be overemphasized. In this respect, Lezak's (1983) posits that age-graded scores are necessary for subjects below the age of twenty. The tests investigated by the present study, involve various aspects of memory which have been well documented to be sensitive to the effects of aging. There are numerous researchers who suggest that a child's memory span increases with age (Isaacs & Vargha-Khadem, 1989; Ladish & Polich, 1989; Siegel & Ryan, 1989). They noted that this was especially the case with a child's short-term verbal memory span for Digits Forward and Digits Backward. Similarly, a positive correlation between age and short-term visual memory in children has been revealed by the Wilson *et al.* (1987) study which noted that pattern span increases rapidly from the ages 5 to 11. Finally, another study reveals that visual incidental recall increased with increased age and education in children (Grades 1 to 3) (Mishra & Singh, 1992). They argued that this appeared to reflect increasing sophistication of information processing strategies. Thus, it is anticipated that the provision of age-differentiated normative data for Digits Forward, Digits Backward, Digits Difference, Digit Supraspan A & B, and Coding A Incidental Recall (Immediate & 30' Delayed), will furnish clinicians with much needed age-graded cut-off scores for these tests.

1.5.2 Sex

Generally, where sex differences have been noted in cognitive test performance, it appears that opinion is confined to a particular pattern. In children and adults, males are generally superior on complex arithmetic problems and visuospatial tasks (Harris, 1978; Lezak, 1983; Nash, 1979; Sherman, 1978 & 1982), while females are usually superior in verbal tests (Cohen & Wilkie, 1979; Lezak, 1983; McGlone, 1976). In children, gender is thought to be an especially important variable due to the starts and fits of normal development and the differential rate of development between boys and girls (Lezak, 1983). However, the research literature on auditory-verbal memory and visual memory (the functions examined by Digit Span, Digit Supraspan, Coding and Coding Incidental Recall), appears to dispute that gender is an important variable in cognitive test performance in children. With regard to auditory-verbal memory, Shen (1985) reports no significant effect for sex. Likewise, McGuinness, Olson & Chapman (1990) reported no sex differences in incidental recall for words in children aged 8 to 9 years. Similarly, on tests of visual memory, no evidence has been found to suggest sex differences (Shen, 1985; Aliotti & Rajabiun, 1991).

With specific reference to the WISC-R, a literature review of sex differences reveals conflicting results. Vance, Hankins and Brown (1988) dispute that sex differences exist on this intelligence battery. However, Carvajal, Roth, Holmes and Page (1992) found that sex differences were evident in their study of forty children (aged 6 years). Likewise, Lynn & Mulhern (1991) found that females scored higher on Digit Span than males (aged 6 to 16 years), while Bromham & Jupp (1991) found that males scored higher than females (aged 6 to 18 years). With respect to Coding, the findings are also mixed and some researchers argue that females consistently score higher than males (Phelps & Ensor, 1987; Smith, Edmonds & Smith, 1989; Lynn & Mulhern, 1991), while others posit the opposite (Moriarty & Ryan, 1987). Phelps & Ensor (1987) propose an interesting explanation for this controversy. They argue that the basis underlying construct being measured by Coding does not differ by sex because, females appear to have superior visual-motor coordination and speed, while males have superior spatial analysis and synthesis skills.

1.5.3 Language

Research on language effects on cognitive test performance is minimal, with information being available on Digits Forward and Digits Backward. In this respect, significant language effects were reported (Hoosain, 1979; Jensen & Figueroa, 1975; Lezak, 1983). Further, Chen & Stevenson (1988) suggest that children's (aged 4 to 6 years) test performance on Digits Forward may be affected by the speed of language, as this task appears to be a function of pronunciation. It is unknown whether administration of this test in a subject's first or second language, may differentially affect the subject's pronunciation speed, and consequently their test performance. A negative effect seems more likely in subjects who are required to complete cognitive tests in their second language. The differential effect of being tested in a first or second language is especially relevant to clinicians in South Africa as eleven official languages are now recognised, while English appears to be the most commonly shared language. With the fairly recent move to indigenous psychology, much research is now being undertaken on developing more relevant test batteries, for example, the Individual Scale for Xhosa speaking pupils (Landman, 1988). However, Shuttleworth-Jordan (1994) argues that abandonment of test batteries, which have been based on westernized populations, is only appropriate when testing rural and illiterate or semi-literate populations. She posits that in her experience, urbanized black subjects often prefer to respond in English rather than in their own language on tasks which require the repetition of digits, even with an interpreter present. Whether Coding and Coding Incidental Recall are administered in a subject's first or second language is unlikely to have an affect on test performance because these are performance and not verbal tests.

1.5.4 Race

The issue of race effects is particularly relevant in South Africa, where the existence of separate cultures is acknowledged and readily accepted by most. This fact is clearly apparent by the popular description of the new South Africa, as the land of the rainbow people. Hence, although race classifications are a legacy of apartheid, they appear to be more readily accepted and used by different race groups in South Africa. Generally, differential racial effects have not been reported in neurological functioning (Lezak, 1983). Similarly, on WISC-R test performance of children (aged 7.1 to 13.6 years), Juliano, Haddad & Carroll (1988) found that there were no significant differences between black and white groups. This is supported by numerous other studies (Naglieri, 1986; Vance, *et al.* 1988). There appears to be no information regarding ethnicity effects on Digit Supraspan A & B, Coding, and Coding Incidental Recall. However, research on Digits Forward and Digits Backward suggest that race plays a variable role on test performance (Jensen & Figueroa, 1975; & Hoosain, 1979).

1.5.5 Education

It is generally acknowledged that education has a variable effect on cognitive test performance (Lezak, 1983; Walsh, 1987). This is especially the case with tests which involve verbal skills, stored information and other school type activities (Lezak, 1983). In children, Mishra & Singh (1992) found that education is positively correlated with test performance on incidental visual recall and suggest that education facilitates sophistication of information processing strategies. Studies on WISC-R performance, highlight the need for level of education to be a standardized variable (Carvajal *et al.,* 1992). Other than this general study, there appears to be no specific information on the effect of education on Digits Forward, Backward, Difference, Supraspan, Coding, and Coding Incidental Recall in children.

1.5.6 Anxiety

Once, again it appears that information in this respect is limited, although it has been well documented that anxiety adversely impacts on the number of digits recalled, however, this adverse effect tends to disappear with practice (Lezak, 1983; Mueller, 1979; Mueller & Overcast, 1976; Pyke & Agnew, 1963). It is recommended that the Digit Span subtest should be repeated later if anxiety is suspected (Lezak, 1983)

1.5.7 Depression

Incidental recall, one of the functions examined by Coding Recall, is negatively affected by depression (Prieto, Cole & Tageson, 1992). Once again, no research appears to have been carried out on the specific effects of depression on Digits Forward, Backward, Difference, Supraspan A & B, Coding and Coding Incidental Recall in children.

1.6 A Statement of the Aims of this Study

Taking into account the methodological limitations of previous studies, and the key variables which effect test performance in children as described above, it was decided to conduct a study to provide normative data on the test performances of non-clinical South African children, restricted to ages 6 and 7, on Digits Forward, Digits Backward, Digits Difference, Digit Supraspan A & B, and Coding Incidental Recall (Immediate & 30' Delayed). An additional aim of this study, was to investigate the influence of sex, English versus Xhosa language, white versus black race groups on these tests. It was hypothesized that no sex, language (English versus Xhosa speaking groups), or racial differences (white versus black race groups) would be found.

CHAPTER 2 : METHODOLOGY

2.1 Subjects

2.1.1 Demographic Data

A total of 56 non-clinical South African subjects from three local English speaking Grahamstown schools were included in this study. The sample consisted of two matched age groups: Group 1 (6 year olds), 28 subjects (11 male and 17 female); and Group 2 (7 year olds), 28 subjects (13 male and 15 female). The first language of all subjects was either English (19 male and 23 female) or Xhosa (5 male and 9 female). Each age group consisted of 21 English and 7 Xhosa speaking subjects, a 3 to 1 ratio respectively. Race was made up as follows: Group 1 (6 year olds), 16 white, 7 black, 3 coloured, 1 Chinese and 1 Indian subject/s; and Group 2 (7 year olds), 20 white, 7 black and 1 coloured subject/s. (As the term 'coloured' is gaining recognition as an authentic sub-culture, it will be adopted in this study.) Educational level ranged from pre-primary (17 subjects); Sub Standard A (36 subjects) to Sub Standard B (3 subjects). Teachers confirmed that no subjects had ever previously failed a standard.

All subjects were of middle class socio-economic status and resident in the Eastern Cape at the date of testing. All subjects, with the exception of 3, were born in South Africa. Subjects participated voluntarily with the approval of the relevant school authorities and parents. No subjects reported any problems with vision, hearing or manual dexterity. Any subject who received remedial teaching and/or occupational therapy and was identified as learning disabled, was excluded from this study (5 subjects). No subjects had a history of psychiatric intervention, brain trauma, or neurological disorders indicative of any cerebral pathology, nor were they under the influence of any sedative medication.

Initially subjects were recruited by the researcher from two Grahamstown English speaking schools, at which all available aged 6 and 7 subjects were approached. Out of a total of 56 potential subjects, 4 were absent at dates of testing; 1 did not speak English; 1 refused to participate; 1 was denied permission to participate by her parents; and 5 were excluded on the basis of identified learning difficulties. In addition, in order to ensure a matched proportion of 3 to 1 for English and Xhosa speaking subjects in the two age groups, data were obtained by the researcher from a third Grahamstown English speaking school, which included all the available aged 6 children and all the available aged 7 Xhosa speaking children in Sub Standard A. Out of the 12 potential subjects approached, all 12 were tested.

The demographic data on all subjects with respect to age, sex, language, race and education appears in Table 1, page 27. The distribution of the groups in percentages with respect to age, sex, language, race and education appear in Table 2, page 28. Examination of Table 2 reveals that both sexes have been adequately represented in this study (42.9% male and 57.1% female); a 3 to 1 ratio of English versus Xhosa speaking subjects was constant across age groups (English 75% and Xhosa 25%); whites were the predominant race group (64.3%), followed by blacks (25%), coloureds (7.1%), Chinese (1.8%), and Indian (1.8%); Level of education ranged from Pre-primary (30.4%), Sub Standard A (64.2%) to Sub Standard B (5.4%); all Pre-primary subjects were age 6, all Sub Standard B subjects were age 7, while both age groups were represented in Sub Standard A. Tables 1 and 2 follow.

Table 1: Demographic Data - Age, Sex, Language, Race and Education

	Total Group	Age 6	Age 7
	n = 56	n = 28	n = 28
Age			
Mean	6.92	6.43	7.41
S.D.	0.58	0.32	0.27
Min -Max (Range)	6.08 - 7.92	6.08 - 6.92	7.00 - 7.92
Sex			
Male	24	11	13
Female	32	17	15
Language			
English	42	21	21
Xhosa	14	7	7
Race			
White	36	16	20
Black	14	7	7
Coloured	4	3	1
Chinese	1	1	0
Indian	1	1	0
Education			
Pre-primary	17	17	0
Sub Standard A	36	11	25
Sub Standard B	3	0	3

Table 2: Distribution of Sex, Language, Race and Education across Age Groups in percentages.(Column Totals)

	Total	Age 6	Age 7
Sex			
Male	42.9	39.3	46.4
Female	57.1	60.7	53.6
Language			
English	75.0	75.0	75.0
Xhosa	25.0	25.0	25.0
Race			
White	64.3	57.1	71.4
Black	25.0	25.0	25.0
Coloured	7.1	10.7	3.6
Chinese	1.8	3.6	0.0
Indian	1.8	3.6	0.0
Education			
Pre-primary	30.4	60.7	0.0
Sub Standard A	64.2	39.3	89.3
Sub Standard B	5.4	0.0	10.7

2.1.2 Intellectual Level

As a control for intellectual level, subjects were tested on the Draw-A-Person (D-A-P) test which was scored according to Goodenough's 51 Draw-A-Man Point Scale (1926); and Harris' 73 Man Point Scale or 71 Woman Point Scale (1963). The Final IQ Estimate was obtained by averaging these two Draw-A-Person scores. The means, standard deviations, range of scores and analysis of variance between age groups 6 and 7 appear in Table 3, page 29. There was no difference in mean IQ scores across the two age groups on either the Goodenough scoring scale ($p = 0.3950$) or the Harris scoring scale ($p = 0.3496$). A multivariate analysis of variance by sex, English versus Xhosa language and white versus black race groups on the total group (mean age 6.92) for the two Draw-A-Person scoring scales and the final estimated IQ, together with test performance, means, standard deviations, and range of scores appear in Table 4, page 30. No significant effects on final estimated IQ scores were found for sex, English versus Xhosa language or white versus black race groups.

These results suggest that both age groups were matched for intelligence with final estimated IQ scores of 117.46 for age group 6, and 117.64 for age group 7 ($p = 0.9641$). The mean IQ for both age groups fell in the High Average IQ range. The final estimated IQ scores for age group 6 ranged from 85 to 155 (Low Average to Very Superior), while age group 7 ranged from 92 to 139 (Average to Very Superior). These scores also reflect that no subject tested fell into the Mentally Retarded range. Tables 3 and 4 follow.

Table 3 : Age-related Data and Analysis of Variance by Age Group - Performance on the Draw-A-Person Test

Scoring Scale	Age Group	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Goodenough	6	28	126.64	16.58	88-165	0.3950	54
	7	28	123.07	14.52	94-144		
Harris	6	28	108.86	17.44	79-147	0.3496	54
	7	28	112.64	12.11	88-134		
Final IQ Estimate	6	28	117.46	16.24	85-155	0.9641	54
	7	28	117.64	13.13	92-139		

Table 4: Data and Analysis of Variance by Sex, Language (English versus Xhosa), and Race (white versus black) for the Total Group (mean age 6.92) for Performance on the Draw-A-Person Test

Scoring Scale	Sex Language Race	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Goodenough	Male	24	122.46	17.63	88-165	0.3218	54
	Female	32	126.66	13.80	97-160		
	English	42	125.71	14.94	94-165	0.4799	54
	Xhosa	14	122.29	17.59	88-152		
	White	36	125.56	15.28	94-165	0.5180	48
	Black	14	122.29	17.59	88-152		
Harris	Male	24	112.67	16.18	83-146	0.4125	54
	Female	32	109.31	14.14	79-147		
	English	42	111.83	15.11	79-147	0.3538	54
	Xhosa	14	107.50	14.70	83-128		
	White	36	111.22	15.54	79-147	0.4441	48
	Black	14	107.50	14.70	83-128		
Final IQ Estimate	Male	24	117.33	16.58	85-155	0.9234	54
	Female	32	117.72	13.26	92-153		
	English	42	118.50	14.40	94-155	0.4068	54
	Xhosa	14	114.71	15.50	85-132		
	White	36	118.11	14.84	94-155	0.4763	48
	Black	14	114.72	15.50	85-132		

The final estimated IQ scores for each subject were categorized by the researcher according to an intelligence rating scale adapted from Wechsler's Intelligence Classifications (Wechsler, 1974 p 26). See Appendix V. The teachers independently estimated the intellectual ability of each subject according to the same intelligence rating scale. This was based on their impressions of subjects' intellectual abilities as shown in the classroom. A multivariate analysis on both age groups for the researcher's and teachers' intelligence ratings is represented in Table 5, page 31. No significant differences between age groups were found. This once again suggests that both age groups were equally matched for intelligence.

A multivariate analysis of variance by sex, English versus Xhosa language and white versus black race groups on the total group for the researcher's and teachers' intelligence ratings appears in Table 6, page 32. No significant effects for sex, English versus Xhosa language and white versus black race groups were found in the researcher's intelligence ratings (p = 0.5098, 0.5723 and 0.6592). Similarly, the effect of sex was not significant in the teachers' intelligence ratings (p = 0.1439). However, language revealed a tendency towards teachers rating English speaking subjects more favourably than Xhosa speaking subjects (p = 0.0513), and race was significant in influencing the teachers' intelligence ratings with black subjects being evaluated more poorly (p = 0.0211). An analysis of variance of regression across age groups 6 and 7 showed that the correlations between the researcher's and teacher's intelligence ratings were not statistically significant (p = 0.1439, 0.4357 and 0.1606, See Figure 1, Appendix VII). It is probable that rather than invalidating the intellectual estimates of the researcher and teachers' ratings, this statistically low correlation, is due to the fact that the study population's IQ range was fairly narrow, with 24 subjects (43%) falling in the High Average Range (110 - 119) and the Superior Range (120 -125), Wechsler (1974). Tables 5 and 6 follow.

Table 5: Age-related Data and Analysis of Variance by Age Group - Researcher's and Teacher's Intelligence Ratings

Rating By	Age Group	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Researcher	6	28	4.29	1.27	2 - 6	0.5869	54
	7	28	4.46	1.17	3 - 6		
Teacher	6	28	3.82	0.94	2 - 6	0.4160	54
	7	28	3.63	0.86	2 - 5		

Table 6: Analysis of Variance by Sex, Language (English versus Xhosa) and Race (white versus black) for the Total Group (mean age 6.92) for Subjects' Intellectual Abilities as rated by the Researcher and Teachers.

Rating By	Sex Language Race	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Researcher	Male	24	4.25	1.36	2 - 6	0.5098	54
	Female	32	4.47	1.11	3 - 6		
	English	42	4.43	1.13	3 - 6	0.5723	54
	Xhosa	14	4.21	1.48	2 - 6		
	White	36	4.39	1.15	3 - 6	0.6592	48
	Black	14	4.21	1.48	2 - 6		
Teachers	Male	24	3.52	0.76	2 - 5	0.1439	54
	Female	32	3.88	0.97	2 - 6		
	English	42	3.86	0.83	2 - 6	0.0513	54
	Xhosa	14	3.32	0.99	2 - 5		
	White	36	3.96	0.79	2 - 6	0.0211	48
	Black	14	3.32	0.99	2 - 5		

2.2 Procedure

Subjects were all tested by the researcher who is proficient in neuropsychological assessment. On completion of an Interview Questionnaire (See Appendix 1), the tests were administered in the following order: (i) WISC-R Coding A Subtest; (ii) Coding A Incidental Recall (Immediate) Test; (iii) Draw-A-Person Test; (iv) WISC-R Digit Span Subtest; (v) Digit Supraspan Test; (vi) Coding A Incidental Recall (30' Delayed) Test. Approximately one hour per subject was required to obtain the history; to establish rapport; and to administer the selected battery of tests. Items 3 to 5 optimally ensured an average 30 minute delay between the immediate and delayed administration of Coding A Incidental Recall. As recommended by Wechsler (1974, p 54) the entire battery was given to each subject in a single sitting.

At each school, a testing room was chosen which ensured good lighting and was free from noise and interruptions. Children's desks and chairs were used to ensure the subjects were appropriately and comfortably seated. During the testing only the researcher and the subject were present. An introductory period of about five to ten minutes of informal conversation put the subjects at ease and helped ensure maximum effort during the testing. All subjects were then told the study's objectives, albeit in fairly simplistic terms. It was explained that all children aged 6 and 7 at their school, who wanted to take part in this study, were being asked to do tests which looked at how well they wrote, drew, listened and learned. They were reassured that they need only try their best. They were also told that most of the tests become more and more difficult and that no one was expected to be able to do everything. Finally, they were informed that these tests would take approximately half an hour. The researcher adopted the procedure of 'testing the limits' of some subjects where is was judged that lowered test performances were as a result of being distracted. A few subjects were retested at a later sitting where anxiety was suspected. Overall, the procedure adopted by this study ensured an integrative qualitative/quantitative approach.

2.3 Measuring Instruments

2.3.1 Interview Questionnaire (Appendix I)

In order to facilitate the gathering of biographical information, a standardized interview questionnaire (based on Bode, 1992) was drawn up. This included basic identifying data (name, age, sex, country of birth, and home language); educational data (school, current standard of education, and the educational level obtained by the head of the household); and socio-economic data (occupation of head of household). Reports of problems with hearing, vision, manual dexterity or learning were recorded on the questionnaire. (The identification and exclusion of subjects who experience problems with manual dexterity was especially important given that the Coding subtest of the WISC-R is dependent upon motor persistence and response speed.) Psychiatric and medical histories were taken to establish whether any subjects needed to be excluded from this study as a result of cerebral damage, head injury, or any other psychiatric or medical condition. Details of current medication were noted in order to exclude subjects whose test performance may have been compromised by the sedative effect of some medicines. Provision was made for additional comments the researcher wished to record. For example, the subject's hand preference and/or general demeanour. Finally, the end of the questionnaire facilitated the recording of all test scores, where each test was listed in order of administration.

2.3.2 WISC-R Coding Subtest and Coding A Incidental Recall Test (Appendices II and III)

In this study, Coding A was expanded to include a test of incidental recall immediately, and thirty minutes following presentation of this subtest. For easy of administering Coding A, the researcher modified the standard Coding worksheet (See Appendix II). A separate sheet was printed which contained an exact replica of this subtest, followed by two sets of 5 individual symbols, which are preceded by the headers Coding A Incidental Recall (Immediate); and Coding A Incidental Recall (30' Minute Delayed). (See Appendix III). This modified form was printed in two colours (red and blue) which retained an important change introduced by Wechsler in 1974 (p 15). Thus, both visual and cognitive concepts were incorporated.

The literature reveals various arguments regarding the distinction between visual and cognitive concepts. Harris (1963, p 199) posits that although a distinction has been made between functions as well as between visual and cognitive learning "cognition cannot so easily be separated into 'visual' and 'cognitive' elements". McFee (1961, p 54), on the other hand, states that visual concepts are "derived from form and surface elements of objects as seen in space and light, as opposed to cognitive concepts of objects derived from past learning". Harris goes go on to contend that McFee may have a point with the argument that by learning to observe visually, that is colour, size and shape, as well as cognitively, subjects may "see many more details and significant relationships as they respond to their environment, both visually and cognitively" (McFee, 1961 p 63 - 64).

In the light of the importance of both these concepts, it was considered that Coding A needed to be administered in **colour**, which is the correct standardized form of the test, as opposed to in black and white, which is often the case in practice when photostat copies of the test are used. A study by Holowinsky & Farrelly (1988) lends support to this argument. They found that scores on tests involving incidental visual memory, may be artificially depressed if the test is administered in black and white. In addition, it was also considered important that either two red lead pencils or felt-tip pens be provided. Although Wechsler (1974) argues for the use of two red lead pencils, a study by Gatewood (1987) assessed the effect of using a lead pencil or a felt-tip pen on WISC-R Coding performance for 40 children (aged 10 to 12 years) and found that the type of writing instrument did not affect writing speed.

Before administering the modified Coding A Subtest, the researcher placed a blank A4 sheet of paper behind this form and folded this in half, so that the tests of Immediate and Delayed Incidental Recall were obscured from the subject's view. The subjects were provided with two red lead pencils, but no eraser. The standard administration of Coding A was then followed. At the end of 120 seconds, the subject was stopped and the last symbol completed was ringed by the researcher. The subject was then asked to finish the test. It was interesting to note that most subjects were exceptionally pleased with themselves when they were allowed to finish Coding A to the end. This seemed to have a positive impact on their interest as they appeared to reinforce their efforts on subsequent tasks. The aspect of motivation is important when testing very young children as they are often so easily discouraged. In addition, this procedure ensured that each subject received the same amount of practice, that is, 45 blocks were completed in all cases. This is an important procedural point, as Schachter (1980) points out that rehearsal facilitates permanent storage. Similarly, Lezak (1983) notes that rehearsal sustains a subject's immediate memory, otherwise she argues that the information may only be stored between 30 seconds to several minutes. Where the subject finished before the time expired, this time was recorded.

The modified form was folded in half again so that only Coding A Incidental Recall (Immediate) was visible. This was then immediately presented to the subject while the researcher said, "I want you to fill in the things here (researcher pointed to the row of 5 symbols) with the same marks that you used just now, but this time see how many you can remember on your own". The final part of this test was administered approximately 30 minutes later. The subject was presented with the folded form with only Coding A Incidental Recall (30' Delayed) visible. The researcher then said, "Remember the test you did where you had to fill in the things here (researcher pointed to the row of 5 symbols) with red marks? Let us see how many you still remember". The immediate and delayed administration of Coding A Incidental Recall was not timed. In both cases, if the subject initially was despondent and stated he/she could not remember, the researcher encouraged the subject by saying, " I am sure you remember some. Go ahead and try your best". No further assistance or encouragement was then given. The standard scoring procedure for Coding A was followed (Wechsler, 1974 p. 99). The maximum score being 50 as this includes time bonuses for perfect performance. With respect to the immediate and delayed administration of Coding A Incidental Recall, the score is the number of symbols correctly paired. The maximum score being 5 for each test of recall.

2.3.3 Draw-A-Person Test (D-A-P, Appendix IV)

Subjects were provided with a blank A4 piece of paper, a pencil and an eraser. The researcher requested subjects to draw a person and to try their best. They were also informed that they could take their time with this test and were asked to tell the researcher when they were finished. Where subjects asked whether they should draw a boy or girl, the researcher replied, "As you like" in all instances. This ensured Harris' (1963) emphasis that the researcher should avoid any type of suggestion, was adhered to at all times. On completion of this test, the researcher asked to be told the gender of the person drawn. This was noted below the drawing.

Given that this was the only test from which subjects' Full Scale IQs (FSIQ) could be estimated, it was decided to use two scoring scales, the average of which would then constitute the subject's Final Estimated FSIQ score for this study. It was anticipated that this would ensure greater validity and reliability in the resultant estimated FSIQ score, than either scale could provide individually. In this regard Wechsler (1974, p 26) warns that an examiner should never estimate or infer a child's Full Scale IQ from his/her scaled score on a single test, or from an average of his/her scaled scores on a limited number of tests. This sentiment is also echoed by Kamphaus & Pleiss (1991). Nevertheless, it was considered that, for the purposes of this study, the use of the D-A-P test for estimating mean FSIQ scores was justified, as substantial correlation between an individual intelligence test result and the D-A-P test score for children between the ages of five and ten, has been found. (Harris,1963, p 247). Similarly, the findings of Bensure & Eliot (1993) suggests that developmental changes in childrens' drawing can reliably highlight changes in intellectual development, while the Atlas & Miller (1992) study revealed that the D-A-P test is an adequate screening estimate of intelligence. More over a literature review reveals that the use of the D-A-P test for accessing intellectual maturity in children, has been shown to be reliable and consistent across a number of drawings. (Goodenough, 1926; Harris, 1963; Anastasi, 1976). Finally, these findings appear to have been substantiated in a South African context as Richter's (1989) study, undertaken on human figure drawings by urban black school children (aged 5 to 8), confirms that the Draw-A-Man Test has validity as a general cognitive measure for these children. Lezak (1983) also argues that D-A-P tests are relatively independent of language and culture.

All subjects' drawings were first scored according to Goodenough's (1926) 51 point scale. From the raw score, a Mental Age score was obtained. This was then converted to a FSIQ score by dividing the Mental Age by the Chronological Age of the subject multiplied by 100. The gender of the figure drawn, the gender of the subject, the raw score, the Mental Age, the resultant FSIQ estimate and the items credited were recorded for each profile. Each D-A-P test was scored a second time, blind to the previous scale. Harris' (1963) 73 Man Point Scale (p 248 - 263) and 71 Woman Point Scale (p 276 - 291) were used for scoring male and female figures respectively. Harris' special short scoring guide for each point scale (p 275 and 292) was used once the researcher became sufficiently conversant with this scoring procedure. The gender of the figure drawn, the gender of the subject, the raw score, the standard Score, and the items credited were recorded for each profile. A Final Estimated FSIQ score for each subject was obtained by averaging the FSIQ and Standard Scores of the two scoring scales.

Tables 32 to 35 in Harris (1963) provide a conversion of the subject's raw score and age, to a standard score which represents the child's position in the test relative to his own age and sex group, in terms of a mean of 100 and a standard deviation of 15. This is comparable to the Intelligence Quotient (IQ) of the WISC-R which is set equal to the mean total score of 100 for each age, and the standard deviation is set equal to 15 IQ points. Further, Wechsler (1974, p 4) notes that in respect of percentile limits, the highest one percent of all children at each age will have IQs of 135 and above; the lowest one percent IQs of 65 and below; the middle fifty percent will have IQs from 90 to 110. This is also comparable with Harris' (1963) percentile limits, that is, the highest one percent will have standard scores of 133 and above; the lowest one percent will have standard scores of 67 and below; and the middle fifty percent will have standard scores of 90 to 110. Statistically, Wechsler's determination of the IQ value is directly comparable with Harris' standard score. Hence a standard score of 120 was interpreted in this study to be equal to an IQ score of 120.

2.3.4 Researcher's and Teachers' Intelligence Ratings (Appendix V)

As there is a significant positive correlation between teacher's evaluations of their scholars and their academic and cognitive test performance (Arcia, Ornstein, & Otto, 1991), a table adapted from Wechsler's (1974, p 26) Intelligence Classifications was drawn up in order to provide teachers with a standardized procedure for rating the intellectual ability of each subject. A naught to six rating scale was used which is equal to the intelligence range of Mentally Deficient (IQ 69 and below) to Very Superior (IQ 130 and above). The researcher's intelligence rating for each subject was dependent upon the subject's final FSIQ estimate, which was obtained in each case from the two scores of the D-A-P test. For example, where a subject's final FSIQ estimate was 114, the researcher rated this subject's intellectual ability as High Average with a rating score of 4. Once scoring of all the tests were completed and the researcher's intelligence ratings allocated, teacher's were asked to estimate the intellectual ability of each subject according to the same scale, based on their performance in the classroom. A teacher's intelligence rating was then recorded for each profile.

2.3.5 WISC-R Digit Span Subtest and Digit Supraspan Test (Appendix VI)

A form modified from Wechsler (1974 p 102 & 103) was drawn up to facilitate administration and scoring of the Digit Span Subtest; Digits Difference; and the Digit Supraspan Test (See Appendix VI). The Digits Forward and Digits Backward raw scores were recorded on the Interview Questionnaire under items 5. and 6. respectively (See Appendix 1). The standard administration of the WISC-R Digit Span Subtest was followed according to Wechsler (1974, p 102 & 103), except that the Digit Supraspan Test (based on Shuttleworth-Jordan, 1992) was administered immediately after Digits Forward and before Digits Backward as follows: When the subject failed both sequences of an equal length on Digits Forward, the researcher said, "That was a little difficult. I am going to say those numbers once more and we will keep trying until you get them right. Listen carefully, and when I am finished say them right after me". The last incorrectly recalled sequence was then repeated to the subject until the subject recalled it correctly. This constituted the Digit Supraspan A Test, and the number of repetitions taken by the subject, the score for this test. On completion of Digit Supraspan A, the researcher said, "That's right. Well done! Now let us try it again until you get it right twice in a row. Listen carefully, and when I am finished say them right after me". The same sequence is then repeated to the subject until the subject recalls it correctly on two consecutive attempts, the first of which represents the score for the Digit Supraspan B Test. It is important to note that the number of repetitions already taken for Digit Supraspan A were included in this calculation.

2.4 Statistical Data Analysis

The B.M.D.P. Statistical Software Incorporated Programme (1990) was used to compute all the statistics for this study. Decimals were rounded off where appropriate to the second decimal figure for all tabulated figures. The means, standard deviations, and range for all test scores, FSIQ estimates, and intelligence ratings were computed for each group separately, and then for the total group. Two-way and multi-way frequency tables were computed as measures of association between age, sex, English versus Xhosa language, white versus black race groups and education for the total group.

The effect of age on all test scores, FSIQ estimates, and intelligence ratings was then investigated by means of a multivariate analysis for Group 1 (6 years) versus Group 2 (7 years). Additional multivariate analyses were then computed for all test scores, FSIQ estimates, and intelligence ratings on the total group to compare male versus female, English versus Xhosa speaking, and white versus black subject performance. Analysis of variance of regression coefficients across age groups were computed in order to establish whether there were any significant correlations between the immediate and delayed trials of Coding A Incidental Recall, and between the new and sustained learning trials of Digit Supraspan A & B. Since there were relatively limited differences for the variables of age, sex, language (English versus Xhosa) and race (white versus black race groups), normative data for age groups 6 and 7 were collapsed, and a single table of guidelines for clinical practice was drawn up which presents the mean scores, standard deviations, and range of scores on all test investigated for the total group (56 subjects, aged 6 to 7 years). As an additional guide for clinical practice, it was possible to compile a second table reflecting normal and deficit scores on Digit Span, Digits Forward, Digits Backward, Digits Difference, Digit Supraspan A & B, Coding A, and Coding A Incidental Recall (Immediate & Delayed) tests. Normal scores were calculated on the total group by adding and subtracting one standard deviation from the mean score for each test. Resultant scores of .5 or more were rounded up, while scores of less than .5 were rounded down. Deficit scores fell outside this calculated range. All data, computations and transcriptions were double checked by the researcher. Although a second rater would have been desirable for the purposes of validity, this was not possible given the limited scope of this research project.

CHAPTER 3 : RESULTS

3.1 Test Data and the Effects of Age, Sex, English versus Xhosa language and white versus black race groups on Test Performance

Normative data on WISC-R Coding A, Incidental Recall (Immediate and 30' Delayed), WISC-R Digit Span, Digits Forward, Backward, Difference and Supraspan A and B tests, the means, standard deviations, ranges of scores and analysis of variance across ages 6 and 7, appear in Table 7, page 42. The effect of age on test performance was not significant for any of the tests (All p-values are greater than 0.05). A multivariate analysis of mean test scores for Group 1 (6 years) versus Group 2 (7 years) revealed relatively high p-values (except for Digits Backward). Although the difference between the two age groups in mean scores on Digits Backward is not significant ($p = 0.0986$), a slight tendency towards a difference was revealed. Table 7 follows.

Table 7 : Age-related Normative Data and Analysis of Variance by Age Group - Test Performance on: WISC-R Coding A (Scaled Score); Incidental Recall (Immediate and 30' Delayed); WISC-R Digit Span (Scaled Score): Digits Forward (Span); Backward (Span); Difference; Supraspan A and B.

Test	Age Group	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Coding	6	28	10.93	3.20	6 - 16	0.1943	54
	7	28	9.93	2.45	6 - 14		
Coding Recall (Imm.)	6	28	4.71	0.53	3 - 5	0.6466	54
	7	28	4.64	0.62	3 - 5		
Coding Recall (Del.)	6	28	4.71	0.60	3 - 5	0.5362	54
	7	28	4.61	0.69	3 - 5		
Digit Span	6	28	12.54	2.74	8 - 17	0.5324	54
	7	28	12.11	2.35	8 - 17		
Digits Fwd	6	28	5.57	1.03	4 - 7	0.2911	54
	7	28	5.86	0.97	4 - 7		
Digits Bwd	6	28	2.86	0.89	0 - 4	0.0986	54
	7	28	3.21	0.69	2 - 5		
Digits Diff	6	28	2.71	1.15	1 - 5	0.8101	54
	7	28	2.64	1.06	1 - 4		
Digit Supra A	6	28	6.85	6.45	1 - 25	0.2214	54
	7	28	5.07	4.09	1 - 16		
Digit Supra B	6	28	8.36	7.46	1 - 30	0.4938	54
	7	28	7.18	5.13	1 - 18		

A multivariate analysis of variance by sex, English versus Xhosa language and white versus black race groups on the total group (mean age 6.92) for all tests, together with test performance, means, standard deviations and range of scores appear in Tables 8, 9 and 10, pages 43-45. There were no effects for sex. For English versus Xhosa language, there were no significant effects, except on Digits Backward (p = 0.0345) with Xhosa speaking subjects performing more poorly (2.64, S.D. 0.63) than English speaking subjects (3.17, S.D. 0.82). For white versus black race groups, there were no significant differences on any of the tests except for Digit Span and Digits Backward (p = 0.0488 and 0.0479 respectively), with white subjects performing better than black subjects on these two tests. The mean score for white subjects on Digit Span was 12.92 (S.D. 2.55), while black subjects scored 11.36 (S.D. 2.17). On Digits Backward the mean score for white subjects was 3.17 (S.D. 0.88) while black subjects scored 2.64 (S.D. 0.63). Tables 8, 9 and 10 follow.

Table 8 : Normative Data and Analysis of Variance by Sex, Language (English versus Xhosa) and Race (white versus black) for the Total Group (mean age 6.92) for Test Performance on WISC-R Coding A (Scaled Score); Incidental Recall (Immediate and 30' Delayed).

Test	Sex Language Race	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Coding	Male	24	10.00	3.01	6 - 16	0.3371	54
	Female	32	10.75	2.76	6 - 16		
	English	42	10.40	2.99	6 - 16	0.9154	54
	Xhosa	14	10.50	2.56	7 - 14		
	White	36	10.42	3.05	6 - 16	0.9283	48
	black	14	10.50	2.56	7 - 14		
Coding Recall (Imm.)	Male	24	4.71	0.55	3 - 5	0.7408	54
	Female	32	4.66	0.60	3 - 5		
	English	42	4.74	0.50	3 - 5	0.1824	54
	Xhosa	14	4.50	0.76	3 - 5		
	White	36	4.69	0.52	3 - 5	0.3067	48
	Black	14	4.50	0.76	3 - 5		
Coding Recall (Del.)	Male	24	4.71	0.55	3 - 5	0.6342	54
	Female	32	4.63	0.71	3 - 5		
	English	42	4.67	0.65	3 - 5	0.9054	54
	Xhosa	14	4.64	0.63	3 - 5		
	White	36	4.64	0.68	3 - 5	0.9851	48
	Black	14	4.64	0.63	3 - 5		

Table 9 : Normative Data and Analysis of Variance by Sex, Language (English versus Xhosa) and Race (white versus black) for the Total Group (Mean Age 6.92) for Test Performance on WISC-R Digit Span (Scaled Score); Digits Forward (Span); Backward (Span); and Difference.

Test	Sex Language Race	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Digit Span	Male	24	12.13	2.09	8 - 15	0.6204	54
	Female	32	12.47	2.85	8 - 17		
	English	42	12.64	2.59	8 - 17	0.1011	54
	Xhosa	14	11.36	2.17	9 - 17		
	White	36	12.92	2.55	8 - 17	0.0488	48
	Black	14	11.36	2.17	9 - 17		
Digits Fwd	Male	24	5.79	0.93	4 - 7	0.6218	54
	Female	32	5.66	1.07	4 - 7		
	English	42	5.74	1.01	4 - 7	0.7616	54
	Xhosa	14	5.64	1.01	4 - 7		
	White	36	5.86	0.93	4 - 7	0.4703	48
	Black	14	5.64	1.01	4 - 7		
Digits Bwd	Male	24	2.92	0.58	2 - 4	0.3444	54
	Female	32	3.13	0.94	0 - 5		
	English	42	3.17	0.82	0 - 5	0.0345	54
	Xhosa	14	2.64	0.63	2 - 4		
	White	36	3.17	0.88	0 - 5	0.0479	48
	Black	14	2.64	0.63	2 - 4		
Digits Diff	Male	24	2.88	0.85	1 - 4	0.2496	54
	Female	32	2.53	1.24	1 - 5		
	English	42	2.57	1.23	1 - 5	0.2085	54
	Xhosa	14	3.00	0.96	1 - 5		
	White	36	2.69	1.12	1 - 5	0.3721	48
	Black	14	3.00	0.96	1 - 5		

Table 10: Normative Data and Analysis by Sex, Language (English versus Xhosa) and Race (white versus black) for the Total Group (Mean Age 6.92) for Test Performance on Digit Supraspan A and B.

Test	Sex Language Race	n	Mean	S.D.	Min-Max (Range)	P-value	DF
Digit Supra A	Male	24	7.25	6.53	1 - 25	0.1258	54
	Female	32	5.00	4.29	1 - 19		
	English	42	6.21	5.74	1 - 25	0.5553	54
	Xhosa	14	5.21	4.46	1 - 16		
	White	36	5.42	4.69	1 - 19	0.8902	48
	Black	14	5.21	4.46	1 - 16		
Digit Supra B	Male	24	9.04	7.80	1 - 30	0.1977	54
	Female	32	6.81	4.97	1 - 19		
	English	42	7.33	6.30	1 - 30	0.3815	54
	Xhosa	14	9.07	6.64	2 - 26		
	White	36	6.42	4.88	1 - 19	0.1262	48
	Black	14	9.07	6.64	2 - 26		

An analysis of variance of regression across age group 6 and 7 (See Figures 2 & 3 in Appendices VIII & IX) showed that there were significant positive linear correlations between the Immediate and Delayed trials of Incidental Recall (p = less than 0.00001, 0.0027 and less than 0.00001 for the total group, age 6 and 7 groups respectively); and between Digit Supraspan A & B (p-values for all three groups were less than 0.0001).

3.2 Normative Guidelines for Clinical Practice

Guidelines for clinical practice are presented in Tables 11 and 12, pages 46 & 47. Table 11 reflects the mean scores, standard deviations and range for the total group (56 subjects, aged 6 to 7 years, with mean estimated FSIQ scores of above average and a mean level of education Sub Std. A) on Digit Span, Digits Forward, Digits Backward, Digits Difference, Digits Supraspan A & B, Coding A, and Coding A Incidental Recall (Immediate & 30' Delayed) tests. Table 12 reflects normal and deficit scores for this population group on all tests investigated.

Table 11 : Interim Normative data on Digit Span, Digits Forward, Digits Backward, Digits Difference, Digit Supraspan A & B, Coding A and Coding A Incidental Recall (Immediate & 30' Delayed), for children aged 6 or 7, with English as a 1st or 2nd language, mean educational level of Sub Standard A, and mean FSIQ estimates of above average.

Test	N	Mean	S.D.	Min-Max (Range)
Digit Span	56	12.32	2.54	8 - 17
Digits Fwd	56	5.71	1.00	4 - 7
Digits Bwd	56	3.04	0.81	0 - 5
Digits Diff	56	2.68	1.10	1 - 5
Digit Supra A	56	5.96	5.43	1 - 25
Digit Supra B	56	7.77	6.37	1 - 30
Coding A	56	10.43	2.87	6 - 16
Coding Recall (Imm.)	56	4.68	0.58	3 - 5
Coding Recall (Del.)	56	4.66	0.64	3 - 5

N = Number of subjects

Table 12 : Interim Normal and Deficit Scores on Digit Span, Digits Forward, Digits Backward, Digits Difference, Digit Supraspan A & B, Coding A and Coding A Incidental Recall (Immediate and 30'Delayed) for children aged 6 & 7 with English as a 1st or 2nd language, mean levels of education of Sub Std. A, and mean estimated intelligence levels of above average.

Test	Normal Scores	Deficit Scores
Digit Span	10 to 15	Less than 10
Digits Forward	5 to 7	Less than 5
Digits Backward	2 to 4	Less than 2
Digits Difference	2 to 4	More than 4
Digit Supraspan A	1 to 11	More than 11
Digit Supraspan B	1 to 14	More than 14
Coding A	8 to 13	Less than 8
Coding A Recall (Imm.)	4 to 5	Less than 4
Coding A Recall (Del.)	4 to 5	Less than 4

CHAPTER 4 :DISCUSSION, EVALUATION OF THIS STUDY, CONCLUSION AND RECOMMENDATIONS

4.1 Discussion

From a clinical perspective, taking all the test results into consideration, the effects of age, sex, language (English versus Xhosa) and race (white versus black race groups) are minimal. Only Digits Backward showed a tendency towards an age effect with mean scores for 6 year olds of 2.86 (S.D. 0.89), and for 7 year olds of 3.21 (S.D. 0.69), although this was not statistically significant ($p = 0.0986$). Further, this difference is less than one integer, and in terms of clinical practice, relatively unimportant. Nevertheless, this insignificant trend appears to support the research literature of a positive correlation between increasing age and increasing Digits Backward scores in children (Isaacs & Vargha-Khadem, 1989; Ladish & Polich, 1989; Siegel & Ryan, 1989).

The absence of age effect on performances on these tests is contrary to findings noted by numerous researchers who all argue adamantly for age-graded normative data in children and adults (Isaacs & Vargha-Khadem, 1989; Ladish & Polich, 1989; Lezak, 1983; Rabbitt, 1992; Shuttleworth-Jordan, 1992; Shuttleworth-Jordan & Bode, in press; Siegel & Ryan, 1989). In the present study, it is highly likely that the absence of age effect is due to the relatively narrow age range, as the mean age for the total sample was 6.92 which suggests that the majority of subjects were either 7 years of age, or relatively close to turning 7. Consequently, the absence an effect for age is not surprising, and does not undermine the importance of age-differentiated normative data.

Although not a primary aim of this study, males and females were adequately represented in the sample (24 boys & 32 girls) in order to allow statistical comparison of test scores across genders. There were no significant differences with regard to gender. However, on Digits Supraspan A, there is a consistent trend for lower performance in male (7.25, S.D. 6.53) compared to female subjects (5.00, S.D. 4.29). Similarly, on Digit Supraspan B, males performed more poorly (9.04, S.D. 7.80) than females (6.81, S.D. 4.97). Clearly, the standard deviations are greater for males and this has importance clinical implications in that it suggests that males are more erratic than females in their performance on this test. Thus, low scores for males must be more cautiously interpreted on this test. Nevertheless, the statistically insignificant finding for sex effect on Digit Supraspan is consistent with the research literature on tests of short-term verbal memory (McGuinness *et al.*, 1990; Shen, 1985).

With regard to race, although the black subjects consisted of a smaller sample groups compared to the white subjects, there were no differences between the groups with respect to the variables of education and intelligence. However, a statistically significant trend for ethnicity was revealed for the Digit Span and Digits Backward tests, with black subjects performing more poorly (11.36, S.D. 2.17 and 2.64, S.D. 0.63), than white subjects (12.92, S.D. 2.55 and 3.17, S.D. 0.88). Wechsler (1974, p 21) notes that, "for each of the twelve tests in the battery, the distribution of raw scores at each age level was converted to a scale having a mean of 10 and a standard deviation of 3". Clearly, the mean scaled scores of white and black race groups on Digit Span, for both age groups investigated, fall into this normal range, but are relatively high when their standard deviations are considered. This is to be expected given the study sample's estimated mean intelligence scores which fell into the above average intelligence range. Clinically, however, the difference in mean scores for white versus black race groups on Digit Span and Digits Backward is of relatively limited utility in practice, as mean score differences are less than two and one integer/s respectively, and fall within one standard deviation of each other. Thus, the overall findings of the present study are consistent the research literature on WISC-R subtest performance, for which results have shown no significant effects for ethnicity (Juliano *et al.*, 1988; Naglieri, 1986; Vance *et al.*, 1988).

On the other hand, Murdoch *et al.* (1994) argue that ethnicity effects are present. However, their normative data were not educationally and age-differentiated as their figures were for Standard 6 children who ranged in age from 11 to 16 years. Nor did they report separate raw scores for Digits Forward, Digits Backward and Digits Difference. Scrutiny of the data presented in this study, reveals that mean Digit Span Scores for black South African children (aged 11 to 16 years) (6.82, S.D. 2.16), are substantially lower than those found in the present study (11.36, S.D. 2.17), notwithstanding that this latter black race group were far younger (aged 6 to 7 years). It is likely that Murdoch's *et al.* (1994) mean scores are less because they included subjects of low intelligence (some falling into the Mild Mental Retardation range), subjects who may have been cerebrally impaired (histories of head injury, assault and involvement in MVAs), and subjects who had repeated school standards. Overall, these subjects were clearly disadvantaged relative to the subjects included in the present study.

With respect to language, only Digits Backward showed an additional statistically significant effect, with English speaking subjects (3.17, S.D. 0.88) outperforming their Xhosa speaking counterparts (2.64, S.D. 0.63). However, as argued with respect to the race effects on Digit Span and Digits Backward, this difference is less than one integer, and is of little utility in clinical practice.

In sum, given the absence of statistically significant effects of age, sex, language (English versus Xhosa) and race (white versus black race groups) on Digits Forward, Difference, Digit Supraspan A & B, Coding A, Coding Incidental Recall (Immediate and 30' Delayed), and the relatively limited practical utility of the differences on Digit Span and Digits Backward, it was possible to draw up summary tables of user-friendly normative guidelines for clinical practice for children aged 6 or 7, with English as a first or second language, a mean educational level of Sub Standard A, and mean estimated intelligence levels in the above average range (See Table 11 & 12, p 45 & 46).

With respect to Table 11, the mean Digit Span score of 12.32 (S.D. 2.54) falls into Wechsler's high normal range for WISC-R subtest scores. Nevertheless, it appears that the lower than expected Digits Backward mean score, together with the poor performance of black subjects on this test, have negative skewed this result. The mean Digits Forward score of 5.71 (S.D. 1.00) is commensurate with the average score of 6 +/- 1 noted in the research literature for normal children (Black, 1983). However, mean scores on Digits Backward (3.04, S.D. 0.81) and Digits Difference (2.68, S.D. 1.10) are inconsistent with Black's (1983) normative scores of 4 to 6 and 1 to 2 respectively. This is a clinically important finding and suggests that factors other than age, sex, intelligence, education, or anxiety are involved. Further, it is unlikely that the limited effects for language (English versus Xhosa) and race (white versus black) on Digits Backward provide an explanation therefor. For example, there may be a developmental lag in the functions measured by Digits Backward in South African children (aged 6 to 7 years) compared to their North American counterparts. Perhaps children in developing countries are relatively disadvantaged with regard to mass media viewing, computer literacy and educational systems. A combination of these factors may account for their poorer performance on tasks requiring auditory-verbal working memory and internal visual scanning ability. This would account for their relatively lower scores on Digits Backward compared to Digits Forward, and the resultant inflated Digits Difference scores. These results suggest that normative data on Digits Forward, Digits Backward and Digits Difference for South African children were urgently needed.

Digits Supraspan A & B scores of 5.96 (S.D. 5.43) and 7.77 (S.D. 6.37) respectively, are elevated when compared to the Supraspan scores of 2 to 4 presented for adults (McFie, 1975; Shuttleworth-Jordan, 1992), which suggests that short-term verbal memory capacity is more advanced in adults than in children. This lends additional support to the reports that children's short-term verbal memory span increases with age (Isaacs & Vargha-Khadem, 1989; Ladish & Polich, 1989; Siegel & Ryan, 1989). Similarly, this shows that normative data specific to children are important.

The mean Coding A score of 10.43 (S.D. 2.87) is commensurate with Wechsler's (1974) normative standardized score of 10 (S.D. 3) for all WISC-R subtests. Unlike the high normal Digit Span score, the Coding A score is less than expected for a population with above average intelligence. Given the absence of variables such as age, sex, language (English versus Xhosa speaking groups), race (white versus black race groups), on Coding A, and that education, intelligence, anxiety and depression were controlled for, other factors must account for the relatively depressed scores. Since Coding is a sequential task, it is argued that it taps similar functions to Digits Backward, in the form of working memory and internal visual scanning ability. This provides further support for the argument posited above, that South African children may be disadvantaged compared to their North American counterparts with regard to mass media viewing, computer literacy, and education systems. Thus, it is possible that a combination of these factors may account for the poorer performance of both white and black South African children on tasks requiring working memory and internal scanning ability. However, these are tentative suggestions which warrant further research.

In contrast to the present study, Murdoch *et al.* (1994) argue for ethnicity differences on Coding scores. They found black subjects (aged 11 to 16 years with an educational level of Std 6) scored 7.43 (S.D. 2.69), while in the present study black subjects (aged 6 and 7 years with a mean educational level of Sub Std A), scored 10.50 (S.D. 2.56). Further, as the ages of subjects in this study are significantly younger than the ages investigated in Murdoch's *et al.* (1994) study, it is suggested that, given the normal cognitive development of children, the subjects tested in the present study should have performed more poorly than the older subjects, but this was not the case. Clearly, the present study's sample of subjects with mean IQ scores of above average, is unlikely to account entirely for this discrepancy. Thus, again it appears that the confounding effects in the Murdoch *et al.* (1994) study of large age variations per standard, the inclusion of subjects with low IQs and possible cerebral damage, as well as subjects who had failed a school standard, are more central to the observed difference between the two studies. For the tests of incidental recall, the mean scores for the total study population (aged 6 to 7 years) on Coding Incidental Recall (Immediate) were 4.68 (S.D. 0.58) and (30' Delayed) 4.66 (S.D. 0.64). These scores suggest that there is little fall off in short-term incidental recall after 30 minutes. This was also the case in the Murdoch *et al.* (1994) study, although the mean scores presented were relatively depressed.

In sum, in terms of clinical practice (See Table 12, page 47), the present study's findings suggests that test scores of less than 10 for Digit Span, less than 5 for Digits Forward, less than 2 for Digits Backward, more than 4 for Digits Difference, more than 11 for Digit Supraspan A, more than 14 for Digit Supraspan B, less than 8 for Coding A, and less than 4 for Coding A Incidental Recall (Immediate and 30' Delayed), should alert the clinician to possible problems with cerebral pathology, and academic skills or developmental disorders for children aged 6 to 7 years with English as a first or second language, a mean educational level of Sub Std. A, and mean estimated FSIQ scores falling in the above average range. Clinicians are cautioned against a common error of interpretation in implementing these normative guidelines, which is the false attribution of significance to comparatively depressed subtest scores. Further, Matarazzo (1990) notes that substantial subtest scatter is usual in normal individuals and that even marked discrepancies between subtest scores need to be assessed in a larger context. Finally, due to the extreme range of Digit Supraspan A & B scores, and the more erratic performance of males compared to females on this task, more care is necessary when using these scores.

4.2 Evaluation of the Study

4.2.1 Reliability of the Data

Subjects were selected according to stringent criteria and were excluded from this study if any aspect was found to be confounding. Before pooling the data from the three schools, there was evidence of very similar trends in the mean test scores. In addition, results revealed that both age groups showed remarkably similar trends in mean scores obtained on all tests. In fact, as no age effect between these groups was identified, the data could be pooled for both age groups. These findings suggest that both administration and scoring procedures were rigorously adhered to. It is anticipated that the present study obtained more reliable scores for Coding Recall, than previous studies, as all subjects received the same amount of practice of pairing symbols prior to being examined for incidental recall. The low standard deviation scores (0.58 and 0.64) for Coding Incidental Recall Immediate & Delayed respectively, lend further support to this suggestion.

Although the numbers for the Xhosa speaking and black race groups, were relatively small, lack of differences between these groups and the English speaking and white race groups, is consistent with the general trend of findings on lack of race differences when age and level of education are strictly controlled (Shuttleworth-Jordan, 1992 & 1994; Shuttleworth-Jordan & Bode, in press). Thus, the data are considered to be a reliable guideline to clinicians of normal performance for both English and Xhosa speaking populations, and white and black race groups on these tests. It is likely that above average mean estimated intelligence levels, may have contributed to inflation of these scores and caution is therefore required when using these normative guidelines for populations of lower intelligence levels.

Given the limited scope of this research project, test-retest data was not collected. However, it is recommended that future researchers attempt to do so as this would then establish the stability of the tests over time as well as highlight the existence of any practice effects.

4.2.2 Value of the Study

Shuttleworth-Jordan's (1992) study appears to present the first normative data on Digits Forward, Digits Backward and Digit Supraspan for age groups in the 60's, 70's & 80's, as well as being the first study to present norms on these tests when English is the second language. She argues that normative data on South African individuals who are of above average intelligence, are useful in clinical and medico-legal settings in South Africa, as it is these individuals who are most likely to be incorrectly declared cognitively intact when compared to norms based on populations with average intelligence. Similarly, she points out that the provision of normative data for individuals who are tested in their second language, will clarify interpretation of these test results. Thus, if is argued that this study has similar utility for children of above average intelligence (aged 6 and 7 years), who would also be more likely to be misclassified if their test performance is compared to norms based on populations with average intelligence. Although many researchers argue that norms may not necessarily be appropriate when used in population groups other than the original normative population (Anastasi, 1976; Cole & Means, 1981; Crawford-Nutt, 1977; Viljoen, Levett & Tredoux, 1994), it appears that the present study adds further support to the argument that, when urbanized South African black children (aged 6 and 7 years) are tested, and education is controlled for, their cognitive test performance appears to be no different, in clinical terms, from the white children's performance. This has important implications in South Africa where there is a strong trend towards indigenous psychology and the development of more culturally appropriate cognitive tests. With the increasing trend of urbanization, it is anticipated that the rural population will continually be more exposed to westernized culture, especially as many rural families are often supported, and visited by relatives who have relocated to urban areas. Thus, it is anticipated the general utility of test batteries, like the WISC-R, on South African populations, will improve over the years as increased educational and employment opportunities occur, which is likely to result in improved socio-economic status. This is possible as the provision of standardized education, more employment and better housing are three of the objectives of the Reconstruction and Development Programme which is currently being implemented in South Africa. Hence, the findings of the present study supports Shuttleworth-Jordan's (1994) argument for utilizing well known and internationally used test batteries for all urbanized race groups with controls for age and education.

Clinicians are encouraged routinely to note the separate raw scores for Digits Forward, Backward, and Difference, to extend the Digits Forward test into a Supraspan test of new and sustained learning and short-term auditory verbal memory, as well as to extend the Coding test into an immediate and delayed test of incidental recall, as interim normative data are presented by this study for comparative purposes. However, the findings of this study suggest that caution needs to be implemented by clinicians when assessing children, as an upward adjustment of the previously suggested deficit scores for Digits

Difference (3 or more) appears to be necessary for South African children who seem to be less proficient in working memory and internal visual scanning functions that their North American counterparts. Hence, only scores which exceed 4 for Digits Difference, are likely to be indicative of problems in these functions. Even then, additional neuropsychological investigation is required before this may be diagnosed. Likewise, caution is necessary when using the scores for Digits Supraspan A & B, as results reveal that a wide range of scores may be taken to reflect normality. Clearly, until a larger, standardisation study is undertaken on Digits Forward, Backward, Difference, Digit Supraspan A & B, and Coding Incidental Recall (Immediate & Delayed) for children aged 6 and 7 years, the normative data provided by this type of study on specific non-clinical reference groups, are the only available comparative standards for clinicians and researchers. It is suggested that the administration procedures adopted by this study should be duplicated with exactness by clinicians and researchers when using these norms for comparative purposes in order to eliminate any confounding variables, and to ensure test reliability.

In sum, it is considered that the objectives of this study were obtained. An adequate sample size was achieved, although a larger population of Xhosa speaking and black subjects would have been preferable. Age groups were found to be of equivalent intelligence levels and the mean level of education for the total group was the same.

4.3 Conclusion

The primary motivation for this study was based on the paucity of normative data on Digits Forward, Backward, Difference, Supraspan and Coding Recall for children aged 6 and 7 years. Given that others (Collaer & Evans, 1982; Imm *et al.*, 1991; & Murdoch *et al.* 1994) had already addressed the need for a test of short-term incidental recall in children aged 8 to 16 years, age groups 6 and 7 were defined as the specific study groups for all tests investigated in this study. Although the data are relevant to a population with a higher than average level of intelligence and therefore are not considered representative of the general population with a normal distribution of intelligence, they nevertheless provide interim guidelines for all children aged 6 to 7 years as tests of attention, memory and learning in children, are known to be relatively independent of intelligence (Lezak, 1983). It is in this age group that early detection and treatment of attention, memory, and learning deficits is extremely important, as neurological pathways are still relatively accessible and it likely that many children will be able to adopt alternative cognitive strategies in order to fully or partially compensate for these deficits. This argument is supported by the theory of the plasticity of the developing brain, one approach of which suggests that the brain has a capacity to adopt new behavioral strategies, that is, the reorganization of existing functions, which may enable the brain-damaged subject to solve problems (Rourke, Bakker, Fisk, & Strong, 1983).

Due to the limited statistical effects for race (white versus black race groups) and language (English versus Xhosa speaking groups) when mean age and educational levels are the same, it must be concluded that, rather than second language and race effects, the importance of **education** in the development of cognitive abilities is paramount. More specifically, attention, memory and learning appear to be cognitive abilities which are not isolated from other cognitive processes, but are embedded in a larger cognitive and social context (Fivush & Hudson, 1990). Clearly, the need to present both age and educationally differentiated normative data for all tests of cognitive abilities is indisputable. Thus, the present study clearly demonstrates that the prevailing trend to reject all standard tests which are based on westernized populations, and to design new culturally relevant tests, may be necessary for rural, semi-literate or illiterate populations, but is misguided and unnecessary for urbanized populations if each age group is matched for the same level of education (Shuttleworth-Jordan, 1992 & 1994; Shuttleworth-Jordan & Bode, in press). Thus, normative data presented by this study are viewed as an initial step in the development of adequate comparative standards in 6 and 7 year old children of above average intelligence, regardless of race or language.

4.4 Recommendations

Additional research is required to establish whether the normative scores proposed by this study are representative for all non-clinical South African children aged 6 to 7, as the mean FSIQ estimate of the study group fell in the high average range. Given the paucity of normative data on Digits Forward, Backward, Difference, Digit Supraspan, Coding Incidental Recall (Immediate & Delayed) on South African children aged 8 to 16 years, research on this older group is also required. With regard to research areas on specific tests investigated by this study, it appears that much additional research is needed on Digits Backward, Coding and Coding Incidental Recall. Local children seem to be developmentally delayed in the functions examined by the Digits Backward and Coding A. Factors other than age, sex, language, race, education, intelligence, anxiety and depression appear to be responsible and require investigation. Further, it would be useful if researchers examined whether deficits on the 30 minute delayed trial of Coding Incidental Recall are able to discriminate effective between left and right lateralized lesions, which is possible on other tests of recall, according to the research literature. Research could also be undertaken with a view to providing normative data for the Coding Incidental Recall test for depressed children as well as those suffering from a dementia. It seems likely that in children, as in adults, researchers may find a significant variance in visual short-term memory impairment between depressive pseudodementia and dementia. This would indeed be a valuable diagnostic aid, as it would facilitate early identification and ensure appropriate treatment, which is particulary important with the non-progressive disintegrative psychoses (eg. encephalitis, infantile myoclonic seizures and lead encephalopathy) as these often benefit from early treatment (Barker, 1988).

With respect to general administration procedures, firstly, it is recommended that clinicians adhere to the standardized procedure of using a colour format for Coding and Coding Incidental Recall at all times, in order to avoid the possible confounding effects due to the use of black and white photostat copies. Secondly, studies investigating cognitive test performance in children should provide very clear administration procedures to facilitate test replication. This is especially important with young children as it appears that a longer time is needed to establish and maintain rapport than in older children (Wechsler, 1974). Additionally, based on the researcher's experience from tests administered in the present study, it appears that young children are likely to be distractible if their routine, for school breaks or special activities, is disrupted. Therefore, it is recommended that future researchers establish these times prior to commencing testing. It is also suggested that, at the outset, children are reassured that they will be finished before break, or back in time to participate in any special activities. It is likely, that the recommendations made in this study may be equally applicable for researchers who are currently collecting normative data on these tests for South African children, aged 8 to 16.

Finally, it is recommended that researchers and clinicians continually update their normative data, as it is clear that old norms may not account for the ongoing educational and experiential development of populations and may inflate subjects' abilities levels, so that even significantly impaired persons will appear to be normal (Nell, 1994). Clearly, the normative data used by researchers and clinicians must be based on equally comparable populations, and as Nell (1994, p 107) states

> norm development without prior construct validation are not norms, but fiction

Thus, the way forward for neuropsychological assessment, appears to be resolutely linked to the continual revision of normative data on cognitive test performance and ongoing philosophical questioning of its utility.

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APPENDIX I

INTERVIEW QUESTIONNAIRE

INTERVIEW QUESTIONNAIRE

DATE OF INTERVIEW: . . . .

NAME: . . . . DATE OF BIRTH: . . . .

SEX: . . . . COUNTRY OF BIRTH: . . . .

HOME LANGUAGE: . . . . SCHOOL: . . . .

CURRENT STANDARD OF EDUCATION: . . . .

OCCUPATION OF HEAD OF HOUSEHOLD: . . . .

EDUCATIONAL LEVEL OBTAINED BY HEAD OF HOUSEHOLD: . . . .

NORMAL TO CORRECTED-TO-NORMAL VISION: . . . .

NORMAL TO CORRECTED-TO-NORMAL HEARING: . . . .

PROBLEMS WITH MANUAL DEXTERITY: . . . .

LEARNING DISABILITIES: . . . .

HISTORY OF BRAIN TRAUMA OR NEUROLOGICAL DISORDER: . . . .

. . . .

PSYCHIATRIC HISTORY: . . . .

. . . .

MEDICAL HISTORY: . . . .

. . . .

MEDICATION: . . . .

. . . .

COMMENTS: . . . .

. . . .

1. CODING (SCALED SCORE): . . . .
2. INCIDENTAL RECALL - IMMEDIATE: . . . .
3. DRAW-A-PERSON: M.A.: . . . . I.Q.: . . . .
4. DIGIT SPAN (SCALED SCORE): . . . .
5. DIGITS FORWARD (SPAN): . . . .
6. DIGITS BACKWARD (SPAN): . . . .
7. DIGITS DIFFERENCE: . . . .
8. DIGIT SUPRASPAN: (A) . . . .(B) . . . . .
9. INCIDENTAL RECALL - 30' DELAYED: . . . .

APPENDIX II

WISC-R CODING SUBTEST

3↑

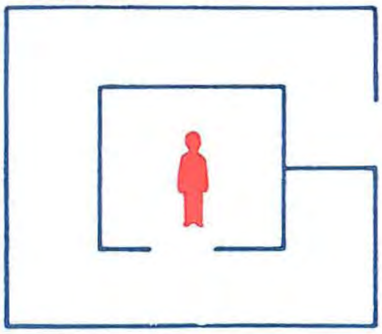
WISC-R®

MAZES
CODING

NAME ____

EXAMINER ______________________________ DATE ______________________

SAMPLE



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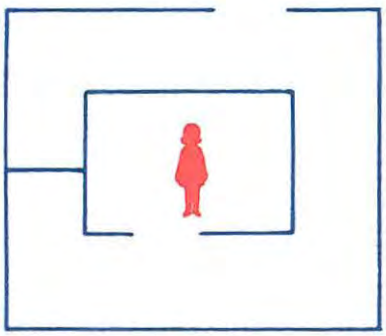

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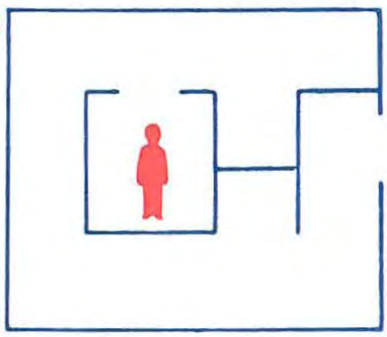

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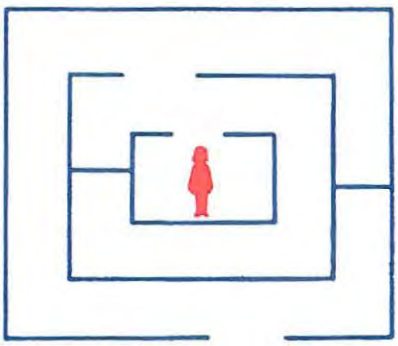

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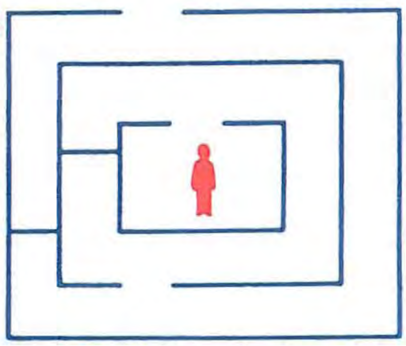
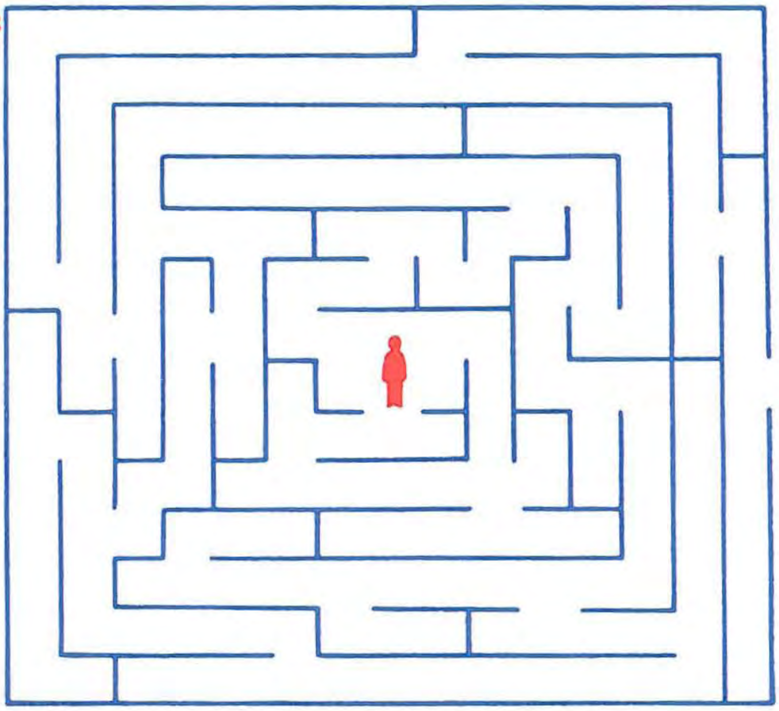


THE PSYCHOLOGICAL CORPORATION
HARCOURT BRACE JOVANOVICH, INC.

9-990359

8



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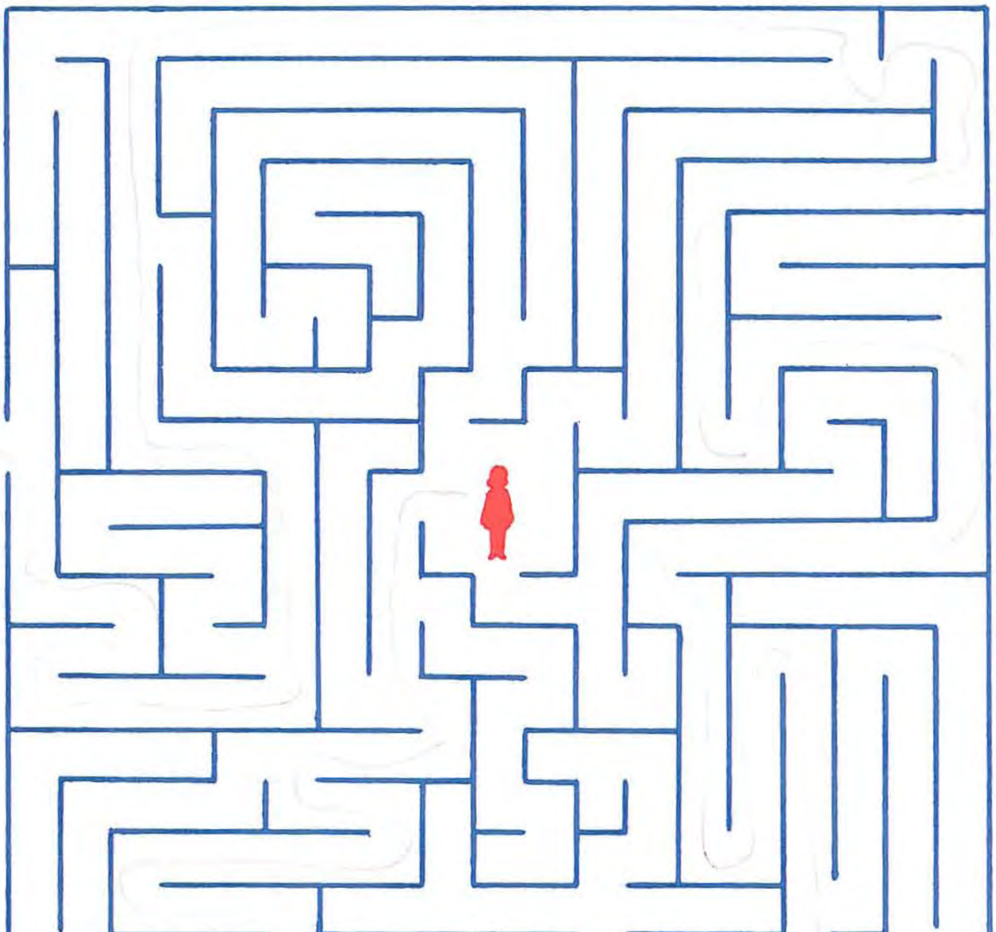


APPENDIX III

CODING A SUBTEST AND INCIDENTAL RECALL TESTS

A

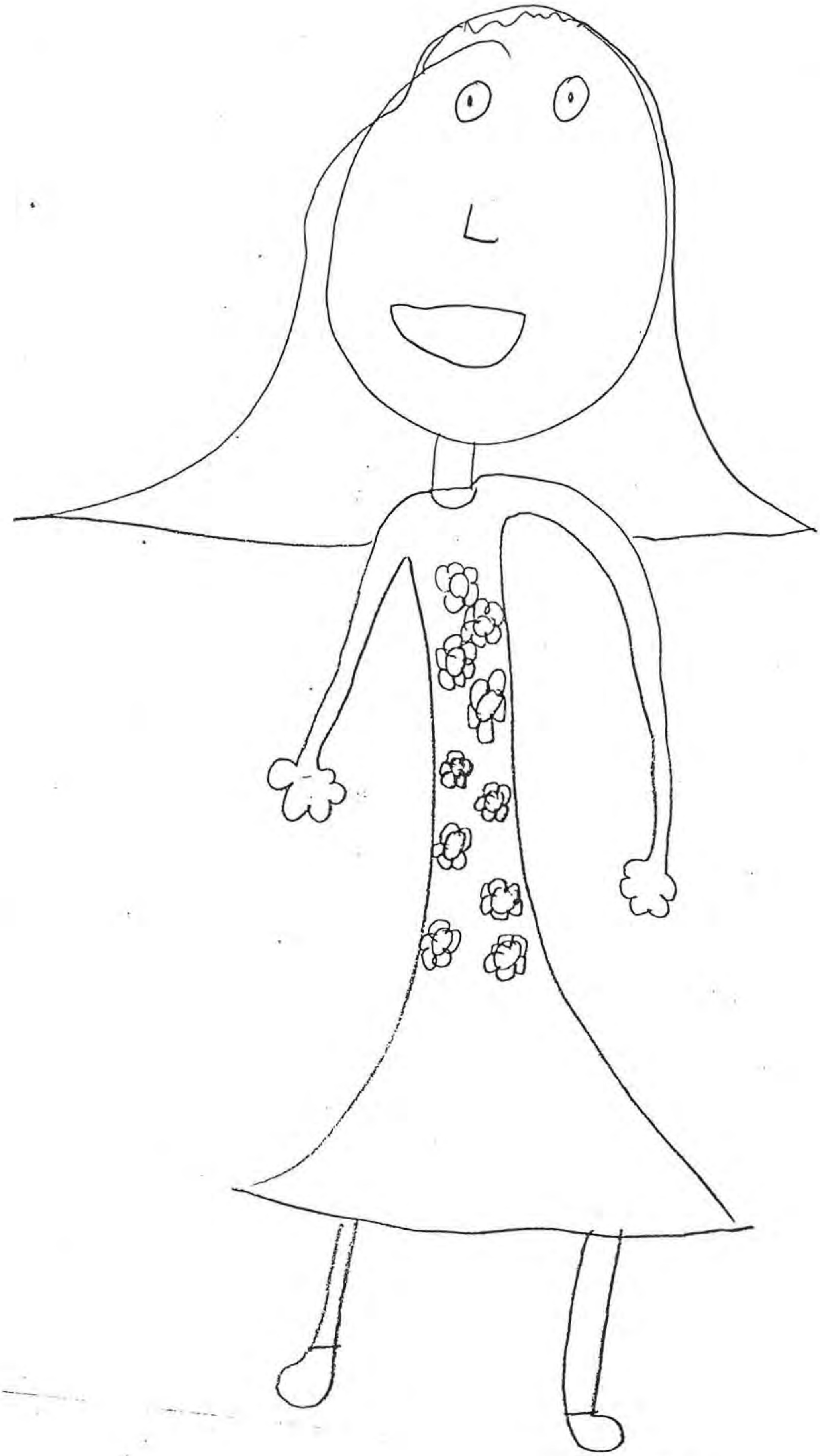
Coding A: Incidental Recall - Immediate

Coding A: Incidental Recall - 30' Delayed

Form Modified from WISC-R (1974)

APPENDIX IV

EXAMPLE OF DRAW-A-PERSON TEST PERFORMANCE AND SCORING PROCEDURE



SUBJECT NUMBER 44

1. Goodenough 51 Point Scale

Girl, by girl 7.6. Raw Score: 24. M.A.: 9.0 FSIQ: 118.4

Items credited: 1, 2, 3, 4a, 4b, 4c, 5a, 6a, 6b, 7a, 7b, 7c, 7d, 8a, 9a, 9c, 10a, 10b, 12c, 14a, 14d, 14f, 16b, 17a.

2. Harris Draw-A-Woman Point Scale

Girl, by girl 7.6. Raw Score: 33 Standard Score: 111

Items credited: 1, 2, 4, 6, 9, 10, 13, 17, 19, 20, 21, 24, 25, 26, 28, 29, 32, 33, 35, 41, 42, 43, 46, 51, 53, 55, 56, 58, 59, 60, 62, 64, 65.

3. Final FSIQ Estimate based on above two Scoring Scales: 114.7

4. 1 to 6 Rating by Researcher based on Final FSIQ Estimate: 4

5. 1 to 6 Rating by Teacher: 4.5

6. Equivalent IQ Range of Teacher's Rating: 110 - 119

APPENDIX V

INTELLECTUAL ABILITIES RATING SCALE WITH CORRESPONDING TIME-TESTED CLASSIFICATIONS OF IQ EQUIVALENTS FOR DIAGNOSTIC TERMS IN COMMON USE

RATING	IQ	CLASSIFICATION	PERCENT INCLUDED THEORETICAL NORMAL CURVE
6	130 and above	Very Superior	2.2
5	120 - 129	Superior	6.7
4	110 - 119	High Average	16.1
3	90 - 109	Average	50.0
2	80 - 89	Low Average	16.1
1	70 - 79	Borderline	6.7
0	69 and below	Mentally Deficient	2.2

Note: Rating Scale adapted from Wechsler's Table 8 on Intelligence Classifications (Wechsler, 1974, p 26).

APPENDIX VI

WISC-R DIGIT SPAN SUBTEST AND DIGIT SUPRASPAN TEST

11. DIGIT SPAN (Optional)

Discontinue after failure on *both trials* of any item. Administer *both trials* of each item, even if child passes first trial.

DIGITS FORWARD

	Trial 1	Pass-Fail	Trial 2	Pass-Fail	Score 2, 1, or 0
1.	3-8-6		6-1-2		
2.	3-4-1-7		6-1-5-8		
3.	8-4-2-3-9		5-2-1-8-6		
4.	3-8-9-1-7-4		7-9-6-4-8-3		
5.	5-1-7-4-2-3-8		9-8-5-2-1-6-3		
6.	1-6-4-5-9-7-6-3		2-9-7-6-3-1-5-4		
7.	5-3-8-7-1-2-4-6-9		4-2-6-9-1-7-8-3-5		

Total Forward Max.=14

Administer DIGITS BACKWARD even if child scores 0 on DIGITS FORWARD.

DIGITS BACKWARD

	Trial 1	Pass-Fail	Trial 2	Pass-Fail	Score 2, 1, or 0
1.	2-5		6-3		
2.	5-7-4		2-5-9		
3.	7-2-9-6		8-4-9-3		
4.	4-1-3-5-7		9-7-8-5-2		
5.	1-6-5-2-9-8		3-6-7-1-9-4		
6.	8-5-9-2-3-4-2		4-5-7-9-2-8-1		
7.	6-9-1-6-3-2-5-8		3-1-7-9-5-4-8-2		

Total Backward Max.=14

Max.=28

Forward + Backward = Total

DIGITS DIFFERENCE : ....

DIGIT SUPRASPAN : ....

Form modified from WISC - R (1974)

APPENDIX VII

FIGURE 1: ANALYSIS OF VARIANCE OF REGRESSION FOR RESEARCHER'S VERSUS TEACHER'S INTELLIGENCE RATINGS

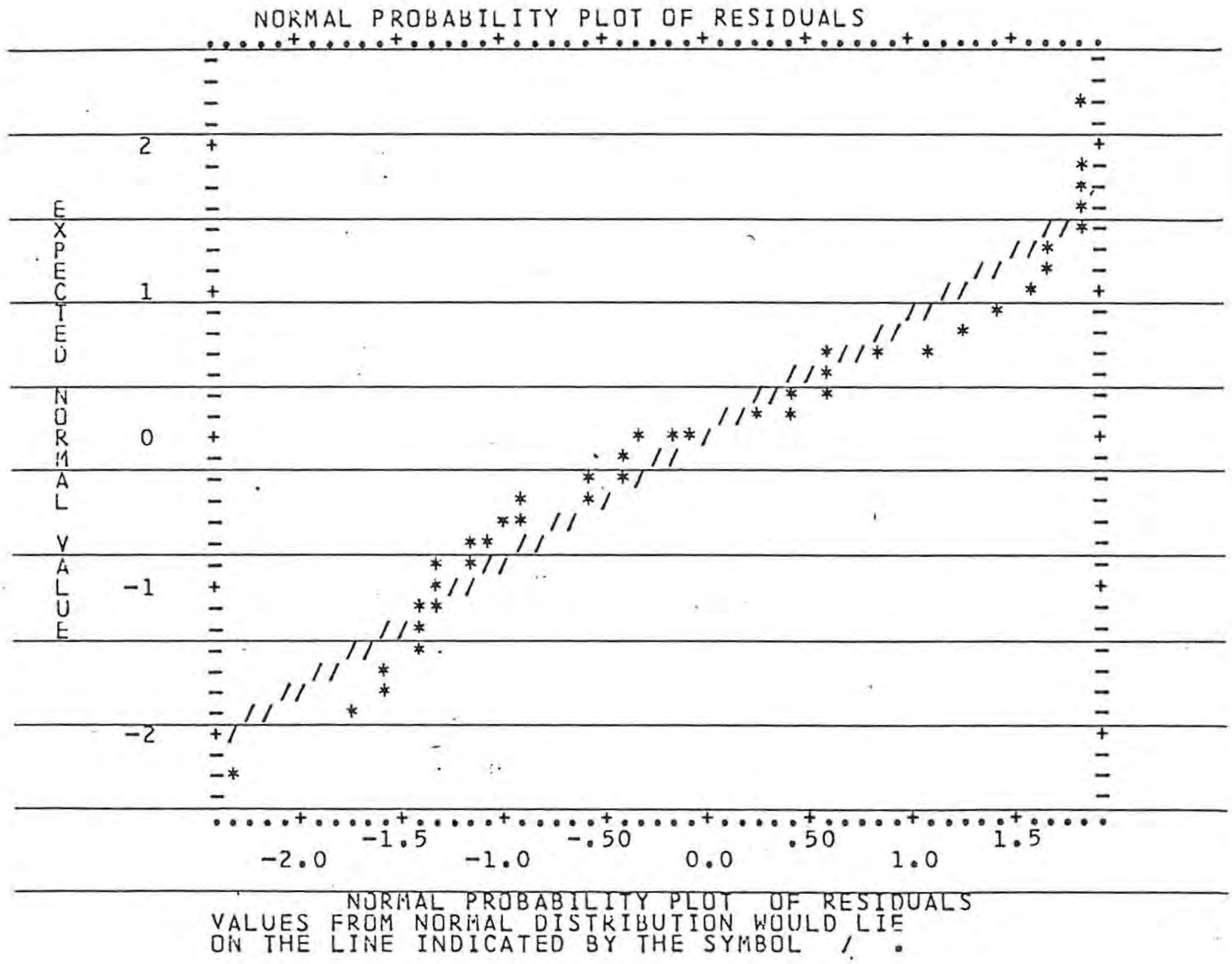


Figure 1(a): Data considered as a Single Group
Multiple R value : 0.1978
P-value : 0.1439

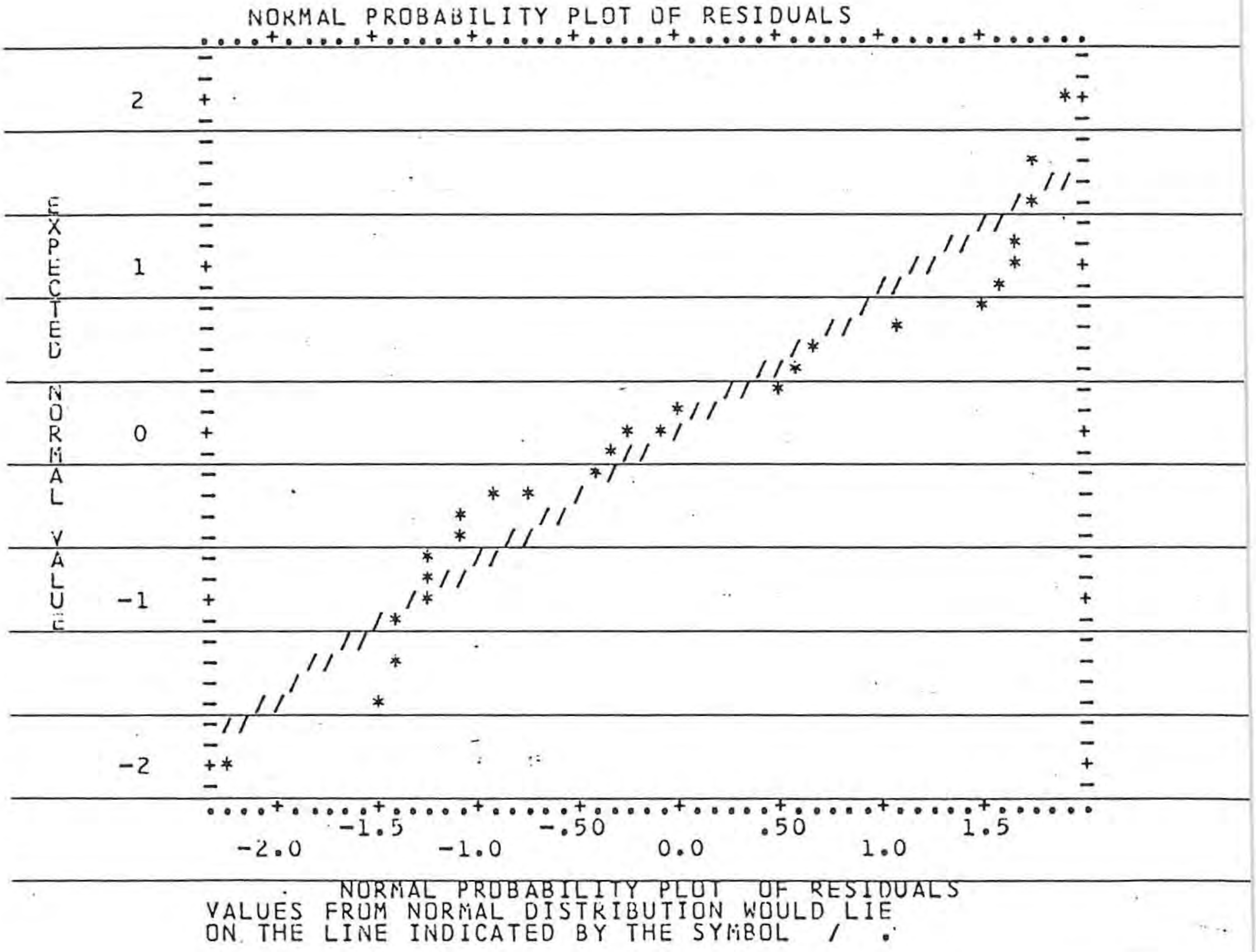
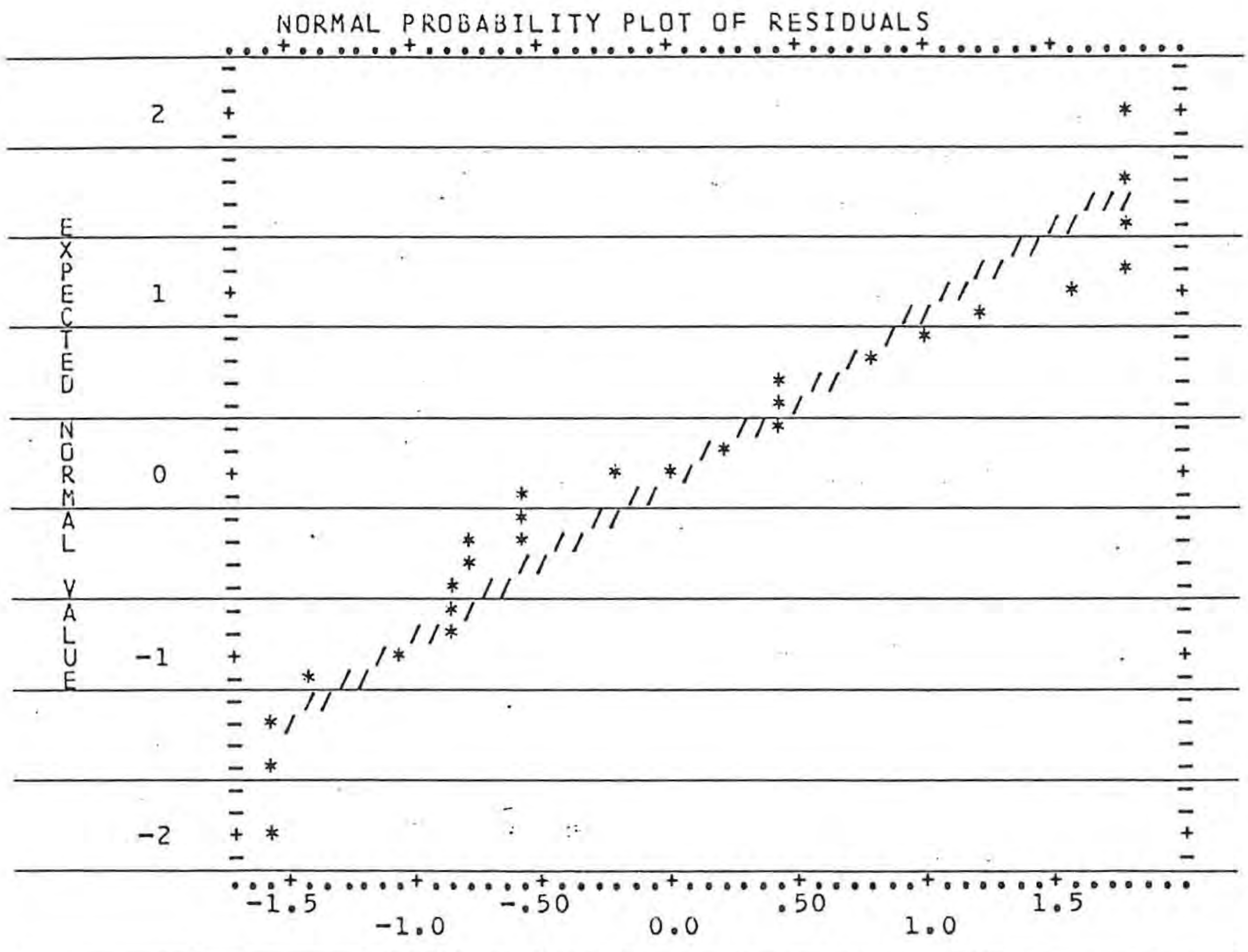


Figure 1(b): Regression for Group 6 years

Multiple R value	:	0.1534
P-value	:	0.4357



NORMAL PROBABILITY PLOT OF RESIDUALS
VALUES FROM NORMAL DISTRIBUTION WOULD LIE
ON THE LINE INDICATED BY THE SYMBOL / .

Figure 1(c): Regression for Group 7 years

Multiple R value	:	0.2725
P-value	:	0.1606

APPENDIX VIII

FIGURE 2: ANALYSIS OF VARIANCE OF REGRESSION FOR CODING A INCIDENTAL RECALL (IMMEDIATE) AND CODING A INCIDENTAL RECALL (30' DELAYED) TESTS

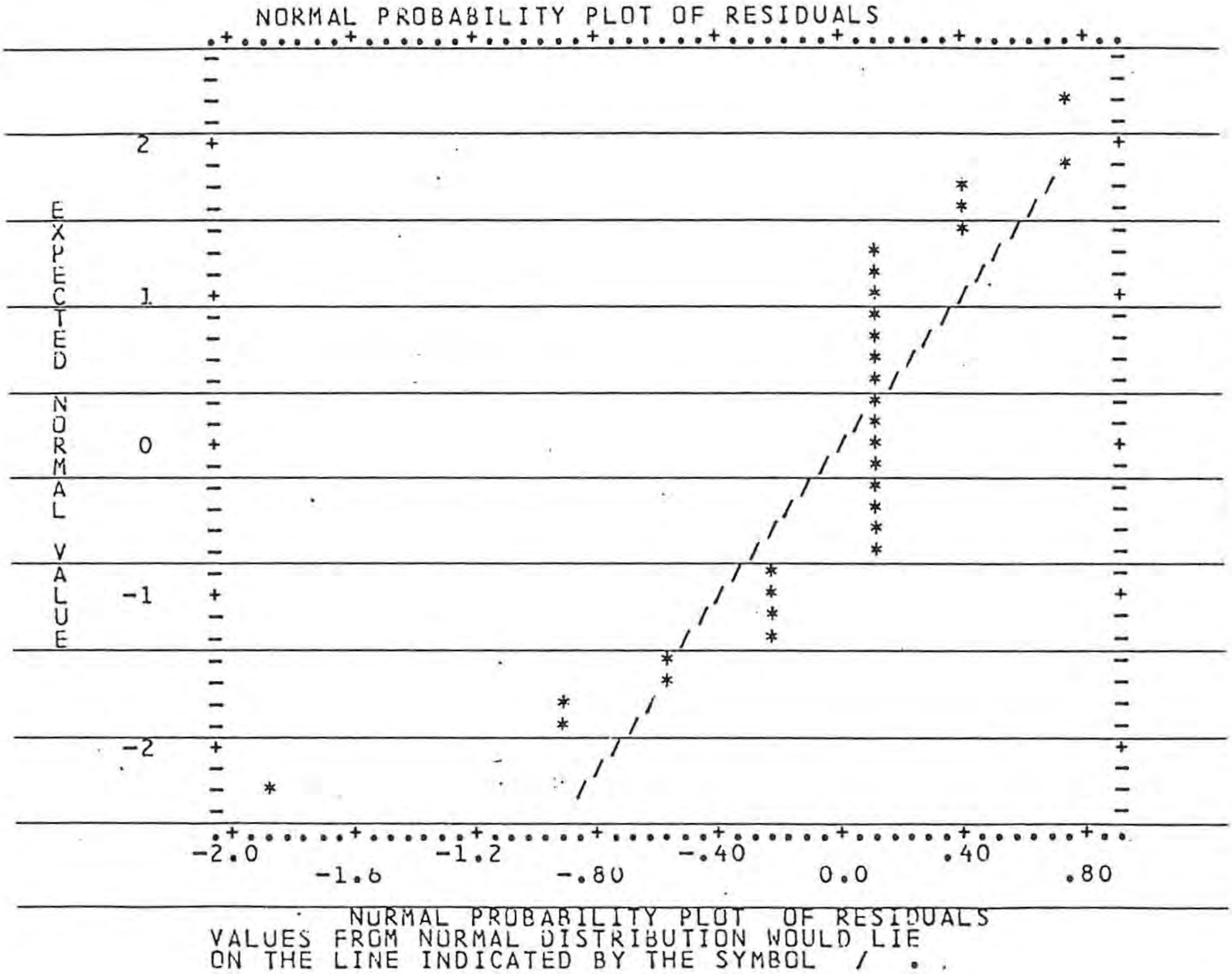


Figure 2(a): Data considered as a Single Group

Multiple R value : 0.7348

P-value : less than 0.00001

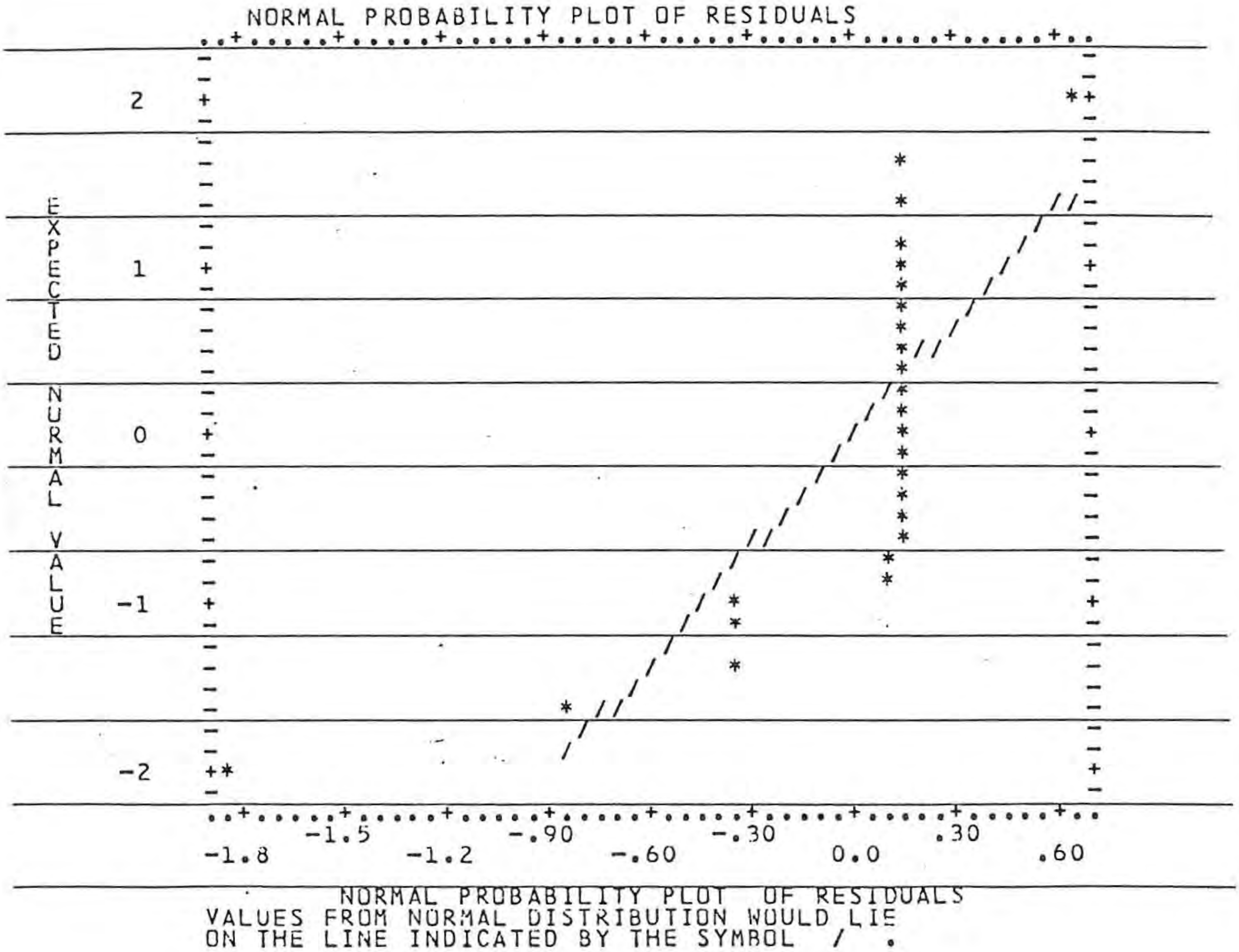


Figure 2(b): Regression for Group 6 years

Multiple R value	:	0.5446
P-value	:	0.0027

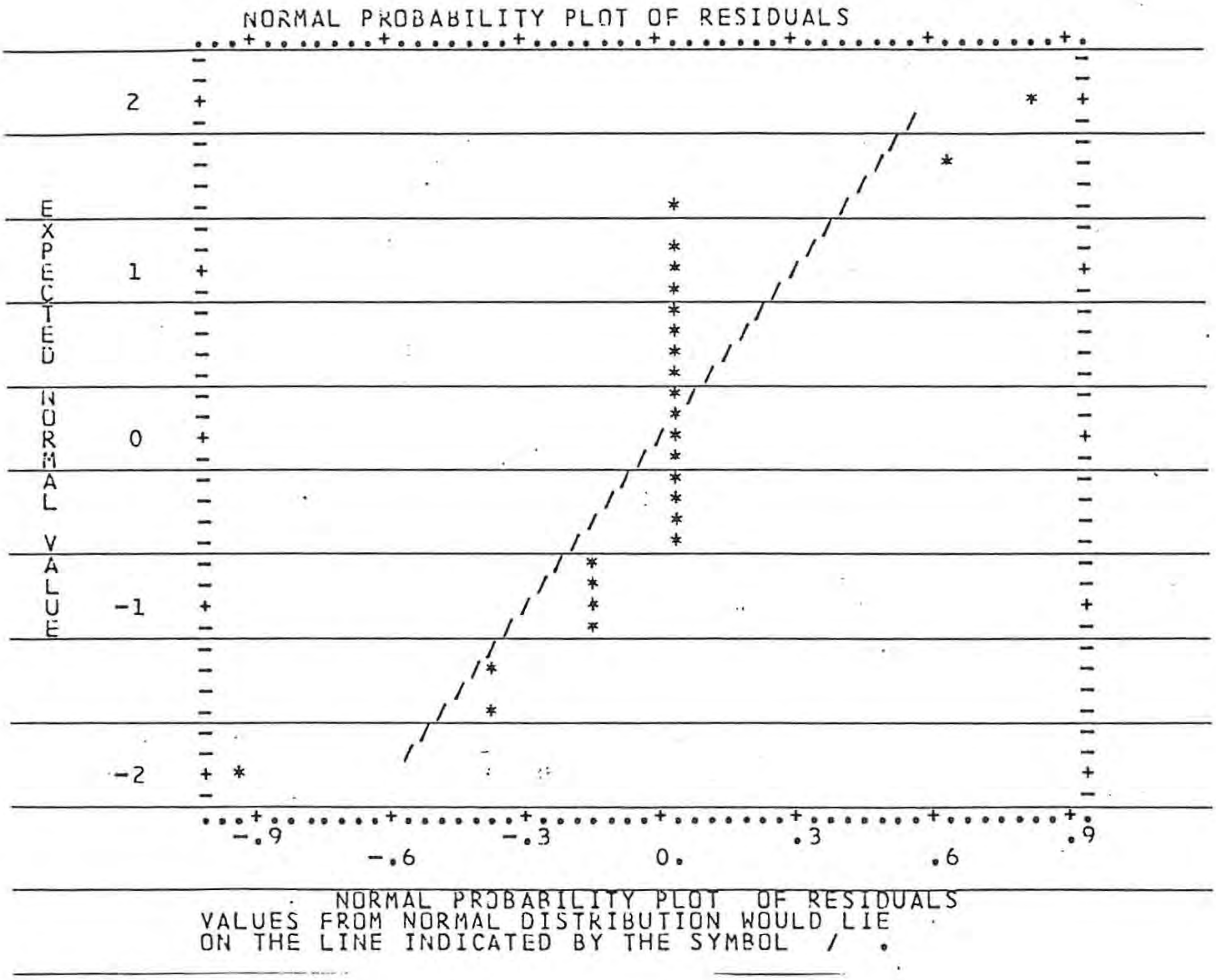


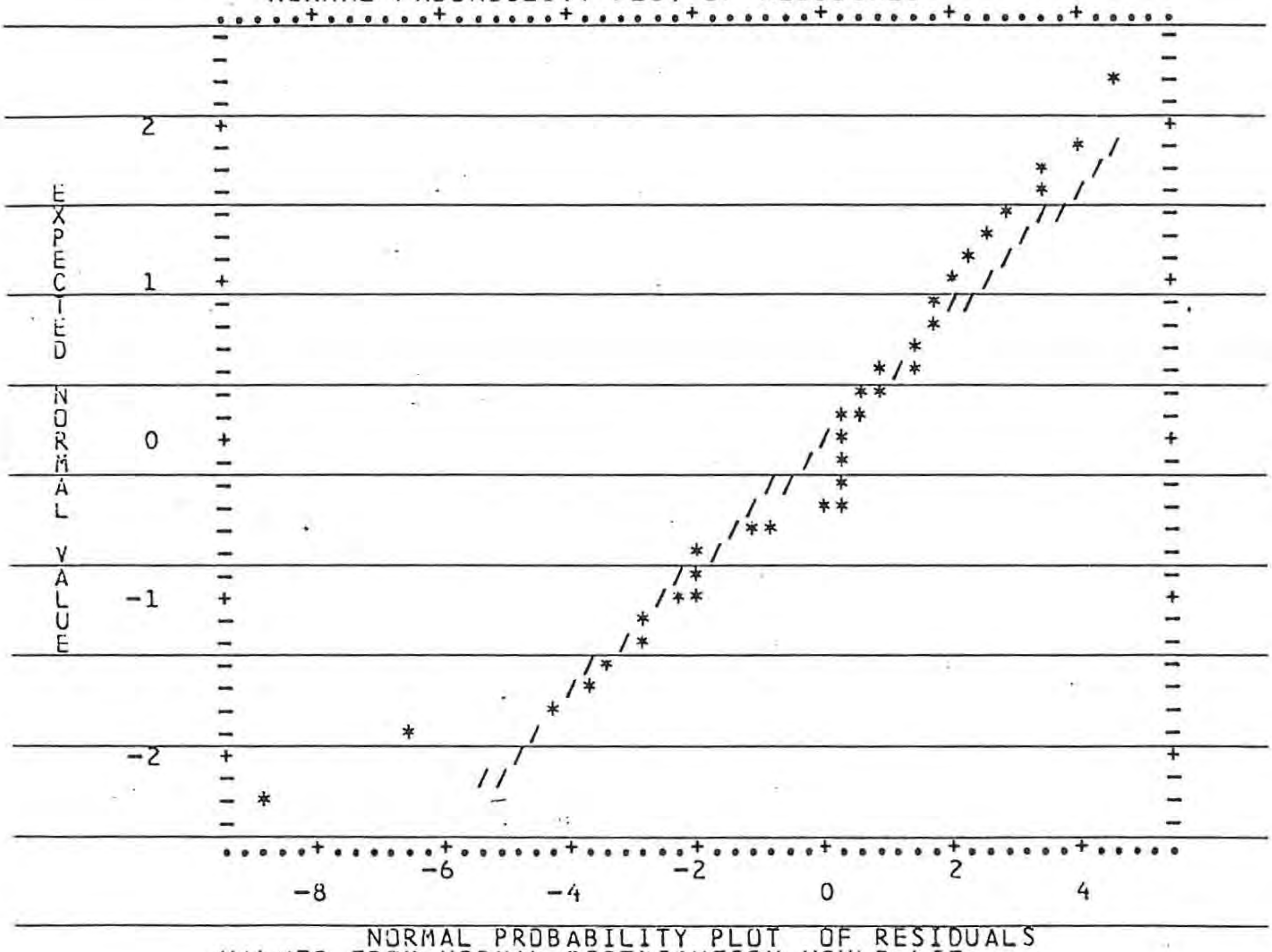
Figure 2(c): Regression for Group 7 years

Multiple R value	:	0.8759
P-value	:	less than 0.00001

APPENDIX IX

FIGURE 3: ANALYSIS OF VARIANCE OF REGRESSION FOR DIGIT SUPRASPAN A AND DIGIT SUPRASPAN B

NORMAL PROBABILITY PLOT OF RESIDUALS



NORMAL PROBABILITY PLOT OF RESIDUALS
VALUES FROM NORMAL DISTRIBUTION WOULD LIE
ON THE LINE INDICATED BY THE SYMBOL / .

Figure 3(a): Data considered as a Single Group

Multiple R value	:	0.8885
P-value	:	less than 0.00001

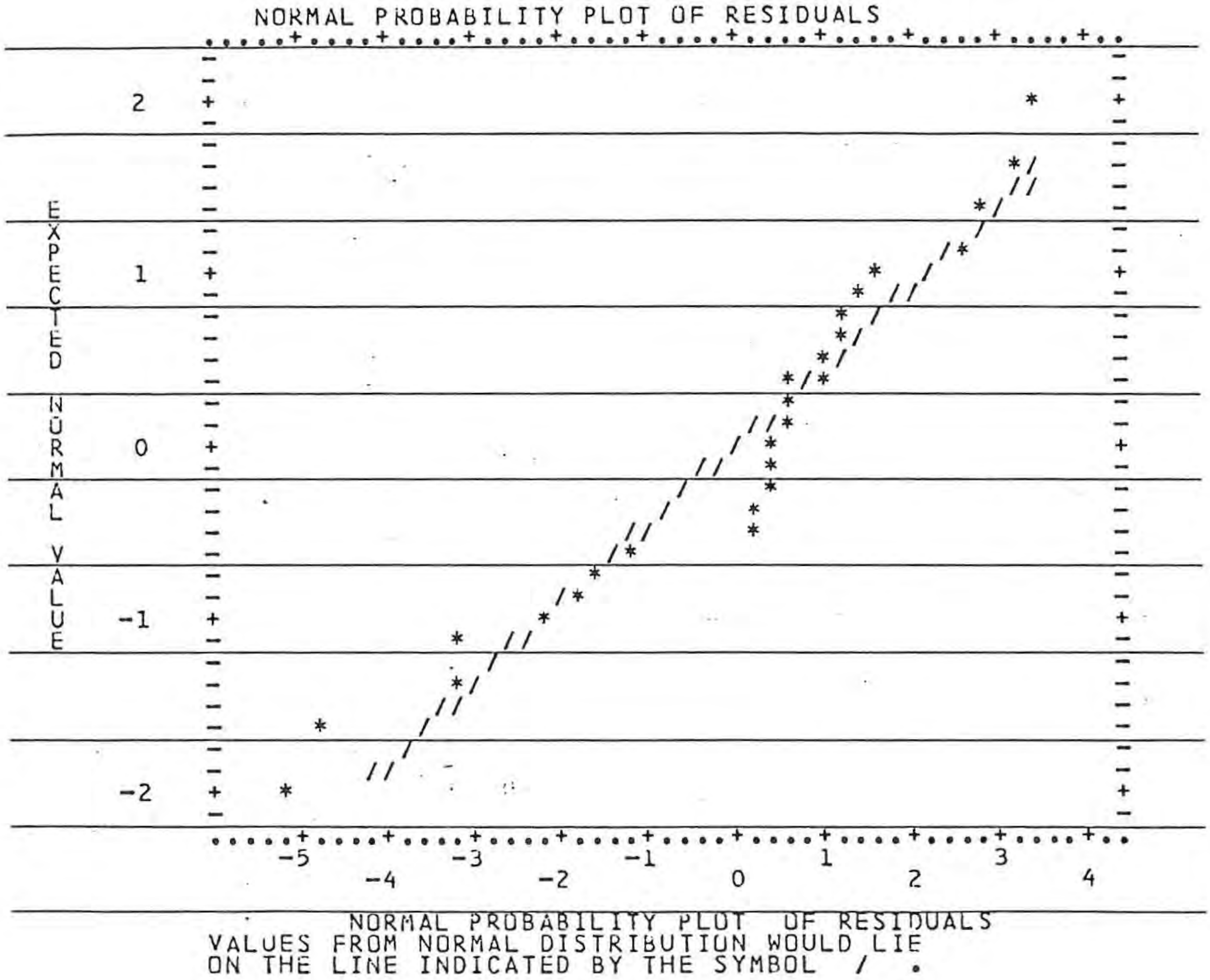


Figure 3(b): Regression for Group 6 years

Multiple R value	:	0.9409
P-value	:	less than 0.00001

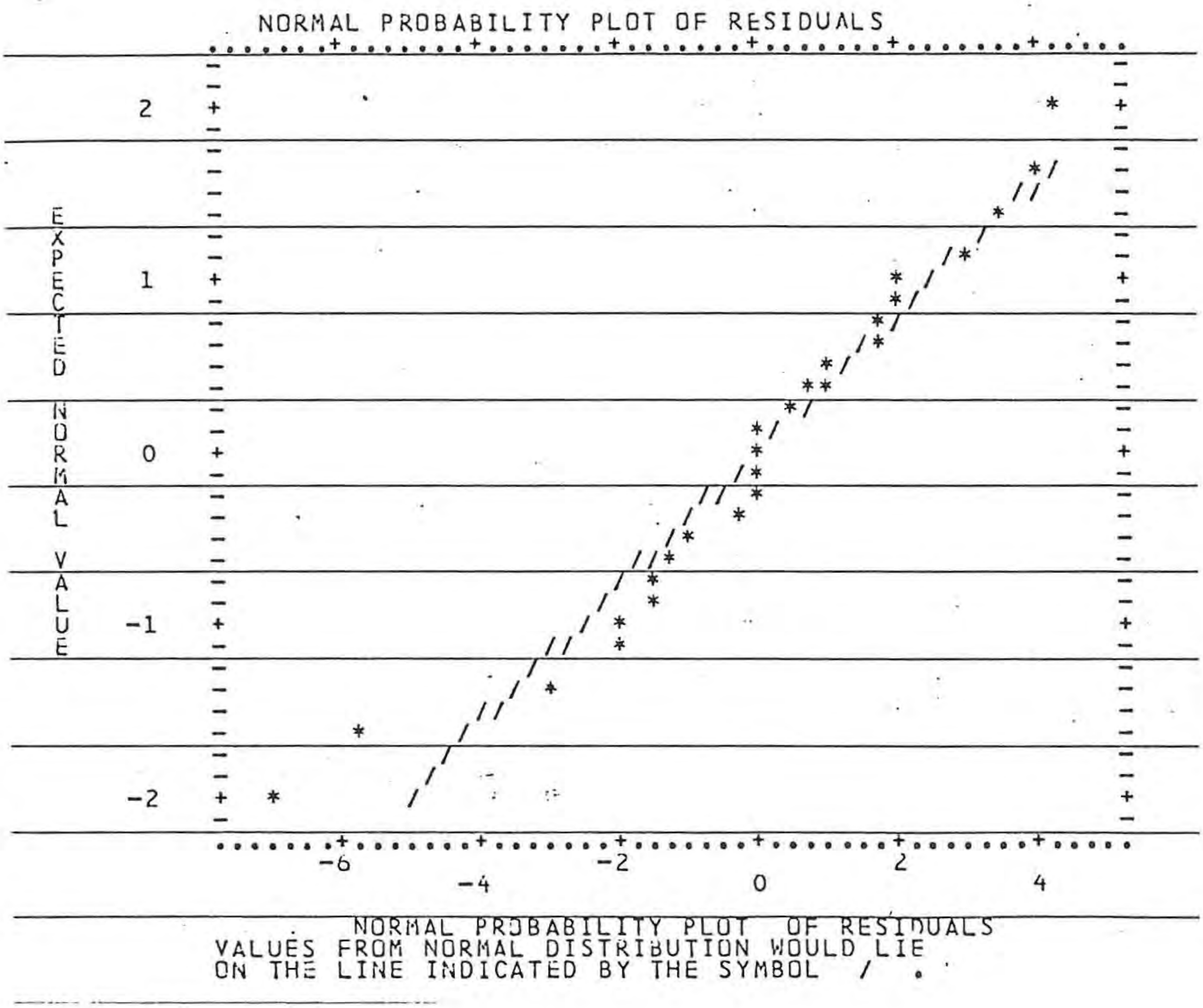


Figure 3(c): Regression for Group 7 years

Multiple R value	:	0.7726
P-value	:	less than 0.00001