Initial Development of a Neuropsychological Screening Measure for School Children

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Abstract

The present study developed a pilot neuropsychological screening measure, called the Repeatable Battery for the Assessment of Neuropsychological Status for Children (RBANS-C) which is designed to be used with children between five and ten years of age. This pilot measure was trialled on a sample of 30 New Zealand primary school children to evaluate its screening ability for children. It is based on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) which is used to screen adults for neurocognitive deficits. Like the RBANS, the RBANS-C is made up of a battery of subtests that assess five cognitive domains, including attention, immediate and delayed memory, visuospatial/constructional abilities and language. Some of the subtests of the RBANS-C were altered to be more suitable for children while others were left the same as in the RBANS. The results from the pilot tryout indicated that some subtests have adequate psychometric properties while others do not. This is most likely due to the small sample size and to a lack of some research controls as well as to inadequacies of some of the subtests. Nevertheless, the results suggest that the RBANS-C seems to identify children with cognitive difficulties, and to some extent isolate those difficulties. No significant sex differences but some considerable age variations were observed since the measure lacks any adjustments for age effects which further improvements of the RBANS-C should incorporate. Also, future research on the RBANS-C will need to develop an alternative form and make necessary modifications to make the RBANS-C an effective neuropsychological screening tool for school children.

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CHAPTER 1: INTRODUCTION

According to the Accident Compensation Corporation (ACC), 14,255 New Zealanders claimed ACC during the year 2001 as a result of having suffered some form of head injury (HI) (ACC, 2001). There is no official data about the incidence of childhood HI in New Zealand but overseas data estimates that as many as 250 per 100,000 children suffer a head injury annually. Many of these children may also endured a traumatic brain injury (TBI) which will never receive any attention, because the effects of TBI, and especially mild TBI (MTBI), often go unrecognized. Therefore, these children struggle through life without the necessary support to cope with the difficulties that commonly result after a brain injury. Since medical and technical advances enable a greater number of children to survive a TBI, and because TBI is one of the most common causes of disruption to normal child development (especially for children between the ages of five and eleven years) there is an urgent need for more research in this area (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001; Boll & Stanford, 1997).

The degree of damage that the brain has suffered is determined by formal assessment with a standardized neuropsychological measure soon after the brain injury. Delaying assessments makes it more difficult to establish baselines against which to assess the progress made during rehabilitation and to address enduring problems that require special attention (Hotz, Helm-Estabrooks, & Nelson, 2001). Since multiple assessments may be necessary at a time when the individual may be affected by fatigue, the most suitable assessment measure would seem to be a short, multi-form and easy to administer screening measure.

Currently, children who are suspected of having sustained a TBI undergo a full neuropsychological assessment which is a lengthy and costly process undertaken by neuropsychologists or other qualified professionals. Sometimes however, a screening measure is sufficient to rule out TBI, or to identify those children who require full assessment. Eliminating the need for full assessment in this way saves time and cost. (Derogatis & Lynn, 1999).

While neuropsychological screening tests, have gradually become available, to assess the effects of TBI in adults, there are few such measures available for children (Ernst, 2000). Furthermore, many tests and assessment procedures are simply downward extensions of adult measures that do not take into consideration the diverse developmental variations seen in the immature brain. Moreover, such measures are rarely educationally relevant and therefore may not be practical to be used in an educational setting (D'Amato, Rothlisberg, & Rhodes, 1997).

In the last decade a number of more concise and appropriate neuropsychological assessment tools have been developed for children. One such measure is the Pediatric Test of Brain Injury (BTBI), which is a short neuropsychological test measuring the cognitive linguistic skills commonly impaired after brain injury (BI), i.e., attention, memory, language, reading, writing, metalinguistics and metacognitive skills. It attempts to take into account developmental and maturational changes and is designed to be relevant to the educational curriculum (Hotz et al., 2001). This measure is still in its developmental stage however and, although brief, does not seem to be used as a screening tool.

Screening measures that have been specifically designed to assess children for neuropsychological impairments have only become available in the last few years. One such test is the School-Years Screening Test for the Evaluation of Mental Status (SYSTEMS), which is a very quick screen for cognitive changes or deficits. This screen was initially based on the adult Mini-Mental Status Exam (MMSE). The SYSTEMS takes 7-12 minutes to administer and is used with children between 5 and 12 years of age. Ouvrier, Hendy, Bornholt, & Black (1999) claim that the SYSTEMS has adequate reliability and no sex, language or socioeconomic biases, adequately separates age groups, correlates highly with mental age and shows high sensitivity and specificity. No information is given about the SYSTEMS sensitivity to screen children with MTBI and the adult MMSE has been found to have low sensitive for MTBI (Derogatis & Lynn, 1999).

Another is the Comprehensive Neuropsychological Screening Instrument for Children (CNSIC), which is a short screen that assesses the main functions commonly impaired after TBI. It measures orientation, language, attention, memory, motor control, visuoconstruction, visuoperception and executive functions in children between six and twelve years of age (Ernst, 2000). This test is also still being developed and no large-scale studies have been undertaken to establish its psychometric properties and normative data.

The current study attempts to develop the foundation work for a neuropsychological screening measure for use with children from five to ten years of age with suspected MTBI. It is based on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) which is an adult screening measure for cognitive impairments, developed by Randolph (1998) that has established psychometric properties and normative data. The children's version of the RBANS will be referred to in the current study as the Repeatable Battery for the Assessment of Neuropsychological Status for Children (RBANS-C) (although it is acknowledged that the formal use of such a title would have copyright implications). In the future it would be useful to develop an alternate form of the RBANS-C making reassessment possible without undue practice effect. Thus, neuropsychologists would not only have access to a quick and easy to administer neuropsychological screening tool focusing on the main domains of functioning affected by TBI in children, but also have an alternate form thereby allowing valid and reliable reassessment to monitor change overtime.

The study to be reported in this thesis is back grounded in Chapter one by an overview of childhood TBI, including the causes, types and neuropathology of brain injuries with a particular focus on MTBI. This is followed by a review of the different neuropsychological assessment approaches, issues and procedures, used with children after TBI and neuropsychological screening measurement is discussed. After this, an examination of psychometric concerns and common measurement issues follows and the RBANS is introduced. Following this, the aims and hypotheses of the research are described.

Chapter two covers the methodological issues pertaining to the current study including participants, procedure and measures that have been used in the study, (i.e., the RBANS-C is introduced and the comparison measures) while Chapter three focuses on the results by conducting analyses of the data collected. Lastly, in chapter four, the findings of the research are discussed followed by the limitations of the research and future research that could follow this study and, finally, what can be concluded from the study.

1.1. Childhood Traumatic Brain Injury

The prevalence of HI in children is high but no clear-cut estimates can yet be made. Those 250 children per 100,000 that experience a HI each year, mostly suffer mild injuries which make up about 82% of all head injuries, while 8% are moderate, 6% severe and 5% fatal (Fennell & Mickel, 1992). Although there has been extensive overseas research on HI in adults, research interest in HI sustained by children has been relatively recent (Anderson, Northam, Hendy, & Wrennall, 2001). There have been some small studies conducted in New Zealand mostly investigating the incidence of HI. One such study was conducted by Broome (1998) which reported that 41% of a sample of 173 New Zealand children between the ages of 11-13 years sustained a HI. Another found that 41% of a sample of 135 adolescents recalled sustaining a HI in the previous three years, suggesting that the overall prevalence of HI in adolescents is 13.6% (Body & Leathem, 1996). One of the cautions associated with the study was that the HI reported may not have been brain injuries. Yet, there is a lack of research of the incidence of HI in primary school children in New Zealand.

1.1.1. Causes and Types of Brain Injuries

As noted above, when an individual suffers a HI it cannot be assumed that he or she has also sustained a traumatic brain injury (TBI). The criteria for diagnosis of TBI include some combination of post traumatic amnesia, (PTA), possible loss of consciousness, (LOC), retrograde amnesia and TBI related outcomes. These terms will be described in more detail below.

A TBI may occur when an individual has been subjected to some external force or trauma such as by being involved in a motor vehicle accident, fall, sport injury, recreational activity, electrical shock, lightning strikes and abuse. If as a result of such an incident, the brain strikes the bony structures inside the skull a TBI, that is often not externally visible, may occurred. On the other hand, 'non-traumatic brain injuries', occur from a lack of oxygen to the brain (anoxia) such as near drowning, strangulations, choking, heart conditions, tumours, strokes and other vascular accidents (Rourke, 2000). Other non-traumatic brain injuries occur due to infections such as encephalitis or meningitis, neurotoxic poisoning and metabolic disorders such as insulin shock and liver or kidney diseases (Savage & Ross, 1994). Finally, brain injuries in children can be a result of a central nervous system dysfunction associated with another medical condition such as diabetes, HIV (human immunodeficiency virus), Sickle Cell Disease, Phenylketonuria, Turner Syndrome, Renal Disease, Acute Lymphoblastic Leukaemia or premature birth or low birth weight (Rourke, 2000).

A TBI can be differentiated according to whether it is a closed versus open or penetrating brain injury. Open injuries involve a direct penetration of the skull, dura, and brain tissue which produces more specific and sometimes focal impairments and are less common in children. On the other hand, closed injuries generate often invisible internal neural tissue damage which produce more generalized deficits (Boll & Stanford, 1997). Closed TBI's in children are commonly caused by accidents and child abuse while open TBIs are a result of gunshot wounds or sharp objects that penetrate the brain (Fletcher & Taylor, 1997).

Boys are twice more likely to suffer a TBI than girls (Fletcher & Taylor, 1997) and pre-school children sustain the second highest incidence of brain injury after school children. Additionally, children aged six to twelve years are twice more likely as younger children to suffer brain injury from pedestrian or motor vehicle accidents and two thirds of physically abused children under three years old suffer a TBI (Savage & Ross, 1994). It is important to consider the age at the time of injury as well as the depth and duration of unconsciousness since such factors influence the outcome of TBI (Lord-Maes & Obrzut, 1996).

According to the Brain Injury Association (1997, cited in Gerstenbrand & Stepan, 2001) TBI is defined as a non-congenital or non-degenerative insult to the brain as a result of some physical external force that may produce loss of consciousness and, therefore, impair cognitive, physical, behavioural and emotional abilities. Such injuries may produce temporary or permanent as well as partial or complete cognitive and/or psychosocial disabilities (Gerstenbrand & Stepan, 2001). Throughout history there has been difficulties with the definition of 'brain injury'. Terms such as congenital brain damage, head injury (HI), traumatic brain injury (TBI), organic brain damage (OBD), minimal brain dysfunction (MBD), acquired brain injury (ABI) and a number of other terms that have been and are still used interchangeably to identify children with brain injuries. This creates confusion in the research literature (Savage & Ross, 1994). Thus, studies on brain injury are difficult to compare because all the terms above are used synonymously but may not examine the same types of injuries (De Kruijk, Twijnstra, & Leffers, 2001).

Furthermore, TBI can be classified into degrees according to severity, with differentiation into the categories of mild, moderate and severe however, which is also not very clear cut. Brain injury severity in children is commonly evaluated with specific measures such as the Glasgow Coma Scale (GCS) which assesses the extent of consciousness, post-traumatic amnesia (PTA), alertness, and confusion of the child as well as through neuroimaging (Anderson, Northam et al., 2001). A score of eight or less on the GCS, PTA of 24 hours or more and loss of consciousness (LOC) of 30 minutes or more indicates a severe TBI while a moderate TBI is diagnosed if there is a GCS of less than 13, LOC of about 30 minutes and PTA between one and 24 hours. Mild traumatic brain injury (MTBI) is diagnosed when an individual suffered LOC of less than 20 minutes, a GCS score between 13 and 15, and PTA of less than 24 hours (Lucas, 1998). However, there is some disagreement whether a MTBI is present even if the above criteria are met (Malec, 1999). In contrast to moderate and severe forms of TBI, cases of MTBI rarely show significant language and motor dysfunctions (Anderson, Northam et al., 2001).

1.1.2. Neuropathology of Traumatic Brain Injuries

The three major processes that are involved in the neuropathology of TBI include diffuse axonal injury (DAI), focal cerebral lesions, and hypoxic-ischemic injury. DAI refers to extensive destruction of neural tissue and white matter deep within the brain that results from fast rotational acceleration and deceleration following a brain trauma. Furthermore, focal cerebral lesions are commonly a consequence of the superimposed skull fracture are associated with frontal and temporal lobes and are located at the site of impact (coup lesion) and often across the skull opposite from the site of impact (countercoup lesion). Generally, such lesions are less common in children, particularly those below the age of three years. Lastly, TBI can cause hypoxic-ischemic injury that arises as a result of reduced oxygen and blood flow to the brain as a result of decreased blood pressure and often elevated intracranial pressure. For unknown reasons, it was found that children and adolescents are more likely to develop extensive increased intracranial pressure than adults (Kelly & Filley, 1994).

1.1.2. Mild Traumatic Brain Injuries

Overseas research suggests that the incidence of a mild traumatic brain injury (MTBI) in children and adolescents is as high as 158 per 100,000 per year but since many such cases are never reported (20 - 40%) this rate could even be higher (Roberts, 1999). Furthermore, studies exploring the effects of MTBI in children, indicate a mixed understanding of the long-term sequelae of MTBI. This is due to the insensitivity of measures used currently to assess the consequences of MTBI in children. Moreover, there is a poor understanding of how MTBI interacts with neurodevelopment and a bias in the reporting of outcomes due to the fact that many MTBI cases do not come to medical attention at all (Thomson & Kerns, 2000).

The outcomes of TBI vary according to the severity of the injury (Ewing-Cobbs, Levin, & Fletcher, 1998). In general, MTBI is characterized by a short phase of changed consciousness and sometimes by post-traumatic amnesia as well as confusion and disorientation (Anderson, Northam et al., 2001). The symptoms commonly observed as a result of MTBI in adults include headaches, dizziness, fatigue, poor concentration, memory disturbance, irritability and depression, which is also known as the post-concussion syndrome and commonly recognized by most health professionals. The cognitive deficits in children after MTBI include difficulties with attention, concentration, memory and information processing and behaviour problems such as aggressiveness, withdrawal, nervousness, irritability, fatigue and sleeping difficulties (Roberts, 1999). Children appear to experience fewer problems with headaches and dizziness than adults. Some studies have found a tendency to enuresis and truancy associated with childhood TBI, although this has not been consistently reported. (Kelly & Filley, 1994).

With time these symptoms improve and in most cases there is almost a full recovery especially in school-aged children who had no previous cognitive difficulties. The duration of deficits resulting from MTBI varies between individuals, most studies report recovery after one month while a number of others suggest recovery within one to three months. However, some researchers argue that there are long-term cognitive impairments as a result of MTBI persisting for some years, regardless of whether the individual experienced LOC (Anderson, Northam et al., 2001; Umile, 1998). For example, according to a survey by Herrington et al. (1993, cited by Roberts, 1999) 25% of MTBI cases exhibit some functional impairment 6 to 18 months post-injury.

Furthermore, Winogren, Knights and Bawden (1984, cited in Roberts, 1999) reported that 6% to 18% of children after a 1-year follow up showed impairment of functioning, while Ylvisaker, Feeney and Mullins (1995, cited in Roberts, 1999) observed wide-ranging permanent injury in a minority of cases (7% to 10%) and for selected neuropsychological measures, cases of permanent injury were as high as 40%. Also, a study by Ponsford, Willmott, Rothwell, Cameron, Ayton and Nelms (1999) reported that in a sample of 70 children with MTBI common symptoms one week post-injury included headaches, dizziness and fatigue that had disappeared for most children (83%) 3 months post-injury. No significant cognitive impairments were reported. Because of this great variation in the conception of the sequelae of MTBI, many health professionals often misdiagnose or overlook childhood cases of MTBI (Kelly & Filley, 1994).

In summary, TBI is one of the common causes of disability during childhood which is the reason for a growth of interest in this area and as well as demands for the need of more research. Children who suffer a HI, resulting in a TBI, tend to experience difficulties in various degrees with cognitive, behavioural and social and psychological functioning depending on the type and severity of the brain injury. The majority of TBIs are mild and there is still a debate about the definition, diagnosis and outcomes of TBI, and especially MTBI. As a result, many children who endure a TBI are never assessed for brain injury and therefore fail to receive the necessary support needed to better cope with their difficulties.

1.2 Neuropsychological Assessment with Children

A complete neuropsychological assessment is conducted to diagnose a neuropsychological disease or disorder, to evaluate the effectiveness or to implement a treatment. The central objective of neuropsychological assessments is to describe how brain functions are related to human behaviours by applying what is known about normal functioning. Overall, the assessment establishes a child's level of functioning which provides valuable information for the management, prognosis and treatment of a specific neuropsychological disease or disorder (Bengtson & Boll, 2001). A neuropsychological assessment differs from psychological assessments in that it focuses mainly on brain-behaviour relationships and on a broader range of abilities, in particular cognition. With children, especially, academic strengths and weaknesses are evaluated by examining arithmetic, reading, spelling and writing abilities. Furthermore, visual, auditory and motor functions are evaluated as well as language and communication. In addition to assessing cognitive abilities a complete neuropsychological assessment also includes an evaluation of social, emotional, physical and adaptive functioning (Bengtson & Boll, 2001).

Since WWII neuropsychologists have developed a number of tests to assess people with brain injuries. During that time, adults and children were viewed similarly on the basis that a child performs in the same way as an adult (Kolb & Fantie, 1997). However, now it has been recognized that children tend to exhibit different brain impairments even when the results are similar to adults. This is because when children are assessed for neuropsychological deficits additional factors such as developmental, social and emotional issues need to be taken into consideration while interpreting test results (Anderson, Northam et al., 2001). Also, it is important to be aware that the cognitive development in children differs according to age since children acquire certain cognitive skills at different age levels and it is most pronounced in children between five to eight years of age (Korkman, Kirk, & Kemp, 2001).

Most commonly, a neuropsychological assessment referral results after an individual has been diagnosed with a brain tumour, epilepsy, a moderate or severe TBI, a learning disability, a psychiatric disorder or mental retardation, phenylketonuria, acute lymphocytic leukaemia, encephalitis and other metabolic disorders (Bengtson & Boll, 2001). However, children who suffer a MTBI may not be assessed for the effects of brain injury simply because they do not get to the attention of health professionals who would normally have referred them for neuropsychological assessment (Roberts, 1999).

Neuropsychological assessment, aims to administer a set of assessment measures to examine a number of different cognitive functions. This is integrated with information about the specific nervous system disorder, i.e. the nature, location, duration and severity of the actual injury and set against an understanding regarding the child's pre-injury functioning, the quality of their environment and their support network (Bengtson & Boll, 2001).

This, information is synthesised from various sources by collecting historical information (educational, medical, developmental and social), conducting behavioural observations and administering psychological tests. In this way, a thorough understanding is achieved of the child's strengths and weaknesses and informs what interventions will help to increase the child's adaptive functioning (Yeates & Taylor, 1998). These interventions may include techniques to compensate for lost abilities, strategies for behaviour management, individual education plans to improve attention as well as self-control and thought organisation (Bengtson & Boll, 2001).

1.2.1 Types of Neuropsychological Assessments with Children

There are two different assessment practices adopted in child neuropsychology. In the fixed battery approach measures such as the Halstead-Reitan Neuropsychological Test Battery (used with 9-14 year olds) or the Luria-Nebraska Neuropsychological Test Battery (for 8-12 year olds) are administered to each child in the same manner regardless of the referral question. In contrast, in the flexible battery or process approach specific tests are selected that are administered following standardized testing procedures. These may be followed by more specific measures aimed to pinpoint the child's strengths and weaknesses, while additionally trying to detect patterns of weaknesses through process observations made during the testing (Bengtson & Boll, 2001)

Commonly, in the flexible battery/process approaches, subtests of intelligence scales such as the Wechsler Intelligence Scale for Children (WISC-III) or the Stanford-Binet Intelligence Scale (SBIS-IV) are used. Standardised intelligence tests such as the WISC-

III, the SBIS-IV, and the Kaufman Assessment Battery for Children are generally used to assess general cognitive abilities in children. Intelligence tests are well standardized, have good psychometric properties and assess a wide variety of cognitive skills to determine the overall functioning of a child. However, they do not measure learning potential and many essential skills but instead function principally as a predictor of academic achievement. They also do not take into account environmental and biological influences (Yeates & Taylor, 1998). An example of a standard measure for children purported to measuring neuropsychological functioning using the process approach is the NEPSY (Korkman, Kirk, & Kemp, 1998).

1.2.2. Domains of Functioning Assessed

The specific cognitive domains generally assessed during a standard neuropsychological assessment are attention and concentration, verbal and non-verbal learning and memory, language, frontal systems/executive functions and visual-spatial perception and constructional abilities. In addition, sensory memory and motor functioning are often assessed as well as general intelligence and academic abilities. By assessing these cognitive domains the necessary information is collected to pinpoint areas of functional strengths and weaknesses (Mitrushina, D'Elia, & Boone, 1999).

Attention and Concentration

Attentional difficulties is one of the most common referral reasons for a neuropsychological assessment. different aspects of attention including selective, divided and focused attention, set shifting and cognitive proficiency are measured during a neuropsychological assessment. Some examples are, the Contingency Naming Test, the Trail Making Test and some subtests of the WISC-III such as Arithmetic, Digit Span, Coding and Symbol Search. It is difficult, however, to isolate observable aspects of attention with neuropsychological tests because attention is such a complex, multi-dimensional cognitive construct that is greatly dependent on situational contexts or compensatory abilities (Yeates & Taylor, 1998).

Some research suggests that attention deficits in children are similar to adults. However, these studies have predominantly followed children just up to one-year post injury. A number of other studies (Anderson, Northam et al., 2001) suggest that children tend to show more persistent global attentional deficits compared to adults with severe to moderate TBI (who exhibit more specific psychomotor slowing as well). This may reflect the fact that children are still in the development stage of acquiring attentional skills at the time of injury. This in turn, may interfere with a child's usual development of attention and could also make a child unable to acquire new attentional skills (Anderson, Northam et al., 2001).

Verbal and Non-verbal Learning and Memory

Like adults, children suffer memory difficulties after TBI. Especially in more severe cases of TBI. According to study by Yeates et al. (1995, cited by Farmer et al., 1999), children with severe TBI exhibited difficulties with word list learning, delayed recall and recognition while those with mild to moderate injuries showed little difficulties with word list learning and recognition but struggled with delayed recall. Other aspects of verbal learning and memory has not been well studied.

Studies on visual-spatial memory found that children with severe TBI tend to have greater difficulties with visual recognition memory (Farmer et al., 1999) and visual learning (Farmer et al., 1999) compared to children with MTBI. However, the results of these studies should be interpreted with caution because of some methodological limitations i.e., utilizing adult and non-standardized measures as well focusing on a single aspects of memory and learning (Farmer et al., 1999).

Memory impairments can significantly influence the child's development since knowledge and learning is vital to acquire new skills. Memory and learning problems are another common reason for a neuropsychological referral. Only in recent years specific measures have become available to assess learning and memory deficits. Examples are the California Verbal Learning Test-Children's Version, the Rey-Osterrieth Complex Figure Test (CFT), the Test of Memory and Learning, the Wide Range Assessment of Memory and Learning (WRAML) and the Children's Memory Scale (Anderson, Catroppa, Rosenfeld, Haritou, & Morse, 2000; Bengtson & Boll, 2001; D'Amato et al., 1997). However, care should be taken when interpreting such tests as memory and learning is dependent on other functions such as language competence and attention (Yeates & Taylor, 1998).

Language Abilities

As with intelligence tests, measures that assess language abilities are not specifically adapted for neuropsychological assessment and often cannot separate other cognitive abilities that may decrease performance on tests that measure language skills. Thus, as it is common in neuropsychological assessment, language tests must take into account performances of other domains of cognitive functioning before making any conclusions (Yeates & Taylor, 1998). Language ability tests such as the Neurosensory Centre Comprehensive Examination of Aphasia, the Peabody Picture Vocabulary Test-Revised and the Clinical Evaluation of Language Fundamentals-Revised are useful for neuropsychological assessments since language abilities are linked to academic success and social competence.

Although, language abilities are infrequently affected after a child experiences a TBI, impairments in communication, including slowed speech, difficulties with fluency and word-finding and illogical stringing of ideas have been reported (Anderson, Northam et al., 2001). Furthermore, children with closed-head injuries exhibit more distinct problems with pragmatics such as with interpreting ambiguous sentences, making references, formulating sentences from single words and explaining figurative expressions (Yeates, 2000).

Executive Functions

The cognitive processes grouped under the term executive functioning include planning, organisation, regulation and monitoring of goal-directed behaviours. Initially, executive functions were informally assessed with measures that assess other cognitive domains. However, in recent years specific tests, such as the Wisconsin Card Sorting Test, The Tower of London, the Children's Category Test and the Delis-Kaplan Executive Function System (DKEFS) have been developed to assess executive functioning. Executive functioning deficits are common in children with neuropsychological impairments and they will partly determine a child's adaptive functioning (Yeates & Taylor, 1998).

Only a handful of studies have investigated the impairments of executive functioning in children who sustained a TBI. According to Garth et al. (1997, cited in Anderson, Northam et al., 2001), children who suffer a moderate to severe TBI tend to show impaired planning and problem solving, a decreased ability for abstract thinking and reduced speed of responding, while the situation for children with a MTBI is less clear.

Visual-spatial Perception and Constructional Abilities

It is important to assess nonverbal abilities after TBI since such deficits are associated with arithmetic and other academic skills as well as with psychosocial difficulties which may lead to poor peer relations. Furthermore, children with TBI or other neurological conditions often exhibit difficulties with nonverbal skills since such skills tend to be very vulnerable to childhood brain damage. Also, attention, organisation as well as motor functioning are dependent on visual-perceptual skills. Therefore, test results of visual-perceptual construction needs to be interpreted in the light of a child's other domains of functioning (Yeates & Taylor, 1998). Examples of tests that assess visual-perceptual abilities, but also require motor operations, include the Developmental Test of Visual-Motor Integration, the Rey-Osterrieth Complex Figure, the Three-Dimensional Block Construction Test and the Judgement of Line Orientation Test (Yeates & Taylor, 1998)

Non-verbal skills are commonly affected after childhood closed-head injuries and can be evaluated with the subtest on the WISC-III which require visual-perceptual and constructional abilities (performance IQ). Impairments have been observed on the Block Design subtest of the WISC-III, the Tactual Performance Test, the Developmental Test of Visual-Motor Integration and the Rey-Osterrieth Complex Figure. Furthermore, children with closed head injury tend to have difficulties with facial discrimination and picture matching (Yeates, 2000).

Motor and Sensory Functioning

It is important to include tests that measure motor and sensory functioning in a neuropsychological assessment because these abilities are also sensitive to neuropsychological impairments and can provide evidence as to localisation of brain dysfunction. Motor speed and ability are assessed with measures such as the Finger Tapping Test, the Purdue Pegboard and the Grooved Pegboard. The sensory functioning assessed includes finger localisation, stereognosis, graphesthesia, sensory extinction and left-right orientation. Measures that assess motor and sensory abilities may help predict learning problems in younger children and differentiate several learning difficulties in older children. However, because these measures have low ceiling levels they do not always detect neurological impairments. Furthermore, motor and sensory assessments are often dependent on other cognitive domains such as attention and motivation in younger children (Yeates & Taylor, 1998).

Motor deficits such as hemiparesis, impaired balance, steadiness and vision are usually only observed in the acute stage of severely brain damaged children while more subtle impairments such as psychomotor slowness and reduced eye-hand coordination are more long-term deficits that may also occur in mildly brain injured children. These deficits may affect some usual physical activities at home as well as a number of abilities needed at school such as writing and drawing which may as a result affect the child's self-esteem, social and educational development (Anderson, Northam et al., 2001). The presence of visual-motor deficits after TBI have been established by Chadwick et al. (1981, cited in Anderson, Northam et al., 2001) and since then these deficits have been regularly documented in adult and children even in cases of MTBI.

Intelligence

In regard to MTBI there tends to be little if any global intelligence deficit either during the early or later stages of recovery (Anderson, Northam et al., 2001). However, intelligence tests can be sensitive to the effects of TBI but they provide an incomplete understanding of memory, attention and problem-solving in particular because they do not directly assess these skills. They provide information about specific abilities by administering individual subtests instead of a full intelligence scale (Fletcher & Taylor, 1997).

Academic Abilities

Researchers have argued that academic underachievement can have the most severe effect on a child's development. However, it is not easy to assess academic skills since there are only a limited number of tests available to measure such skills and teachers commonly are reluctant to remark on a child's deficient functioning. Examples include the Wide Range Achievement Test-Third Edition, The Woodcock-Jonston Test of Achievement-Revised, the Kaufman Test of Educational Achievement and the Peabody Individual Achievement Test-Revised to assess reading, writing and mathematical skills. However, achievement tests do not provide information about specific cognitive domains that may also contribute to a child's underachievement (Yeates & Taylor, 1998). Also, it has been claimed that pre-injury academic difficulties have already been present in some children with TBI so that the incident of underachievement in brain injured children is overrated. Instead of using standardized tests it has been argued that school placement is a better predictor of underachievement (Anderson, Northam et al., 2001).

1.2.3. Neuropsychological Screening

Compared to a full neuropsychological assessment, screening is used to identify specific disorders or diseases from a large group of people to decide if further assessments need to be undertaken for certain individuals (Cohen & Spenciner, 1998). That is, it is not used as a diagnostic tool, but rather as a primary filtering process to identify individuals with the highest likelihood of having a particular disorder or disease that further diagnostic assessment can be carried out. Screening tests allow early detection of diseases and disorders which in turn increases the chance of providing more effective and immediate treatment. Furthermore, evidence suggests that by making use of screening measures costs of assessments and treatments will considerably be reduced since unnecessary full assessments will be eliminated for individuals who were shown to be unaffected by a specific disorder during the screening process (Derogatis & Lynn, 1999).

The effectiveness of a cognitive screening test compared to a full cognitive assessment is measured by its sensitivity, specificity and positive predictive power for identifying children with cognitive impairments. That is, children who are 'true positives' are correctly identified by the test as having cognitive deficits, while "true negatives" are correctly recognised as having no deficits. On the other hand, 'false negatives' are children with impairments who were not recognized by the tests and 'false positives' are children who were incorrectly identified as having cognitive deficits (Russell, Bernholt, & Ouvrier, 2002).

According to Meisels and Wasik (1990, cited in Cohen & Spenciner, 1998) it is important that screening tests are brief, norm-referenced, inexpensive, standardized and objective in administration and scoring, cover all necessary domains of development and are reliable and valid. If the focus is too narrow important information might be overlooked. As mentioned above, screening tests need to be norm-referenced, i.e., that the performance of a child who is being screened is compared to the performance of children who have previously completed the same screening test. The norm sample should be based on children who are similar in backgrounds and characteristics as the children who are being screened with the test. Moreover, since many different professionals tend to administer screening tests it is important that the scoring and administration procedure is standardized, i.e., the calculation of scores, the instructions and the outcomes are clearly explained and consistent for each administration. As with any other test administration with children it is important to take into account the environmental and developmental factors as well as the child's physical status and to establish rapport (Cohen & Spenciner, 1998).

In summary, neuropsychological assessments with children need to allow for developmental, environmental and adaptive factors before conclusions are drawn from test results. The cognitive functions commonly assessed include attention and concentration, verbal and non-verbal learning and memory, language, executive functioning, visual-spatial perception and constructional abilities, sensory memory and motor functioning as well as general intelligence and academic abilities. Since neuropsychological assessments are individually administered, lengthy and need to be conducted by trained and qualified professionals they are very costly and time consuming. This limits the availability of such assessment which means that not all children who are in need for a neuropsychological assessment undergo one and may never receive the necessary therapeutic interventions. Thus, it is useful to administer screening test to children who are suspected of having a brain injury before undergoing a full neuropsychological assessment.

1.3. Issues in Test Development

The foremost assumption that should be made about any psychological test is that results can be influenced considerably in many observable and measurable aspects by individual and environmental differences. Psychological tests attempt to compensate for these individual differences by observing behaviours systematically under more controlled conditions (Walsh & Betz, 2001). Psychological tests allocate numbers or test score to an observable behaviour that is being measured (Murphy & Davidshofer, 2001) and in turn summary statements are developed about those behaviours (Lezak, 1995).

Any test, especially if it is newly developed, needs to be standardized, so that testing occurs under controlled conditions with as many extraneous variables as possible eliminated (Walsh & Betz, 2001), i.e. test data needs to be collected from appropriate normative samples to reflect the make up of the general population (Rust & Golombok, 1999). Tests subdivide normative data into different groups (for e.g. according to age or race) so that an individual's test scores can be compared to the appropriate norm group (Murphy & Davidshofer, 2001).

There is a lack of good normative data in neuropsychology. Many reports seen in the research literature are based on very small samples and most do not assess normal individuals so that there is not enough information on how normal children respond to specific neuropsychological measures (Reynolds, 1997). Without the appropriate normative data from large samples of the population, which are stratified and random, examiners are unable to assess the effects of demographic variables, such as ethnicity gender and socioeconomic status, on neuropsychological test performance. Neuropsychologists often ignore the effects of demographics on test performance since they believe that such factors do not influence brain functioning. However, gender effects have been observed on the Coding and Digit Symbol subtest, which is well recognized as a result of extensive research (Reynolds, 1997).

1.3.1. Psychometrics

Psychometric properties such as reliability and validity are critical for evaluating and choosing psychological tests. Most neuropsychological tests, and even the most commonly used measures available, usually include little detail about their psychometric properties and rarely get tested on normal individuals making them unreliable and invalid if used repetitively and with normal individuals (Lezak, 1995; Yeates & Taylor, 1998). It is very important to develop normative data for neuropsychological tests, however, there are often no large-scale studies conducted to collect such data. One reason is the lack of financial support for such research since it is not aimed at confirming a research hypothesis. Thus, normative data for neuropsychological test is difficult to find since it is often embedded in clinical investigations or case studies (Mitrushina et al., 1999).

A test is said to be 'good' if it meets the necessary requirements of reliability and validity, and as already mentioned above, appropriate norms. These criteria, however, are not commonly part of neuropsychological tests (Lezak, 1995). Reliability refers the consistency of test scores. That is, a reliable test produces consistent scores on test items (internal or split-half reliability), on two alternative forms of a test (alternative form reliability), on two different administrations of the same test (retest reliability) or by different examiners (inter-rater reliability) (Murphy & Davidshofer, 2001). Therefore, reliability is the initial requirement and probably the most important psychometric characteristic of a test (Reynolds, 1997). Overall, reliability refers to the proportion of variance in performance that be attributed to true differences in behaviour and what proportion to error (Retzlaff & Gibertini, 2000).

The second important characteristic of a test is its validity, which refers to the usefulness or applicability of a test, meaning that it evaluates whether a test measures what it is designed to measure. The common methods to assess validity include content, construct, predictive (or criterion-related) and concurrent validity. Content and construct validity examines whether the test content (test items) measures the construct (domain of functioning) that it attempts to measure while criterion validity investigates whether a test correlates well with an external criterion (a related, external and observable behaviour). Lastly, concurrent validity examines whether the test correlates with other tests that measure the same construct. These validities are not independent from each other and a test needs to have all of them to be acceptable. That is, the test content should be connected to the construct it measures and other test that assess that construct and in turn predict some behaviour (Retzlaff & Gibertini, 2000).

In summary, neuropsychological tests commonly include little information on normative data, validity and reliability because they are usually not well researched. It is important, however, to include such information to make sure that a test accurately measures specific cognitive functions.

1.4. The Repeatable Battery for the Assessment of Neuropsychological Status

The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) was developed by Christopher Randolph and is a short, individually administered measure to assess attention, language, visuospatial/constructional abilities and immediate and delayed memory in adults between 20 and 89 years of age. The measure includes 12 subtests and takes about 20-30 minutes to administer. It has been standardized on 450 healthy American adults using a stratified, nationally representative sample and showed sound validity and reliability. It includes an alternative form that is useful for treatment and rehabilitation purposes. Although the RBANS was initially designed to assess dementia in older adults it has been found to be a valuable neuropsychological screening tool to establish the cognitive status of younger adults. It can be used by different health professionals and is quick and easy to administer and cost-effective (Randolph, 1998). The RBANS subtests measure different cognitive abilities, and appears to be an appropriate instrument from which to develop a similar measure for children. Below is a description of all the subtests and what they attempt to measure (see Appendix C for the RBANS test protocol) .

Subtest 1, 9 & 10 - List Learning, Recall and Recognition

For the List Leaning subtest (1), ten words that are semantically different are read to the examinee and he or she is asked to recall as many as possible. This procedure is repeated four times. At a later stage, for the List Recall subtest (9) the examinee is asked to recall the words of the list. After that, 20 words are read to the examinee, (List Recognition subtest 10) while ten of the words are from the target list and the others are new words. The examinee is asked to indicate which words were on the list. Both of these subtests (9 and 10) attempt to assess delayed memory, while List Recall measures delayed recall and List Recognition delayed recognition of words (Randolph, 1998).

Subtest 2 & 11 - Story Memory and Recall

The Story Memory subtest (2) requires the examinee to retell a story from memory after it has been read to him or her twice. (immediate memory). At a later stage, for the Story Recall subtest (11), the examinee is again asked to retell the story from memory without having it read to him or her again (delayed memory) (Randolph, 1998).

Subtest 3 & 12 - Figure Copy & Recall

The examinee is asked to draw on a blank page an exact copy of a complex geometric figure that is presented to him or her. With this subtest visouspatial and constructional abilities are measured. After a delay the examinee is asked to draw the figure from memory (Figure Recall, subtest 12) to assess delayed recall and reproduction of visual information (Randolph, 1998).

Subtest 4 - Line Orientation

A drawing is shown to the examinee which is made up of 13 lines, numbered 1 to 13, which extend equally from a mutual centre point to form a semicircular fan-shaped pattern. The examinee is asked to match two lines, which are pictured below the drawing, that extend from a mutual centre point, like on the drawing above. This is repeated ten times with different sets of lines each time. This subtest attempts to assess visuospatial abilities (Randolph, 1998).

Subtest 5 - Picture Naming

A series of pictures of different objects are presented to the examinee who is asked to name each of them. If the picture is clearly misperceived a semantic cue is given to the examinee (Randolph, 1998). With this subtest language ability, and in particular cued word retrieval, is assessed (Franzen, 2000).

Subtest 6 - Semantic Fluency

The examinee is asked to name as many fruits and vegetables (Form A) or animals found in the zoo (Form B) in one minute. This test assesses spontaneous word retrieval within one semantic category (Randolph, 1998).

Subtest 7 - Digit Span

The examinee is asked to repeat a string of digits in the same order that is read to him. The first trial starts with two digits and for each second consecutive trial one more digit is added. This test attempts to measure attention as well as immediate verbal recall (Randolph, 1998).

Subtest 8 - Coding

The examinee is presented with a page with one row of boxes on the top of the page that functions as the key and asked to fill in below within 90 seconds as many boxes with a number between 1 and 9 that corresponds with a symbol according to the key on the top of the page (Randolph, 1998). It measures principally attention, but also speed of processing, motor skills and visual-motor coordination (Lezak, 1995).

1.5 The Present Study

1.5.1 Aims

The aim of this research is to develop and trial a pilot neuropsychological screening measure for children between the ages of five to ten years, that is easy to administer, short, practical and inexpensive. Information arising from such a screen would be used to determine whether a child should undergo a full neuropsychological assessment and to assist in treatment and rehabilitation planning. Due to time and resource constraints the preliminary measure developed and reported on in the current study was trialled on a limited number of school children and did not include any children diagnosed with MTBI. In the future, an alternative form of the measure would need to be developed. In short, the current research attempts to set the foundation for future developments to create a repeatable neuropsychological screening measure for children based on the Repeatable Battery of Neuropsychological Status (RBANS).

1.5.2 Hypotheses

Hypothesis 1: *The psychometric properties such as validity and reliability are expected to be high and similar to the RBANS, if each RBANS-C subtest has consistency and measures what it intends to measure.*

As discussed in previous chapters, a test needs to have sound validity and reliability to be considered an effective test (Lezak, 1995). Therefore, it is predicted that if the RBANS-C subtests show adequate reliability and validity the test is considered to be effective. Furthermore, if the RBANS-C subtests are well-designed for children they should show validity and reliability coefficients similar to the RBANS subtests.

Hypothesis 2: *The RBANS-C will identify cognitive deficits such as problems with attention and concentration, learning and memory, information processing and visual-spatial perception and constructional abilities in those children in the sample who have such deficits.*

According to research, the cognitive deficits commonly associated with MTBI, include difficulties with attention, concentration, memory and learning, language, information processing and visual-spatial perception and constructional abilities (Mitrushina et al., 1999; Roberts, 1999). If there are children in the sample selected who have experienced some of the above cognitive deficits the RBANS-C is expected to identify those deficits.

<u>Hypothesis 3</u>: *Those children who were identified thorough the questionnaire (filled out by their parents) as having cognitive impairments will perform less well on the RBANS-C than children who were not documented to have cognitive impairments by the questionnaire.*

Although it may not necessarily mean that a child did or did not experiences a TBI just by way of the questionnaire a correlation may still exist between the cognitive impairments identified in the questionnaire and the child's performance on the RBANS-C. Thomson and Kerns (2000) note that many measures currently used with children are not very sensitive to the consequences of MTBI. Therefore, children who are known to have cognitive deficits, but who may have been evaluate with inappropriate measures that did not identify cognitive difficulties, did not undergo further evaluation.

<u>Hypothesis 4</u>: *Children who performed below average on the RBANS-C are expected to perform below average on the standardized neuropsychological assessment battery.*

It is expected that the children in the sample who have cognitive deficits and, therefore, performed below average on the RBANS-C will also perform below average on the standardized assessment battery than children who performed above average on the RBANS-C with no recognized cognitive impairments. The above statement by Thomson and Kerns (2000), that most neuropsychological measures are insensitive to the effects of MTBI, applies to this hypothesis as well. If the RBANS-C subtests detect the cognitive deficits they intend to, they will have to correlate with the results of the standardized subtests which were selected for this research to compare each RBANS-C subtest to.

<u>Hypothesis 5</u>: *Performance on the List Recognition subtest will be higher than on the List Recall subtest of the RBANS-C for all of the children tested.*

According to (Lezak, 1995) individuals with cognitive dysfunctions perform less well on the Recall trial of the California Verbal Learning Test (CVLT) (which is the test the List Recall of the RBANS-C is based on) than control subjects. However, these individuals tend to show a normal learning curve in the Recognition trial of the CVLT (which is the basis for the List Recall subtest of the RBANS-C.

Hypothesis 6: Individuals with suspected brain injury will obtain low scores on the Coding subtest of the RBANS-C.

According to Lezak (1995) the Digit Symbol (Coding) subtest of the Wechsler Intelligence Scales, is very sensitive to brain damage, including MTBI. That is, it is the one subtest of the Wechsler Intelligence Scales that is most likely to detect brain dysfunction.

Hypothesis 7: There will be some children within the sample of individuals assessed that will have endured a MTBI but who have not been recognized of having such an injury.

According to research, as many as 20-40% of MTBIs do not get reported and therefore do not come to the attention of health professionals. Furthermore, the prevalence of MTBI, in line with overseas data, suggest that 158 per 100,000 children suffer a MTBI (Roberts, 1999). Accordingly, it is reasonable to expect that in a randomly selected group of 30 children, some will have sustained a MTBI which never received medical attention.

Hypothesis 8: There will be differences in the performance on the RBANS-C subtest between the age groups assessed in this research.

As noted by Korkman, Kemp and Kirk (2001), neurocognitive development is most pronounced in children between five to eight years of age than those between nine and twelve years of age. Also because children acquire different cognitive skills depending on maturation an age effect is expected to be present for the RBANS-C subtests.

Hypothesis 9: Differences in performance on the RBANS-C between the boys and girls tested in this study are not expected.

Lezak (1995) notes that differences in cognitive performance between males and females have been documented, but most of them are doubtful and unproven or if present they tend to be very weak. She also suggests that while interpreting test results caution should be taken when allowing for sex differences to influence any conclusions. Therefore, the RBANS-C is expected not to demonstrate any sex differences, or if it does, those differences will be insignificant.

CHAPTER 2: METHOD

2.1. Participants

30 school children volunteered to take part in the study. They were all students at Birkenhead primary school, which is a decile 10 public school situated in the North Shore, Auckland, New Zealand. The children were aged between 5.4 to 10.6 years (average age was 8.1 years). The sample was made up of 15 boys and 15 girls, who came from varying cultural and socio-economic backgrounds.

Table 1. Characteristics of Sample

School Level (Age Band)	No.	Age	Sex	Special Observations
Years 1 and 2 (Ages 5 to 7) [1]	1	5.9	F	R
	2	5.3	F	Q, R
	3	6.2	M	
	4	5.2	M	R
	5	5.3	M	
	6	6.2	F	
	7	5.6	M	P, R
	8	6.1	F	
Year 3 (Ages 7 to 8)	9	7.5	F	R
	10	7.3	F	
	11	7.5	F	R
	12	7.5	M	P, R
	13	7.6	M	
Year 4 (Ages 8 to 9)	14	8.3	M	
	15	8.7	F	
	16	8.5	F	
	17	8.2	M	
	18	8.7	F	R
	19	8.8	M	R
Year 5 (Ages 9 to 10)	20	9.7	M	R
	21	9.6	M	Q, R
	22	9.5	F	
	23	9.3	F	
	24	9.5	F	R
	25	10.5	M	Q, R
Year 6 (Ages 10 to 11)	26	10.6	F	
	27	10.3	M	R
	28	10.3	M	
	29	10.5	M	
	30	10.7	F	R

Q = Identified in questionnaire as having cognitive difficulties or HI
P = Consistent low performance on RBANS-C
R = Retested with Standardized Assessment Battery
[1] Year 1 and 2 is a composite class

2.2. Procedure

The researcher approached the principal of Birkenhead primary school seeking permission to conduct the study. After approval from the principal the researcher distributed packs to be sent home to parents. The packs included an information sheet, (see Appendix A) a consent form (see Appendix A) and a short questionnaire (see Appendix A). A contact number was included on the information sheet for the parents should they wish to ask any questions about the research before signing the consent form.

The children who returned consent forms signed by their parent/s were then themselves asked if they wished to take part in the study (after the purpose and nature of their involvement in the study was discussed with them). Before each administration of the measures commenced a brief period was spent in establishing rapport. The RBANS-C (see protocol in Appendix B) was administered to children separately in a quiet room with each assessment taking approximately 20 minutes. After the measure was administered each child was asked for some feedback to ensure that there were no adverse consequence from the trial assessment and to obtain information to be used for future modification of the test. After four weeks two children from each age group were retested with a battery of standardized neuropsychological tests similar to the subtests of the RBANS-C. Furthermore, some of the children who were identified through the questionnaire filled out by their parents as having problems with some specific cognitive functions or having experienced a possible TBI and who also performed more poorly on the RBANS-C, were retested as well with the battery of standardized measures (see below for descriptions of measures and Appendix D). The tests included in this battery were selected on hand of following the same format as the RBANS-C subtests and measuring the same cognitive construct.

2.3. Measures

The RBANS was used as the basis for the RBANS-C since it assesses the cognitive domains that are commonly affected in children who suffer a TBI. Prior to the commencement of the study, the RBANS was administered to a six, eight and ten year old child to obtain a guide to which subtests and test items were appropriate/not appropriate for children. The other tests described below, following the RBANS-C subtests, were selected because each of them is similar to one of the subtest of the

RBANS-C. In this way, each RBANS-C subtest can be compared to a currently used standardized test to assess its validity.

1.3.2. Repeatable Battery for the Assessment of Neuropsychological Status for Children (RBANS-C)

A draft measure for children was developed following the format of the RBANS. It includes all the 12 subtest of the original RBANS developed by Christopher Randolph (1998). Some of the subtests have been adapted to be more appropriate for school-children while others were left unchanged. The changes considered necessary were identified by administering the RBANS to a six, eight and ten year old school child who found some of the test items too difficult. The subtests and items of the RBANS for Children (RBANS-C) was reviewed by three neuropsychologists and any feedback was taken into consideration for the final preliminary measure of the RBANS-C (see Appendix B).

Like the RBANS, the RBANS-C attempts to assess five different domains of functioning, including immediate memory, visuospatial/constructional abilities, language, attention and delayed memory (Randolph, 1998). Below is a description of each subtest of the RBANS-C, what each intends to measure, a rationale for including the subtest and what modifications were made to each to make it more appropriate for children. An effort was made to make the test content of the RBANS-C more appropriate for New Zealand children.

Subtest 1, 9 & 10 - List Learning, Recall and Recognition

In List Learning (subtest 1) the child is orally presented four times with a list of ten words that he or she is asked to recall. After some delay, for List Recall (subtest 9), the child is asked to recall the ten words from memory. Following this, the child is presented with 20 words, while 10 of these words are from the List Learning subtest and the child is asked to identify which words were on the list.

The List Leaning subtest on the RBANS is based on the California Verbal Learning Test (CVLT) or the similar Ray Auditory Verbal Learning Test (RAVLT). The CVLT is the most commonly applied and studied test of memory by measuring immediate recall, repetitive learning and delayed recall and interference (Franzen, 2000). A children's version has been developed for the CVLT to assess children between 5 and 16 years of age (CVLT-C) (Spreen & Strauss, 1998). The CVLT for children has been found to be sensitive to brain injury but more so for children with severe TBI than those with moderate or mild TBI (Franzen, 2000).

The rationale for including this subtest is that children, like adults, with TBI exhibit difficulties with immediate and delayed verbal recall and with concentration, which are cognitive functions assessed by this test. This subtest has been shortened by excluding the interference trial of the CVLT to be more suitable for a screening test. The List Learning subtest of the RBANS-C was slightly changed from the adult RBANS by following more the format of the children's version of the CVLT. In other words, the list was made up of more semantically similar words instead of having words from various semantic categories as in the RBANS.

Subtest 2 & 11 - Story Memory and Recall

For Story Memory (subtest 2), the same short story is orally presented twice to the child who is each time asked to retell the story as complete as possible immediately after it has been read by the examiner. After a delay the child is asked to recall as much detail as it can of the story from memory (Story Recall, subtest 11). The Story Memory subtest is designed to assess immediate memory and the Story Recall, delayed memory or recall. As mentioned above, the test is included because children with TBI have difficulties with immediate and delayed memory of verbal information. Some other test that are similar to the Story Memory and Recall subtests are the Stories subtests 1 and 2 of the Children's Memory Scale (Cohen, 1997). The story has been changed for the RBANS-C because the original RBANS story was considered too complex for children. However, the story is made up of the same number of content units as the RBANS.

Subtest 3 & 12 - Figure Copy & Recall

The child is presented with a geometrical figure for Figure Copy (subtest 3), and is asked to copy the figure onto a blank page. After a delay, without prior warning, the child is asked, to recall the figure from memory (Figure Recall, subtest 12). This subtest is based on the Rey-Osterrieth Complex Figure Test (CFT) which was developed by Rey and Osterrieth (Franzen & Berg, 1998). It attempts to assess planning, organizational and problem-solving skills as well as perceptual, motor and memory skills (Spreen & Strauss, 1998). The subtest is included in the RBANS-C because non-verbal skills are frequently affected by TBI. The RBANS figure is less complex than that of the Rey-Osterrieth and the usual immediate recall trial is excluded because delayed recall is more sensitive to memory impairments than immediate recall (Spreen & Strauss, 1998). It is different to the RBANS figure because an attempt was made to make it more appropriate for children (refer to Figure 1 and Table 2 below).

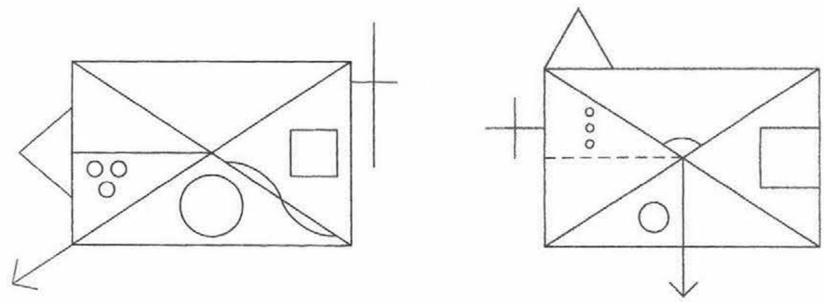

Figure 1. Differences Between RBANS and RBANS-C Figures

Table 2. Changes to RBANS Complex Figure

RBANS Figure Segment	Reason For Change for RBANS-C
Triangle	Positioning of triangle is difficult to place
Outside Cross	Unequal lines are difficult to draw
Curving Line	Curving is difficult to draw
Circle	Size of circle is difficult to draw

Subtest 4 - Line Orientation

In this subtest, the child is presented with a drawing which is comprised of 13 lines, which are numbered 1 to 13 and that extend equally from one point to form a semicircular fan-shaped pattern (see Appendix B for an example). The child is asked to match two lines, which are pictured below the fan-shaped drawing that extend from a centre point, like on the drawing above for ten trials. This subtest attempts to assess visuospatial abilities and is based on the Judgment of Line Orientation test which was developed by Benton, Hannay and Varney (1975, cited in Franzen & Berg, 1998). It measures visual-spatial abilities and in particular it assesses the ability to estimate angular relationships. It is a valuable test for the assessment of perceptual abilities justifying its inclusion in the RBANS-C (Franzen & Berg, 1998). This subtest was left unchanged from the RBANS as it was considered appropriate for the assessment of children, especially since a similar subtest is included in the NEPSY.

Subtest 5 - Picture Naming

The child is shown ten simple colour pictures of common everyday objects and is asked to name each of them. This test is similar to the Boston Naming Test (BNT) (Kaplan, Goodglass, & Weintraub, 1983) and attempts to measure word retrieval or confrontation naming. The BNT has initially been developed for adults but is also used to assess children (Yeates, 1994). Care is recommended in interpreting results since poor performance on the BNT may indicate impairments in other domains of functioning than just word retrieval (Franzen, 2000). Children with severe HI perform less well on the BNT than children without HI (Franzen, 2000) and the test has been found to distinguish children with reading difficulties from those without reading difficulties (Teeter & Semrud-Clikeman, 1997). Since language abilities, such as naming, can be affected by TBI it is useful to include this subtest in the RBANS-C. This subtest has been modified from the RBANS to make it more suitable for children by reducing the difficulty of the pictures. For instance, one of the RBANS pictures shows a 'well' which will be very difficult for a five year old child to name (refer to Appendix B for some sample pictures).

Subtest 6 - Semantic Fluency

The child is asked to name as many animals within two minutes. It is the same as the RBANS (form B) Semantic Fluency subtest and very similar to the NEPSY Verbal Fluency subtest. The time limit has been extended from one to two minutes. This subtest measures a child's ability to generate words within a specific semantic category (i.e. animals). Since word production, or the generation of word lists, has shown to be a valuable indicator of brain impairment, it is important to include this subtest in the RBANS-C (Lezak, 1995).

Subtest 7 - Digit Span

This subtest is based on the Digit Span subtest of the WISC-III. The child is asked to repeat a string of digits that are orally presented by the examiner. After every second trial one digit is added to the string and if the child fails both trials of each equal long set of digits the test is discontinued. According to Lezak (1995) Digit Span is the most frequently used neuropsychological measure of immediate verbal recall. It is sensitive to age and brain dysfunction and tends to be affected by daytime (Franzen, 2000). This subtest is included in the RBANS-C, since children with TBI show difficulties with attention, concentration and immediate recall like adults and it was left unchanged from the RBANS, because it is suitable for children in its original form.

Subtest 8 - Coding

This subtest is based on the Coding subtest of the WISC-III which has been found to be more sensitive to brain damage, including MTBI, than any other Wechsler Scale subtest (Lezak, 1995). In this subtest the child is presented with a key that shows a set of nine symbols that correspond to the numbers 1-9 and is asked to fill in as many boxes of rows underneath some random numbers from 1-9 that correspond to the symbols according to the key on top of the page in 90 seconds. This subtest has been slightly changed from the original RBANS by asking the child to fill in symbols into boxes, rather than numbers that correspond to symbols according to a key on the top of the page (which is the case in the RBANS). This corresponds to the Coding subtest of the WISC-III where the task is to fill in symbol to offset difficulties that younger children might have with writing numbers than symbols.

1.3.3 Comparison Measures

To estimate the RBANS-C concurrent validity a regularly used standardized measure was selected for each subtest and administered to a subset of ten children from the 30 children selected. For the List Learning, List Recall and List Recognition as well as for the Story Memory and Story Recall, the Children's Memory Scale was chosen which includes very similar subtests like these. The format and administration is slightly different for some of them but these were the best matching tests available to the researcher. The NEPSY subtests Arrows (the Judgment of Line Orientation Test would have been more appropriate but not accessible to the researcher) and Verbal Fluency were selected because they were again the best tests available to the researcher to compare to the Line Orientation and Semantic Fluency RBANS-C subtests. For the RBANS-C Picture Naming subtest the almost identical Boston Naming Test was selected as the comparison measure and for the RBANS-C Digit Span and Coding subtests the WISC-III Digit Span and Coding subtests were selected since they are basically equivalent. The RBANS-C Figure Copy and Recall subtests were compared to the Rey-Osterrieth Complex Figure Test because it follows the same testing principles and administration, although, with a slightly more complex geometric figure. These tests are described below (see also Appendix D for test materials).

Children's Memory Scale

The CMS offers a comprehensive assessment of learning and memory functions in children and adolescents from 5 to 16 years of age, and maintains high standards of technical quality, reliability, and validity (Franzen, 2000). The core battery consists of six subtests and there is an additional battery of three subtests. The administration of the entire battery takes a minimum of 60 minutes (Cohen, 1997).

Stories Subtest (Immediate and Delayed Recall)

For the Stories subtest of the CMS the examinee is read a short story and is asked to retell it. After the examinee has recalled as much as he or she can remember of that first story a second short story is read to the examinee and again he or she is asked to recall as much as possible about the story. The Stories 2 subtest ask the examinee to recall the two stories from memory after a delay without having them read to him or her (Cohen, 1997).

Word Lists Subtest (Learning, Delayed Recall, Delayed Recognition)

In this subtest, the child is read a list of words from different semantic categories that he or she is asked to learn. For the first trial all the words are read while for the second to the fourth trial only those words are read that the examinee did not remember in the previous trials. After a delay the examinee is asked to recall the words from memory to assess delayed recall or delayed memory. Following this, for the Word List Recognition subtest of the CMS the examinee is read some of the words that were on the list and some that were not and is asked to indicate which words were from the list. This allows the measurement of delayed recognition for words (Cohen, 1997).

NEPSY: A Developmental Neuropsychological Assessment

The NEPSY was developed by Korkman, Kirk and Kemp (1998). It is a flexible assessment tool to measure the neuropsychological development of children between the ages of 3 and 12 years. It assesses five domains of functioning, including attention/executive functioning, language, visuospatial processing, sensorimotor abilities and memory and learning. The standardized sample included 1000 children, 100 from each age level with equal numbers of each sex. Reliabilities for each domain of functioning ranged between .70 to .91. and reliability coefficients for the subtests were as low as .50 to as high as .91. In regard to the test's validity, no confident estimates can be made at this stage because of limited research (Ahmad & Warriner, 2001).

Arrows Subtest

The Arrows subtest of the NEPSY asks the examinee to indicate which two arrows point exactly to the middle of a target that is presented on the page (see page x in Appendix X). Each page has eight arrows and a target. There are 15 trials and after four failures of identifying the two arrows the test is discontinued. The test attempts to assess the judgment of line orientation and directionality (Korkman et al., 1998).

Verbal Fluency Subtest

The Verbal Fluency subtest of the NEPSY assesses the ability to produce words within certain semantic and phonemic categories. The child is given 60 seconds to think of as many words in each categories. The two semantic categories are Animals and Food or Drink and the two phonemic categories are 'S-words' and 'F-words" The two phonemic categories are only administered to children between 7 and 12 years of age (Korkman et al., 1998).

Boston Naming Test

The Boston Naming Test (BNT) was developed by Kaplan, Goodglass and Weintraub in 1983 to be used with adults to test word retrieval or confrontation naming. It has been found to be a valuable test to identify adults who are aphasic. It is also commonly used to assess children for language difficulties, and especially those with learning disabilities (Kirk, 1992). The original test consists of 85 line drawings of everyday items that increase in difficulty. A 60-item revised version was later developed as well as 30-item and 15-item short form. The examinee is asked to name each line drawing that is presented. The examinee is given a semantic cue only if the picture is obviously misperceived. If he or she fails to name six pictures consecutively the test is discontinued (Spreen & Strauss, 1998).

Wechsler Intelligence Scale for Children-3rd Edition (WISC-III)

The Wechsler Intelligence Scale for Children 3rd Edition (WISC-III) is used with children between 6 to 16 years of age to assesses intellectual functioning. It is individually administered and includes 13 subtests that assess different domains of functioning, including verbal comprehension, perceptual organization, freedom from distractibility and processing speed. Neuropsychologists make use of this measure by administering specific subtest to assess certain cognitive functions. The WISC-III has been well researched and has good psychometric properties (Wechsler, 1992).

Coding Subtest

Children between 6 to 7 years of age are given a key on the top of the page with shapes that are linked to different symbols (Coding A) while those between 8 to 16 years of age are presented with a key that associates the numbers 1 to 9 to various symbols (Coding B). The child is asked to either draw the symbol in the corresponding shape (Coding A) or in the box below its corresponding number (Coding B) according to the key. A time limit of 120 seconds is given to fill in as many as possible shapes or boxes (Wechsler, 1992).

Digit Span (Forward) Subtest

A series of orally presented digits are presented to the child who is asked to repeat the sequences. The Digit Backwards trial asks the child to repeat the orally presented number sequences backwards (Wechsler, 1992). However, this trial was excluded for this study.

Rey-Osterrieth Complex Figure Test (Copy and 30' Delayed Recall)

The Rey-Osterrieth Complex Figure Test (CFT) was developed by Rey in 1941 and further improved and standardized by Osterrieth in 1944 (Franzen & Berg, 1998). It measures planning, organizational and problem-solving abilities as well as perceptual, motor and memory skills. The test has been shown to be sensitive to memory impairments in TBI. The examinee is asked to copy a complex figure on a blank page and after a 3 minute and later at a 30 minute delay he or she is asked without prior warning to reproduce the figure from memory. The test has been slightly changed from this original administration by excluding the 3 minute immediate recall trial of the figure. Although the CFT was originally designed for adults it is used with children and norms for children are available (Spreen & Strauss, 1998). New Zealand norms have also been researched for children between 7 and 18 years of age (Fernando, Chard, Butcher, & McKay, unpublished).

CHAPTER 3: RESULTS

This chapter presents the results of the study. First, it provides the descriptive statistics for the RBANS-C subtests of the whole sample and the subgroup of children retested with the standardized assessment battery. Following is an examination of the psychometric properties of the RBANS-C. Next, questionnaire results are presented which is followed by an investigation whether the RBANS-C identifies children with cognitive impairments. Other analyses that are conducted include whether there are any significant differences between the age bands that were included in the sample as well as whether there were significant sex difference for any of the RBANS-C subtests.

3.1. Descriptive Statistics

<u>Table 3.</u> Shows Descriptive Statistics of Raw Scores of RBANS-C Subtests of all Children Tested and Standard Scores [a] of Standardized Assessment Battery of Children Retested

	N	Min.	Max.	Mean	Std. Deviation
List Learning	30	16	33	25.27	4.57
Story Memory	30	8	24	19.10	3.21
Figure Copy	30	16	20	18.90	1.13
Line Orientation	30	12	20	16.87	1.76
Picture Naming	30	19	20	19.97	.183
Semantic Fluency	30	9	34	21.07	6.67
Digit Span	30	5	15	7.43	1.65
Coding	30	10	36	20.73	7.67
List Recall	30	0	10	6.47	1.93
List Recognition	30	17	20	19.57	0.73
Story Recall	30	0	12	10.57	2.46
Figure Recall	30	9	19	14.77	2.69

	N	Range	Min.	Max.	Mean	Std. Deviation
CMS Words	15	14.00	5.00	19.00	11.93	4.09
CMS Stories	15	7.00	9.00	16.00	13.40	1.91
Complex Figure Test (Copy)	15	4.00	11.00	15.00	12.73	1.16
NEPSY Arrows	15	6.00	9.00	15.00	12.73	2.21
Boston Naming Test	15	4.00	8.00	12.00	10.60	1.12
NEPSY Verbal Fluency	15	9.00	7.00	16.00	10.27	2.91
WISC-III Digit Span	15	11.00	7.00	18.00	11.07	3.12
WISC-III Coding	15	6.00	9.00	15.00	11.33	2.02
CMS Words Recall	15	9.00	6.00	15.00	10.47	2.56
CMS Words Recognition	15	7.00	7.00	14.00	10.60	2.26
CMS Stories Recall	15	10.00	6.00	16.00	12.40	2.41
Complex Figure Test (Recall)	15	7.00	7.00	14.00	10.47	2.00

[a] Standard Scores Tables taken from Cohen, 1997; Spreen and Strauss, 1998; Korkman et al., 1998; and Wechsler, 1992

As Table 3 shows, the largest range and standard deviation for the RBANS-C subtests is observed for Coding, closely followed by List Learning and Semantic Fluency. There was little difference in performance for Picture Naming and List Recognition. Extreme low scores, as shown by the minimums, are present for most subtest and especially for List Recall, Semantic Fluency and Story Recall while extreme high values are also shown for most subtests that may characterize possible outliers. On the other hand, for the standardized assessment battery, high range and standard deviations are shown for

CMS Words and Digit Span. Low scores, as shown by the minimums, are most prominent for subtests CMS Words, Words Recall and CMS Stories Recall.

3.2. Psychometric Properties of RBANS-C

Two forms of reliability (internal consistency and split-half) is calculated depending on the subtest as well as two types of validity (concurrent and construct validity). Only these types of psychometrics were examined because some methods do not apply to this study and others do not have the necessary requirements to be computed. That is, due to time and resource restrictions no repeatable form is as yet available to evaluate alternate-form reliability, and no retesting with the same test-form was carried out to determine test-retest reliability. criterion validity was not estimated because the study did not include an external criterion (such as educational performance).

3.2.1. Reliability

Internal Consistency

The method of internal consistency, which is commonly computed with the Cronbach's Alpha coefficient, determines the reliability of a test by comparing each item with all other test items (intercorrelations between test items). According to Mitrushina, D'Elia, & Boone (1999), reliabilities of neuropsychological tests commonly range between 0.80 to 0.95, while for screening tests, reliabilities are acceptable if they are as low as 0.60.

Table 4. Internal Consistency of RBANS-C Subtests

Subtest	N	N of Items	Cronbach's Alpha Coefficient
List Learning	30	10	α = .64
Story Memory	30	12	α = .69
Figure Copy	30	10	α = .34
Line Orientation	30	20	α = .37
Picture Naming	30	10	α = .00
Semantic Fluency	30	40	α = .93
Digit Span	30	16	α = .71
Coding	30	40	α = .94
List Recall	30	10	α = .44
List Recognition	30	20	α = .25
Story Recall	30	12	α = .87
Figure Recall	30	10	α = .23

[1] Split-half method was used to calculate reliability for Digit Span
[2] Although the Complex Figure subtest only consists of one test item the individual parts that make up the figure are considered as individual test items

High internal consistencies for the RBANS-C subtests, as shown in Table 4, were calculated for Coding and Semantic Fluency, while Digit Span and Story Recall were moderate and List Learning and Story Memory were low but still acceptable for a screening measure. However, Figure Copy, Line Orientation, List Recall, List Recognition and Figure Recall have low internal reliability and Picture Naming does not have any internal consistency at all.

3.2.2. Validity

Concurrent Validity

Concurrent validity was calculated by comparing the results of the 10 children that were retested with the standardized assessment battery. Outliers (values that are considerably higher or lower than most values) can greatly affect the correlation coefficient and especially in small samples (Pallant, 2001). Thus, to calculate the concurrent validity of the RBANS-C subtests, such outliers were removed by excluding those children which performed considerably below or above the mean of the general sample.

The shaded area in Table 5 (see next page) shows correlations expected to be significant to determine each RBANS-C subtest's concurrent validity. Significant correlations were only observed between the RBANS-C List Learning subtest and the Words subtest of the Children's Memory Scale ($r = 0.67$) as well as between the Figure Copy RBANS-C subtest and the Rey-Osterrieth Complex Figure Test (Copy) ($r = 0.72$). Other noticeable correlations, which, however, were not significant, include the RBANS-C Semantic Fluency and the NEPSY Verbal Fluency subtest ($r = 0.44$), RBANS-C Digit Span and the WISC-III Digit Span subtest ($r = 0.48$), RBANS-C List Recall with the CMS Words subtest ($r = 0.41$) and the RBANS-C Figure Recall subtest with the Rey-Osterrieth Complex Figure Test (Recall) ($r = 0.44$).

Table 5. Spearman's Rho Correlation Coefficient to Estimate RBANS-C Concurrent Validity. [1 2]

		CMS Words Subtest	CMS Stories Subtest	Complex Figure Test (Copy)	Arrows Subtest NEPSY	Boston Naming Test	NEPSY Verbal Fluency Subtest	WISC-III Digit Span Subtest	WISC-III Coding Subtest	CMS Words Recall Subtest	CMS Words Recognition Subtest	CMS Stories Recall Subtest	Complex Figure Test (Recall)
List Learning	Correlation Coefficient	.667*	.335	.335	.288	.244	.257	.382	.115	.496	.342	.506	.165
	Sig. (2-tailed)	.035	.343	.343	.419	.497	.474	.276	.753	.145	.334	.136	.649
	N	10	10	10	10	10	10	10	10	10	10	10	10
Story Memory	Correlation Coefficient	-.244	-.368	-.349	-.329	-.368	-.150	-.349	-.025	-.412	-.403	-.362	.106
	Sig. (2-tailed)	.497	.296	.323	.353	.296	.679	.323	.945	.237	.248	.305	.771
	N	10	10	10	10	10	10	10	10	10	10	10	10
Figure Copy	Correlation Coefficient	.682*	.963**	.724*	.773**	.862**	.347	.167	-.141	.264	.577	.938**	.245
	Sig. (2-tailed)	.030	.000	.018	.009	.001	.326	.645	.698	.461	.081	.000	.494
	N	10	10	10	10	10	10	10	10	10	10	10	10
Line Orientation	Correlation Coefficient	.456	.362	.432	.358	.464	.096	.003	-.639*	.273	.512	.318	.083
	Sig. (2-tailed)	.185	.304	.212	.310	.177	.793	.993	.047	.445	.131	.371	.820
	N	10	10	10	10	10	10	10	10	10	10	10	10
Picture Naming	Correlation Coefficient	-.058	.174	-.058	.058	.058	-.058	-.296	.354	-.548	-.414	.174	.406
	Sig. (2-tailed)	.873	.631	.873	.873	.873	.873	.407	.316	.101	.235	.631	.244
	N	10	10	10	10	10	10	10	10	10	10	10	10
Semantic Fluency	Correlation Coefficient	.459	.421	.177	.184	.317	.440	.612	.368	.336	.416	.512	-.274
	Sig. (2-tailed)	.182	.226	.625	.611	.372	.203	.060	.295	.343	.232	.130	.443
	N	10	10	10	10	10	10	10	10	10	10	10	10
Digit Span	Correlation Coefficient	.454	.636*	.216	.237	.439	.263	.481	.260	.275	.447	.675*	-.256
	Sig. (2-tailed)	.188	.048	.548	.509	.204	.463	.159	.469	.442	.195	.032	.476
	N	10	10	10	10	10	10	10	10	10	10	10	10
Coding	Correlation Coefficient	.723*	.742*	.602	.673*	.790**	.829**	-.074	-.161	.083	.539	.626	.128
	Sig. (2-tailed)	.018	.014	.066	.033	.007	.003	.838	.658	.820	.108	.053	.725
	N	10	10	10	10	10	10	10	10	10	10	10	10
List Recall	Correlation Coefficient	.319	.271	.308	.275	.208	.063	.321	-.342	.409	.446	.384	-.031
	Sig. (2-tailed)	.369	.449	.386	.441	.565	.862	.366	.334	.240	.197	.273	.931
	N	10	10	10	10	10	10	10	10	10	10	10	10
List Recognition	Correlation Coefficient	-.131	-.435	-.174	-.263	-.348	-.349	.266	.000	-.046	-.266	-.261	.174
	Sig. (2-tailed)	.718	.209	.631	.463	.324	.323	.458	1.000	.900	.458	.466	.631
	N	10	10	10	10	10	10	10	10	10	10	10	10
Story Recall	Correlation Coefficient	.056	.382	.202	.271	.405	.203	.240	.011	-.318	.114	.360	.022
	Sig. (2-tailed)	.877	.276	.575	.448	.246	.574	.504	.975	.370	.753	.307	.951
	N	10	10	10	10	10	10	10	10	10	10	10	10
Figure Recall	Correlation Coefficient	.391	.522	.384	.389	.378	-.183	.391	.185	.122	.106	.699*	.441
	Sig. (2-tailed)	.263	.121	.273	.266	.282	.613	.264	.608	.737	.771	.025	.203
	N	10	10	10	10	10	10	10	10	10	10	10	10

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

[1] Extreme values were excluded for this analysis and data was non-standardized (i.e. not corrected for age differences)

[2] Spearman's Rho correlation coefficient was selected because most of the data of the standardized assessment battery were not normally distributed.

Construct Validity

It is accepted that some RBANS-C subtests will correlate with each other, as a result of measuring the same cognitive domain of functioning. Evidence for construct validity cannot be condensed to one single correlation coefficient because it requires multiple studies and different analyses due to it's complexity (Randolph, 1998). However, some evidence for construct validity can be calculated in this research by attempting to uncover correlations between those subtests measuring the same construct. In addition to evaluating construct validity with the use of Spearmans' Rho correlation coefficient factor analysis was also carried out as shown in Table 6. The Principal Axis Factoring method was chosen as it is the most useful method for this analysis (Coakes & Steed, 2000). Table 7 displays the correlation coefficients between each subtest of the RBANS-C (see page 46).

Table 6. Factor Analysis of RBANS-C Subtests

	Factor			
	1	2	3	4
Story Recall	1.085			
Story Memory	.820			
List Recall	.703			
Semantic Fluency	.530			
Coding	.482	.365		
List Learning	.392			.341
Line Orientation		.855		
Figure Copy		.765		
Figure Recall		.348		
Picture Naming			.934	
Digit Span				.728
List Recognition				

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

The factor analysis, suggested that four factors should be extracted, which then were rotated and the final results are presented in Table 6. Most of the loadings were on factor 1, which made up 37% of all loadings as read by the initial factor extraction. Factor 1 was labelled 'memory' because all the subtests that load with Factor 1 are dependent on some form of memory (not so much for Coding and Semantic Fluency than the other subtests). The highest loading for this factor is Story Recall (1.09) followed by Story Memory (0.82), List Recall (0.70), Semantic Fluency (0.53), Coding (0.48), and List Learning (0.39). Furthermore, subtests Line Orientation, Figure Copy and Figure Recall show loadings on the same factor (2). These subtests (more so for

Line Orientation and Figure Copy than Recall) intend to measure visuospatial/ constructional abilities' which, therefore, specifies the attribute of Factor 2. Factor 3 was named 'language' since it loads highly only with Picture Naming, which is one of the subtests that attempts to assess this cognitive domain. List Learning loads on Factor 4 together with Digit Span which was labelled 'attention and concentration' since Digit Span and List Learning are highly dependent on these cognitive functions.

Table 7 (see next page) shows the correlation coefficients between the RBANS-C subtests. In line with the Factor loadings shown in Table 5, significant and high correlations are shown between List Learning and Story Memory (r = 0.65), List Recall (r = 0.64) and Story Recall (r = 0.62) and between Story Memory and List Recall (r = 0.65) and Story Recall (r = 0.79) as well as between List Recall and Story Recall (r = 0.70). Additionally, Semantic Fluency correlated significantly with Story Memory (r = 0.43), Coding (r = 0.53), List Recall (r = 0.54) and Story Recall (r = 0.56) and List Learning also correlates with Semantic Fluency (r = 0.44) and Coding (r = 0.44) while Coding correlates with List Recall (r = 52) and Story Recall (r = 57). All these subtest also loaded high on Factor 1. Additionally, Coding significantly correlate with Figure Copy (r = 0.55) and Line Orientation (r = 0.46) and Line Orientation with Figure Copy (r = 0.37) which all also load on Factor 2 as shown in Table 5. List Learning and Digit Span (r = 0.37) correlate significantly and also load on Factor 4. Other subtest that correlated significantly but did not load on the same factor include List Learning with Figure Copy (r = 0.42), Line Orientation with List Recall (r = 0.43) and Figure Copy with List Recall (r = 40).

<u>Table 7.</u> Spearman's Rho Correlation Coefficients to Compare RBANS-C Subtests

		List Learning	Story Memory	Figure Copy	Line Orientation	Picture Naming	Semantic Fluency	Digit Span	Coding	List Recall	List Recognition	Story Recall	Figure Recall
List Learning	Pearson Correlation	1	.645**	.416*	.190	-.071	.442*	.377*	.443*	.641**	.089	.620**	.208
	Sig. (2-tailed)	.	.000	.022	.314	.709	.014	.040	.014	.000	.639	.000	.270
	N	30	30	30	30	30	30	30	30	30	30	30	30
Story Memory	Pearson Correlation	-	1	.289	.284	.124	.431*	.219	.478**	.645**	.196	.792**	.107
	Sig. (2-tailed)	-	.	.121	.128	.515	.017	.245	.008	.000	.298	.000	.574
	N	-	30	30	30	30	30	30	30	30	30	30	30
Figure Copy	Pearson Correlation	-	-	1	.371*	.151	.240	.209	.549**	.325	.029	.233	.334
	Sig. (2-tailed)	-	-	.	.043	.425	.202	.267	.002	.080	.877	.215	.071
	N	-	-	30	30	30	30	30	30	30	30	30	30
Line Orientation	Pearson Correlation	-	-	-	1	.131	.164	-.076	.462*	.434*	-.267	.224	.132
	Sig. (2-tailed)	-	-	-	.	.490	.385	.691	.010	.017	.154	.234	.488
	N	-	-	-	30	30	30	30	30	30	30	30	30
Picture Naming	Pearson Correlation	-	-	-	-	1	-.026	.049	.018	-.052	-.112	-.033	.194
	Sig. (2-tailed)	-	-	-	-	.	.890	.795	.924	.784	.554	.861	.303
	N	-	-	-	-	30	30	30	30	30	30	30	30
Semantic Fluency	Pearson Correlation	-	-	-	-	-	1	.235	.526**	.535**	.077	.561**	.309
	Sig. (2-tailed)	-	-	-	-	-	.	.212	.003	.002	.685	.001	.097
	N	-	-	-	-	-	30	30	30	30	30	30	30
Digit Span	Pearson Correlation	-	-	-	-	-	-	1	.197	.194	.190	.183	.264
	Sig. (2-tailed)	-	-	-	-	-	-	.	.297	.304	.315	.332	.159
	N	-	-	-	-	-	-	30	30	30	30	30	30
Coding	Pearson Correlation	-	-	-	-	-	-	-	1	.514**	.090	.574**	.325
	Sig. (2-tailed)	-	-	-	-	-	-	-	.	.004	.637	.001	.080
	N	-	-	-	-	-	-	-	30	30	30	30	30
List Recall	Pearson Correlation	-	-	-	-	-	-	-	-	1	.051	.700**	.395*
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	.	.790	.000	.031
	N	-	-	-	-	-	-	-	-	30	30	30	30
List Recognition	Pearson Correlation	-	-	-	-	-	-	-	-	-	1	.026	.158
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	-	.	.890	.404
	N	-	-	-	-	-	-	-	-	-	30	30	30
Story Recall	Pearson Correlation	-	-	-	-	-	-	-	-	-	-	1	.156
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	-	-	.	.409
	N	-	-	-	-	-	-	-	-	-	-	30	30
Figure Recall	Pearson Correlation	-	-	-	-	-	-	-	-	-	-	-	1
	Sig. (2-tailed)	-	-	-	-	-	-	-	-	-	-	-	.
	N	-	-	-	-	-	-	-	-	-	-	-	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

<u>Hypothesis 1</u>: The psychometric properties such as validity and reliability are expected to be high and similar to the RBANS, if each RBANS-C subtest has consistency and measures what it intends to measure.

This hypothesis is somewhat supported by the results since some subtests show acceptable reliability and validity coefficients and some did not as shown by Tables 4 to 7. Internal consistency coefficients ranged between .00 to .93 and suggests satisfactory coefficients for List Learning, Story Memory, Semantic Fluency, Digit Span, Coding, and Story Recall. Also, concurrent validity was significant, as shown by Table 5 for List Learning and Figure Copy while non-significant but moderate correlations were calculated for Semantic Fluency, Digit Span, List Recall and Figure Recall. Furthermore, construct validity, as shown by Table 6 and 7, showed factor loadings and significant correlations for most of the subtests but more research is needed to make any clear conclusions.

Split-half reliability coefficients were calculated for each index of the RBANS by age group and these ranged from .75 to .90 while intercorrelations between the RBANS index scores from the normative sample ranged between .28 to .63 which indicates relatively separate factors. Furthermore, concurrent validity was estimated by comparing the RBANS index scores to external measures that assess the same construct which ranged between .49 to .82 (Randolph, 1998).

However, comparisons are difficult to make between the RBANS psychometric properties and that of the RBANS-C since the RBANS estimates its reliabilities and validities for its five different cognitive indexes , i.e., immediate memory (List Learning, Short Memory), visuospatial/constructional abilities (Figure Copy, Line Orientation), language (Picture Naming, Semantic Fluency), attention (Digit Span, Coding), delayed memory (List Recall, List Recognition, Story Memory, Figure Recall) instead of individual subtests, which are based on converted index scores not on raw scores. Furthermore, Freeman (2001) notes that the RBANS lacks information to support its validity and reliability. Therefore, it is unwise to make any comparisons between the psychometric properties of the RBANS and the RBANS-C.

3.3. Questionnaire Responses

The questionnaire completed by the parents revealed two cases of cognitive impairments (Individual number 21 was indicated to have difficulties with concentration, attention and remembering and individual number 25 was described as having difficulties with concentration, visual perception and information processing) which, however, were not attributed to a HI or a TBI. Furthermore, one child was reported as having endured a HI, while no indication of brain injury was made, i.e. no cognitive impairments were reported. However, this child performed below average on both the RBANS-C and the standard test battery. In addition to these three children two others were excluded from some of the analyses on hand of their noticeably below average performance on the RBANS-C and the standard test battery.

3.4. Does the RBANS-C Identify Children With Cognitive Impairments?

The study included some children, as identified by the parental questionnaire, with already had existing cognitive deficits. Furthermore, it was observed that the performances of some children on the RBANS-C and also on the standardized assessment battery administered was consistently below average than the rest of the sample (see Table 10 to 12 in Appendix E). The researcher decided to investigate if there is a pattern to provide some initial evidence that the RBANS-C seems to identify children who have cognitive impairments which may or may not be attributed to a MTBI.

Figure 2 and 3 points out that some individual children, including those identified as being cognitively impaired by the questionnaire, did perform consistently lower on most subtest of the RBANS-C as well as the standardized assessment battery than the whole group respecting to age. Particular individuals 2, 7 and 21. Individuals 7 and 21 were isolated by the researchers because of their more or less consistent below average performance on all the subtests of the RBANS-C and the standard assessment battery.

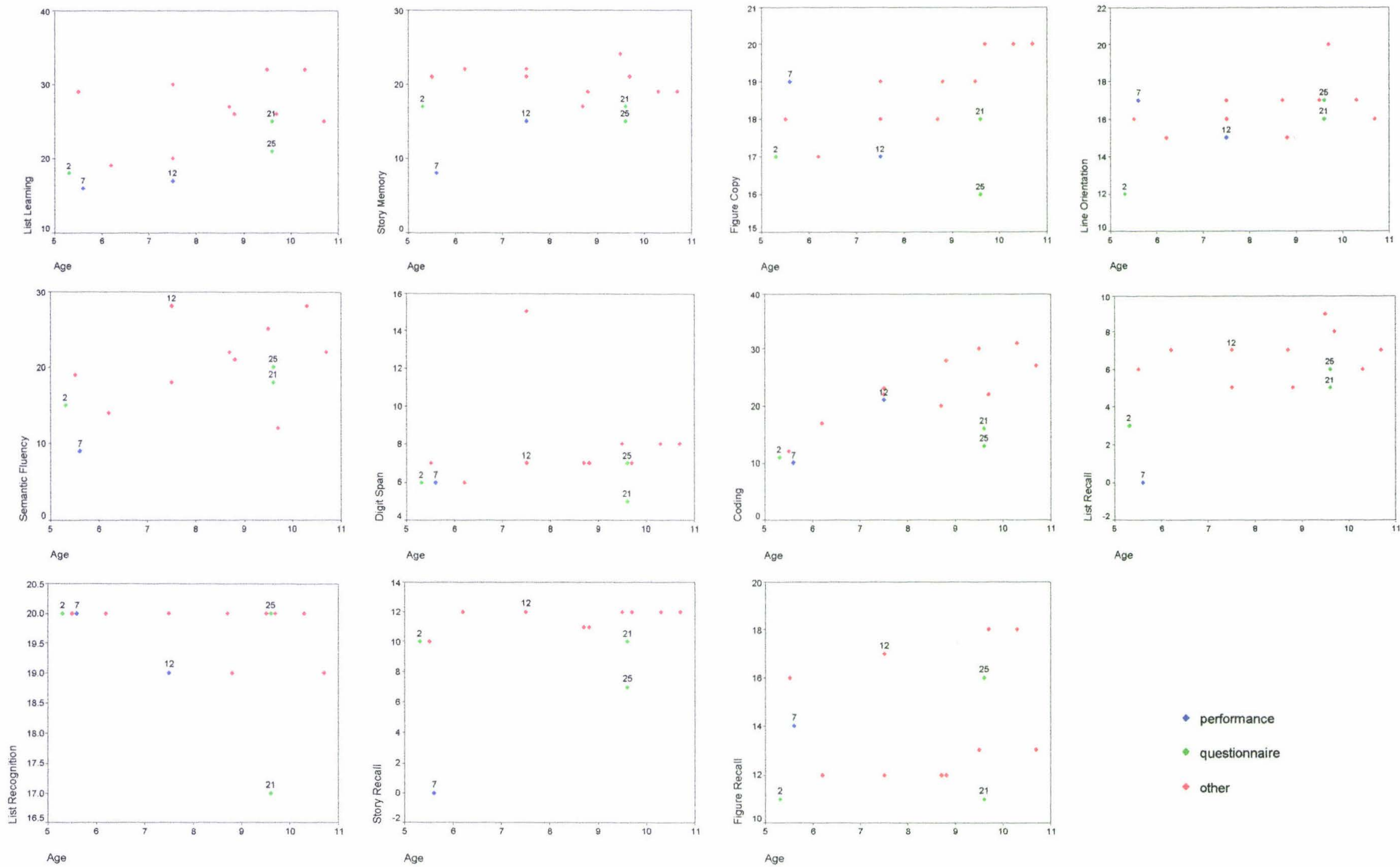

Figure 2. **Results for All RBANS-C Subtests Except Picture Naming of whole Sample Respecting to Age and Cases Identified by Questionnaire and by Low Performanc**

[1] Subtest Picture Naming was excluded because they was almost no variation in performance between all individuals

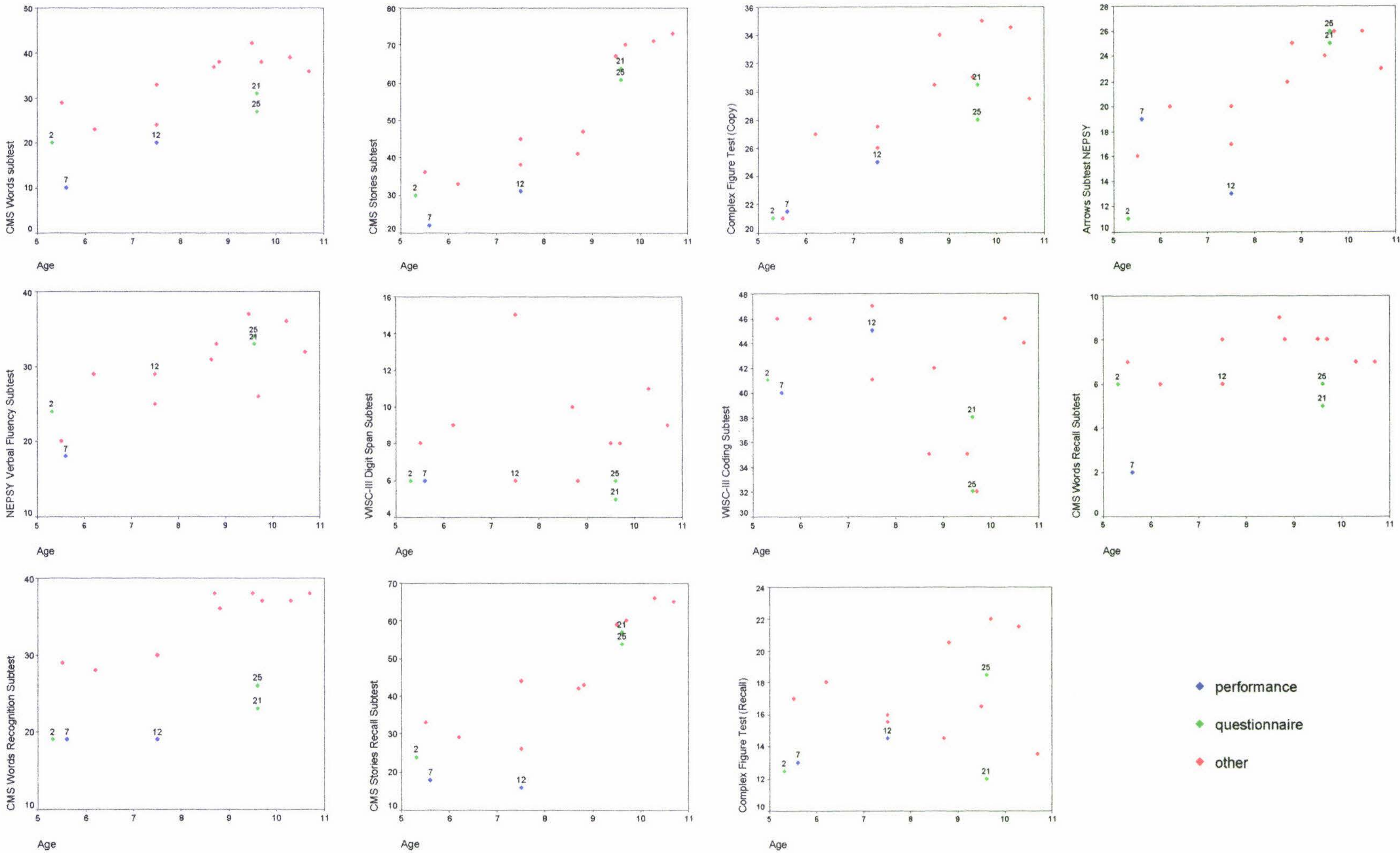

Figure 3. Results for All Standard Tests Except BNT of All Children Retested Respective to Age and Cases Identified by Questionnaire and Low Performance [1]

[1] BNT was excluded because they was almost no variation in performance between all individuals

<u>*Hypothesis 2:*</u> *The RBANS-C will identify cognitive deficits such as problems with attention and concentration, learning and memory, information processing and visual-spatial perception and constructional abilities in those children in the sample who have such deficits.*

According to the questionnaire, participant 21 was identified as having difficulties with concentration, attention and remembering and participant 25 with concentration, visual perception and information processing. By comparing this information to the results of those two individuals as shown by Figure 2 and 3 (also see Table 10 in Appendix E). There is some support for this hypothesis since participants 21 and 25 showed below average performance on Digit Span and Coding of RBANS-C and WISC-III subtests indicating difficulties with attention. Participant 21 scored below average compared to the rest of the sample on the RBANS-C List Learning, Story Memory, List Recall, List Recognition, Story Recall and Figure Recall as well the CMS Words Learning, Stories Learning, Words Recall and Recognition and Figure Recall which all measure either immediate or delayed memory. Thus, there is some evidence that this child shows difficulties with remembering as highlighted in the questionnaire. Participant 25 showed some difficulties with Figure Copy and the Rey-Osterrieth CFT indicating some deficits with visual processing. Further support for this hypothesis is that language difficulties were not mentioned in the questionnaire for both of these children and the results indicate that neither seems to have language difficulties.

<u>*Hypothesis 3*</u>: *Those children who were identified thorough the questionnaire (filled out by their parents) as having cognitive impairments will perform less well on the RBANS-C than children who were not documented to have cognitive impairments by the questionnaire.*

The results above support this hypothesis since the two individuals (number 21 and 22), which were identified in the questionnaire as having existing cognitive difficulties, performed below average of the sample according to their age groups for most of the measures as shown by Figures 2 and 3.

<u>Hypothesis 4</u>: *Children who performed below average on the RBANS-C are expected to perform below average on the standardized neuropsychological assessment battery.*

This hypothesis is also supported by the results as shown by Figures 2 and 3, which indicate lower performances on the standardized assessment battery for those individuals which scored below average on the RBANS-C compared to the whole sample.

<u>Hypothesis 5</u>: *Performance on the List Recognition subtest will be higher than on the List Recall subtest of the RBANS-C for all of the children tested.*

Results in Table 3, which shows the descriptive statistic of the sample, provides evidence to support this hypothesis. That is, the minimums and maximums as well as the range and standard deviation for List Recall are much higher than for List Recognition. Furthermore, Figure 1 shows much less variation in the performance for the List Recognition than it does for the List Recall subtest and the majority of scores fall on or just below the upper limit of the List Recognition subtest but not for List Recall.

<u>Hypothesis 6</u>: *Individuals with suspected brain injury will obtain low scores on the Coding subtest of the RBANS-C.*

The results provide support for this hypothesis, since the RBANS-C Coding subtest was the best indicator of all subtests to differentiate those individuals with and without recognized cognitive functioning for this sample. That is, as shown by the descriptive statistic (Table 2) Coding showed the highest standard deviation and range. Also, according to Figure 2, the individuals with identified cognitive impairments, performed well below the average of their age group. The results were not as clear for those individuals with suspected but unrecognized cognitive deficits.

<u>Hypothesis 7</u>: *There will be some children within the sample of individuals assessed that will have endured a MTBI but who have not been recognized of having such an injury.*

The responses on the questionnaire provides some evidence for this hypothesis, since some of the children in the sample selected were identified to have cognitive impairments. However, it cannot be concluded that these impairments resulted from a

MTBI. Furthermore, one individual had experienced a HI which also seems to have caused brain injury, according to the results on the RBANS-C and the standard assessment battery as shown in Figures 2 and 3 and Appendix E (Table ?). However, no clear conclusions can be made.

3.5. Differences Between Age Groups on RBANS-C

It is important to explore the differences in performance between the diverse age groups that were assessed in this study. Tests for children especially, need to be adjusted for age since developmental and maturational factors can significantly distort results if they have not been considered and in turn controlled for (Korkman et al., 2001).

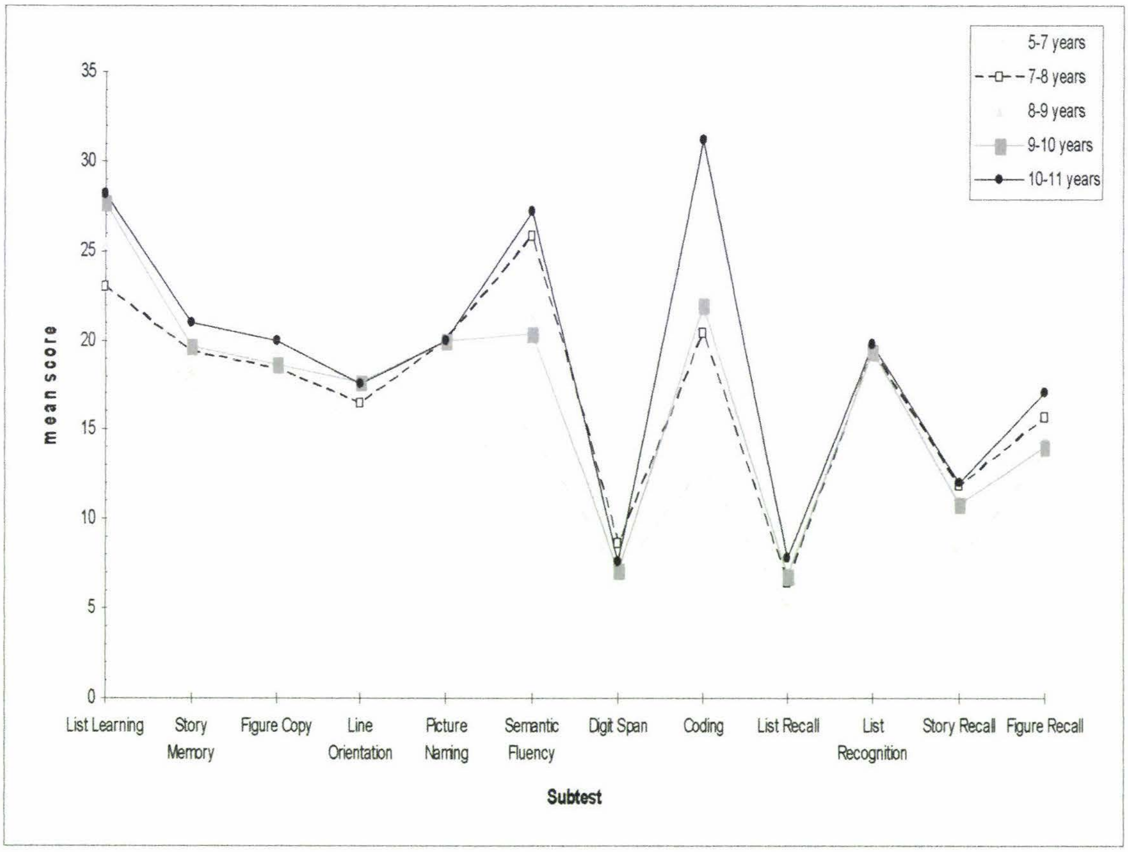

Figure 4. Age Differences for All Subtests of RBANS-C

Figure 4 shows some considerable age differences for some of the RBANS-C subtests, an in particular for Semantic Fluency and Coding. Table 8 confirms that there is a significant difference between the age groups for those two RBANS-C subtest. Although, most other subtest and especially List Learning, Story Memory, Story Recall and Figure Recall indicate age differences in Figure 4 one-way ANOVA analyses shown in Table 8 do not indicate any significant age differences for these subtests. Almost no age differences were observed for Picture Naming and List Recognition.

Table 8. One-way ANOVAs Between Age Groups for RBANS-C subtests

Subtest	F-statistic	Significance Level
List Learning	F(5, 24) = 2.03	.110
Story Memory	F(5, 24) = 0.95	.465
Figure Copy	F(5, 24) = 1.61	.197
Line Orientation	F(5, 24) = 2.17	.092
Picture Naming	F(5, 24) = 0.77	.582
Semantic Fluency	F(5, 24) = 4.15	**.007***
Digit Span	F(5, 24) = 0.66	.659
Coding	F(5, 24) = 5.09	**.003***
List Recall	F(5, 24) = 2.35	.072
List Recognition	F(5, 24) = 0.87	.513
Story Recall	F(5, 24) = 2.28	.078
Figure Recall	F(5, 24) = 1.47	.235

* indicates significant difference

Hypothesis 8: There will be differences in the performance on the RBANS-C subtest between the age groups assessed in this research.

Support for this hypothesis is provided by Figure 3 and Table 8 which indicate that there are differences, some of them significant, between the various age groups. Significant age effects are present for Coding and Semantic Fluency while other subtests such as List Learning, Story Memory, Story Recall and Figure Recall show age differences in Figure 3 but which are not significant as shown by Table 8.

3.6. Sex Differences

Since it has been found that males and females perform differently on certain neuropsychological tests it is necessary to calculate the differences in performance on all RBANS-C subtest between the boys and girls tested in this research. The non-parametric Mann-Whitney U test was selected for this analysis because of the small sample size and since most of the RBANS-C subtest were not normally distributed for this sample.

Table 9. Sex Differences of Complete Sample for All RBANS-C Subtests

	List Learning	Story Memory	Figure Copy	Line Orientation	Picture Naming	Semantic Fluency
Mann-Whitney U	78.500	103.500	108.500	111.000	105.000	111.500
Wilcoxon W	198.500	223.500	228.500	231.000	225.000	231.500
Z	-1.416	-.376	-.174	-.064	-1.000	-.042
Asymp. Sig. (2-tailed)	.157	.707	.862	.949	.317	.967
Exact Sig. [2*(1-tailed Sig.)]	.161[a]	.713[a]	.870[a]	.967[a]	.775[a]	.967[a]

a. Not corrected for ties.

	Digit Span	Coding	List Recall	List Recognition	Story Recall	Figure Recall
Mann-Whitney U	80.000	104.500	107.000	99.000	95.500	96.000
Wilcoxon W	200.000	224.500	227.000	219.000	215.500	216.000
Z	-1.445	-.333	-.233	-.676	-.768	-.691
Asymp. Sig. (2-tailed)	.148	.739	.815	.499	.443	.490
Exact Sig. [2*(1-tailed Sig.)]	.187[a]	.744[a]	.838[a]	.595[a]	.486[a]	.512[a]

a. Not corrected for ties.

No significant sex differences were observed for all RBANS-C subtests, as shown by Table 9 above. The subtests with the strongest probability value to indicate possible sex differences include List Learning and Digit Span. Line Orientation, Semantic Fluency, Figure Copy and List Recall, on the other hand, show very low differences in performance between the girls and boys assessed in this sample.

Hypothesis 9: Differences in performance on the RBANS-C between the boys and girls tested in this study are not expected.

This hypothesis is supported since Table 9 shows that there were no significant sex differences in this sample. The subtests that tend to indicate a possible difference which are however insignificant, are List Learning and Digit Span.

CHAPTER 4: DISCUSSION

4.1. Findings

It should be noted at the outset that the results of the current study are tentative, since they are based on a small sample that was not randomly selected. Also, the subgroup of individuals who were identified as having possible cognitive difficulties are not representative of children who suffered a MTBI since the selection criteria was not systematic or controlled.

However, the study still can make the observation that the RBANS-C seems to be able to pick out children and identify their deficits, which scored below average on the RBANS-C as well as the standardized assessment battery than most of the children in the sample, and that were also identified in the parental questionnaire as having cognitive difficulties. Although, it is not certain whether the cognitive difficulties identified in those children can be attributed to a MTBI since the study did not control for any third factor that could have caused those differences in performance.

Some of the RBANS-C subtests showed promising results since they seem to have adequate validity and reliability for this sample and also appear to pick out children who may have cognitive impairments that may or may not be attributed to a possible brain injury. Most specifically, Coding, Semantic Fluency and Story Recall and Digit Span show high internal reliability. However, they all lack concurrent validity since only List Learning and Figure Copy correlated well with their equivalent standardized assessment subtests. Yet, these subtests showed adequate construct validity like most of the subtests and particularly Story Recall loaded the highest on Factor 1 (memory). High factor loadings were also observed for Story Memory, List Recall and Semantic Fluency for Factor 1, Line Orientation and Figure Copy for Factor 2 (visual/spatial abilities), Picture Naming for Factor 3 (language) and Digit Span for Factor 4 (attention and concentration). Some validity and reliability coefficients were only moderate or very low, which is most likely due to the small sample size. Much more research is needed to make any clear conclusion about the psychometric properties of the RBANS-C.

In addition to having the highest internal consistency, the Coding subtest was found to be the best predictor of this sample to differentiate individual abilities as well as

In addition to having the highest internal consistency, the Coding subtest was found to be the best predictor of this sample to differentiate individual abilities as well as children with cognitive dysfunction which supports one of the hypotheses of this study. Moreover, the hypothesis, that List Recognition showed higher results than List Recall was also supported as suggested by the literature that recognizing words is easier than spontaneously recalling them from memory.

Wedding suggests (1988, cited in Berg, 1997) that digit span backwards is thought to be a better measure of impaired immediate memory than digit span forward. The results show that the Digit Span subtest of the RBANS-C did not as clearly differentiate individuals with cognitive impairments as other subtests. However, the lack of an appropriate comparison group and the size of the sample makes it difficult to make any definite conclusions about this subtest.

Performance on the Picture Naming subtest for all individual assessed does not seem to differentiate individuals as shown by the descriptive statistics, Figure 4 and by the low internal reliability coefficient. It will be necessary to collect more results with other samples and with children who have a recognized MTBI to establish whether this subtest does not differentiate individuals successfully. If this is the case the subtest should be modified by changing the pictures to increase the naming difficulty.

An important consideration for future modifications made to the RBANS-C is the effect age can have on the performance on each subtest. As shown by the results there is some significant age differences in some subtest such as Coding and Semantic Fluency. This is in line with current research since age effects are often observed for different cognitive functions and especially with children.

Corresponding to current research, there were no significant sex differences for any of the subtests. Moreover, even though the RBANS-C attempted to make the test content appropriate for New Zealand children there does not appear to be a significant difference in performance between the RBANS-C and the standardized assessment battery. However, since the raw scores of the standardized assessment tests were transformed with the use of American normative data this conclusion might not be accurate. Future research that focuses on developing New Zealand normative data for the RBANS-C will allow to identify whether the RBANS-C seems to be more suitable, than overseas measures, to assess the cognitive functions of New Zealand children.

4.2. Limitations of the Study and Future Research

Only Cronbach's alpha was computed to measure the reliability of all the subtest of the RBANS-C. Other methods to test reliability, such as by using an alternative form should be carried out, which is planned for future developments for the RBANS-C. However, split-half reliability will not be appropriate for most RBANS-C subtests. Also, further data needs to be collected to better estimate the construct validity of each RBANS-C subtests and it would be useful to include an external criterion, such as a child's performance in specific school tasks, to measure each subtest's external validity.

This initial design of the RBANS-C has not taken much thought in to the developmental differences that exist between a five and ten year old child. That is, as noted by Korkman et al., (2001) the cognitive development of children is very dependent on age and therefore is different for each age group. As it is shown in the results there are some variations in performance between the different age groups. Further developments on the RBANS-C should design and evaluate graded administrations and test items to take into account the development differences in children. It would be useful to conduct more research in this area since Korkman et al., (2001) note, that not many studies have as yet investigated the effects of age across different cognitive measures.

Furthermore, not many major changes have been made to the test format, i.e. the RBANS-C appears to be more or less a downward extension from the RBANS which is not what it attempts to be. The measure may need to be adapted much more to better meet the testing requirements for children. This will include an investigation whether other subtests than the ones included in this screening measure are more appropriate to be used to screen children for specific cognitive functions.

Performances on the standardized assessment battery seems to be superior for some of the subtests which might indicate possible practice effects. Since the first testing and the retesting were only 4 weeks apart future studies should plan a longer time interval between the first and second testing even if it is not the same test form. Yet, some practice effects will be unavoidable when the same children are used for both administration. A possible alternative would be to use a matched control research design to minimize such effects.

4.4. Conclusion

The current research provides preliminary data on a short neuropsychological screening measure for young children. The data are compromised by limited sample size. The administration of the measure to a large group of children, will establish better normative guidelines. Furthermore administration of the measure to a group of children who are confirmed to have suffered a MTBI will reveal the extent to which the RBANS-C is able to identify the difficulties experienced by children with MTBI. However, the results of the preliminary tryout seem to suggest that the RBANS-C has the potential to become a valuable screening measure for children if it is further modified, which, however, requires a great deal more research.

References:

ACC. (2001). *ACC injury statistics 2001 online*. Retrieved 4 September, 2002, from http://www.acc.co.nz/about-acc/injury-statistics-2001/1.-all-registered-claims/diagnosis-by-injury-site.html

Ahmad, S. A., & Warriner, E. M. (2001). Review of the NEPSY: A Developmental Neuropsychological Assessment. *The Clinical Neuropsychologist, 15*(2), 240-249.

Anderson, V., Catroppa, C., Morse, S., Haritou, F., & Rosenfeld, J. (2001). Outcome from mild head injury in young children: A prospective study. *Journal of Clinical and Experimental Neuropsychology, 23*(6), 705-717.

Anderson, V., Catroppa, C., Rosenfeld, J., Haritou, F., & Morse, S. A. (2000). Recovery of memory function following traumatic brain injury in pre-school children. *Brain Injury, 14*, 679-692.

Anderson, V., Northam, E., Hendy, J., & Wrennall, J. (2001). *Developmental neuropsychology: A clinical approach*. Hove: Psychology Press.

Bengtson, M. L., & Boll, T. J. (2001). Neuropsychological assessment of the child. In M. C. Roberts (Ed.), *Handbook of clinical child psychology* (3 ed., pp. 151-171). New York: John Wiley & Sons.

Berg, R. A. (1997). Screening tests in clinical neuropsychology. In J. Webster (Ed.), *The neuropsychology handbook: Foundations and assessment* (Vol. 1, pp. 331-363). New York: Springer Publishing Company.

Body, C., & Leathem, J. (1996). Incidence and aetiology of head injury in a New Zealand adolescent sample. *Brain Injury, 10*(8), 567-573.

Boll, T. J., & Stanford, L. D. (1997). Pediatric brain injury: Mechanisms and amelioration. In E. Fletcher-Janzen (Ed.), *Handbook of clinical child neuropsychology* (2nd ed., pp. 140-156). New York: Plenum.

Broome, E. L. (1998). *Mild head injury in children: Incidence, etiology and neuropsychological sequelae*. Unpublished Masters of Arts Thesis, Massey University, Palmerston North, New Zealand.

Coakes, S. J., & Steed, L. G. (2000). *SPSS: Analysis without anguish*. Brisbane: John Wiley & Sons Australia Ltd.

Cohen, L. G., & Spenciner, L. J. (1998). *Assessment of children and youth*. New York: Longman.

Cohen, M. J. (1997). *Children's Memory Scale*. San Antonio, TX: The Psychological Corporation.

D'Amato, R. C., Rothlisberg, B. A., & Rhodes, R. L. (1997). Utilizing a neuropsychological paradigm for understanding common educational and psychological tests. In C. R. Reynolds & E. Fletcher-Janzen (Eds.), *Handbook of clinical child neuropsychology* (2nd ed., pp. 270-295). New York: Plenum.

De Kruijk, J. R., Twijnstra, A., & Leffers, P. (2001). Diagnostic criteria and differential diagnosis of mild traumatic brain injury. *Brain Injury, 15*(2), 99-106.

Derogatis, L. R., & Lynn, L. L. (1999). Psychological tests in screening for psychiatric disorder. In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcomes assessment* (2nd ed., pp. 41-79). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Ernst, W. J. (2000). *The development and construction of a neuropsychological screening instrument for detecting neurocognitive deficits in children with acquired brain injury*. Unpublished doctoral thesis, James Madison University.

Ewing-Cobbs, L., Levin, H. S., & Fletcher, J. M. (1998). Neuropsychological sequelae after traumatic brain injury: Advances since 1985. In M. Ylvisaker (Ed.), *Traumatic brain injury rehabilitation in children and adolescents* (2nd ed., pp. 11-26). Boston: Butterworth-Heinemann.

Farmer, J. E., Haut, J. S., Williams, J., Kapila, C., Johnstone, B., & Kirk, K. S. (1999). Comprehensive assessment of memory functioning following traumatic brain injury in children. *Journal of Developmental Neuropsychology, 15*(2), 268-289.

Fennell, E. B., & Mickel, J. P. (1992). Behavioural effects of head trauma in children and adolescents. In M. G. Tramontana & S. R. Hooper (Eds.), *Advances in child neuropsychology: Volume 1* (pp. 24-49). New York: Springer Verlag.

Fernando, K., Chard, L., Butcher, M., & McKay, C. (unpublished). *Standardisation of the ray complex figure test in NZ children and adolescents*. Auckland, New Zealand.

Fletcher, J. M., &, & Taylor, H. G. (1997). Children with brain injury. In E. J. Mash & L. G. Terdal (Eds.), *Assessment of childhood disorders* (3rd ed., pp. 453-480). New York: The Guilford Press.

Franzen, M. D. (2000). *Reliability an validity in neuropsychological assessment* (2nd ed.). New York: Kluwer Academic/Plenum Publishers.

Franzen, M. D., & Berg, R. A. (1998). *Screening children for brain injury* (2nd ed.). New York: Springer Publication Company.

Freeman, S. J. (2001). *14th mental measurement yearbook online: Test review of the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)*. Retrieved 12th April, 2003

Gerstenbrand, F., & Stepan, C. A. (2001). Mild traumatic brain injury. *Brain Injury, 15*(2), 95-97.

Hotz, G., Helm-Estabrooks, N., & Nelson, N. W. (2001). Development of the pediatric test of brain injury. *Journal of Head Trauma Rehabilitation, 16*, 426-440.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test (Revised 60-item Version)*. Philadelphia: Lea & Febiger.

Kelly, J. P., & Filley, C. M. (1994). Traumatic brain injury in children. In C. N. Simkins (Ed.), *Analysis, understanding and presentation of traumatic brain injury* (pp. 37-52). Washington DC: National Head Injury Foundation.

Kirk, U. (1992). Confrontation naming in normally developing children: Word-retrieval or word knowledge? *The Clinical Neuropsychologist, 6*(2), 156-170.

Kolb, B., & Fantie, B. (1997). Development of the child's brain and behavior. In E. Fletcher-Janzen (Ed.), *Handbook of clinical child neuropsychology* (2nd ed., pp. 17-41). New York: Plenum.

Korkman, M., Kirk, U., & Kemp, S. (1998). *NEPSY: A Developmental Neuropsychological Assessment*. San Antonio, Texas: The Psychological Corporation.

Korkman, M., Kirk, U., & Kemp, S. (2001). Effects of age on neurocognitive measures of children ages 5 to 12: A cross-sectional study on 800 children from the United States. *Developmental Neuropsychology, 20*(1), 331-354.

Lezak, M. D. (1995). *Neuropsychological assessment* (3 ed.). New York: Oxford University Press.

Lord-Maes, J., & Obrzut, J. E. (1996). Neuropsychological consequences of traumatic brain injury in children and adolescents. *Journal of Learning Disabilities, 29*(6), 609-617.

Lucas, J. A. (1998). Traumatic brain injury and postconcussive syndrome. In P. D. Nussbaum (Ed.), *Clinical Neuropsychology: A pocket handbook for assessment*. Washington DC: APA.

Malec, J. F. (1999). Mild traumatic brain injury: Scope of the problem. In R. J. Roberts (Ed.), *The evaluation and treatment of mild TBI* (pp. 15-37). New Jersey: Lawrence Erlbaum.

Mitrushina, M. N., D'Elia, L. F., & Boone, K. B. (1999). *Handbook of normative data for neuropsychological assessment*. New York: Oxford University Press.

Murphy, K. R., & Davidshofer, C. O. (2001). *Psychological testing: Principles and applications* (4 ed.). New Jersey: Prentice-Hall Inc.

Ouvrier, R., Hendy, J., Bornholt, L., & Black, F. H. (1999). SYSTEMS: School-years Screening Test for the Evaluation of Mental Status. *Journal of Child Neurology, 14*, 772-780.

Pallant, J. (2001). *SPSS survival manual: A step by step guide to data analysis using SPSS*. Crows Nest, NSW: Allen & Unwin.

Ponsford, J., Willmott, C., Rothwell, A., Cameron, P., Ayton, G., Nelms, R., et al. (1999). Cognitive and behavioral outcome following mild traumatic head injury in children. *Journal of Head Trauma Rehabilitation, 14*, 360-372.

Randolph, C. (1998). *The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)*. San Antonio, TX: The Psychological Corporation.

Retzlaff, P. D., & Gibertini, M. (2000). Neuropsychometric Issues and problems. In R. D. Vanderpleeg (Ed.), *Clinician's guide to neuropsychological assessment* (pp. 277-299). New Jersey: Laurence Erlbaum Associate Publishers.

Reynolds, C. R. (1997). Measurement and statistical problems in neuropsychological assessment of children. In C. R. Reynolds & E. Fletcher-Janzen (Eds.), *Handbook of clinical child neuropsychology* (2nd ed., pp. 180-203). New York: Plenum Press.

Roberts, M. A. (1999). Mild traumatic brain injury in children and adolescents. In N. S. Varney & R. J. Roberts (Eds.), *The evaluation and treatment of mild traumatic brain injury* (pp. 493-512). Mahwah, NJ: Laurence Erlbaum Associates Publishers.

Rourke, B. P. (2000). Review and future directions. In K. O. Yeates, Ris, M. D, Taylor, H. G. (Ed.), *Pediatric neuropsychology: Research, theory, and practice* (pp. 459-469). New York: The Guilford press.

Russell, L., Bernholt, L., & Ouvrier, R. (2002). Brief cognitive screening and self concepts for children with low intellectual functioning. *British Journal of Clinical Psychology, 41*, 93-104.

Rust, J., & Golombok, S. (1999). *Modern psychometrics: The science of psychological assessment* (2 ed.). London: Routledge.

Savage, R. C., & Ross, B. (1994). School-aged children with traumatic brain injuries. In C. N. Simkins (Ed.), *analysis, understanding and presentation of traumatic brain injuries* (pp. 53-64). Washington DC: National Head injury Foundation.

Spreen, O., & Strauss, E. (1998). *A compendium of neuropsychological tests*. San Antonio, TX: The Psychological Corporation.

Teeter, P. A., & Semrud-Clikeman, M. (1997). *Child neuropsychology: Assessment and interventions for neurodevelopmental disorders*. Boston: Allyn & Bacon.

Thomson, J. B., & Kerns, K. A. (2000). Mild traumatic brain injury in children. In A. Raskin & C. A. Mateer (Eds.), *management of mild traumatic brain injury* (pp. 233-251). New York: Oxford University Press.

Umile, E. M., Plotkin, R. C., & Sandel, M. E. (1998). Functional assesssment of mild traumatic brain injury using SPECT and neuropsychological testing. *Brain Injury, 12*, 577-594.

Walsh, W. B., & Betz, N. E. (2001). *Tests and assessment* (4 ed.). New Jersey: Prentice Hall.

Wechsler, D. (1992). *Wechsler Intelligence Scale for Children (3rd Edition)*. New York: Psychological Corporation.

Yeates, K. O. (1994). Comparison of developmental norms for the Boston Naming Test. *The Clinical Neuropsychologist, 8*(1), 91-98.

Yeates, K. O. (2000). Closed-head injury. In H. G. Taylor (Ed.), *Pediatric neuropsychology: Research, theory, and practice* (pp. 92-116). New York: The Guilford Press.

Yeates, K. O., & Taylor, H. G. (1998). Neuropsychological assessment of older children. In S. R. Beers (Ed.), *Neuropsychology* (pp. 35-61). New York: Plenum Press.

Appendix A: Information Sheet, Consent Form and Questionnaire

Massey University

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Development of a Neuropsychological Screening Measure for Children

INFORMATION SHEET FOR PARENTS OF SCHOOL CHILDREN

This research is being conducted by Andrea Reimann as part of her Masters of Arts at Massey University under the supervision of Professor Janet Leathem. Contact Andrea by calling (09) 443-9799 extension 9772 (leave a message) or Janet by calling (09) 443-9799 extension 6768.

The aim of this research is to develop and test a short neuropsychological test for children aged between eight and ten years, that measures attention, memory, learning and language abilities. Such a measure would be helpful in the assessment of the difficulties often associated with concussion and mild traumatic brain injury, especially as these children often need to have the tests repeated as they recover.

The researcher approached the principal at the school your child attends to ask whether the research can be conducted within the school. This information sheet was handed out to teachers to be passed on to you to ask whether you would like your child to participate in the research. If you decide to do so your child will be approached by the researcher who will explain the research to him or her and asked if he or she would like to take part.

Participation is entirely voluntary and you have the right to decline. If you do agree, please sign and return the consent form on the next page or phone the numbers above for any questions. You are free to withdraw your child at any time during the project. Please be assured that any information that you provide will be kept confidential and will be seen only by the researcher and her supervisor. The test results will not be made available to you or anybody else.

Please indicate on the consent form if you wish to receive a summary report of the overall project that will be available to you at the end of the research. Although there will be no direct benefit to your child for participating in this study, the outcomes of this research will later be presented at conferences, published in psychological journals, where we hope that it will eventually benefit children with concussion and mild traumatic brain injury.

Thank you for considering this request.

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Janet Leathem (PhD)
Professor of Neuropsychology

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This project has been reviewed and approved by the Massey University Human Ethics Committee, WGTN Protocol 02/120. If you have any concerns about the conduct of this research, please contact Dr Pushpa Wood, Chair, Massey University Regional Human Ethics Committee: Wellington, telephone (04) 801 2794 ext 6723, email P.Wood@massey.ac.nz.

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Development of a Neuropsychological Screening Measure for Children

CONSENT FORM

☐ I have read and understand what has been set out in the Information Sheet where the details of the study was explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

☐ I understand I or my child have the right to withdraw from the study at any time and to decline to answer any particular questions.

☐ I understand that I or my child has the right to withdraw from the study at any time.

☐ I agree to provide information to the researcher on the understanding that my name will not be used without my permission. (*The information will be used only for this research and publications arising from this research project*).

☐ I agree to participate in this study under the conditions set out in the Information Sheet.

Signed: ....

Name: ....

Date: ....

If you would like to receive a summary of the general research findings at the conclusion of the study, please write your address below:

....

....

....

Please complete the three questions on the following page and return them together with this consent form

This project has been reviewed and approved by the Massey University Human Ethics Committee, WGTN Protocol 02/120. If you have any concerns about the conduct of this research, please contact Dr Pushpa Wood, Chair, Massey University Regional Human Ethics Committee: Wellington, telephone (04) 801 2794 ext 6723, email P.Wood@massey.ac.nz.

Questionnaire for Parents

1. Has your child ever been involved in an accident causing an injury to the head that did or did not result in loss of consciousness? If yes, can you give some more details about the incident.

2. Has your child previously been assessed for difficulties with concentration, memory, learning, attention or language? Did your child ever require special needs assistance for such cognitive difficulties at school? If yes, what specific difficulties and what assistance was given?

3. Has your child ever displayed behavioural or social difficulties? If yes, what kind?

Appendix B: RBANS-C

1 - List Learning

Trial 1

Say: **I read you a list of things I need to buy at the supermarket. Listen carefully and when I have finished tell me all the things that you can remember. OK?**

Trial 2-4

Say: **I am going to read the list again. When I am finished, I want you again to tell me all the things you can remember. OK?** *Record Responses in Order.*
Read the list again before trial 3 and 4 and say: **Which things do you remember?**

Scoring: 1 point for each word correctly recalled on each trial.

List	Trial 1	Trial 2	Trial 3	Trial 4
Milk Lettuce				
Paper				
Honey				
Butter				
Soap				
Fruit				
Bread				
Sugar				
Bacon				
Number Correct				
	Total Trial 1 +	Total Trial 2 +	Total Trial 3 +	Total Trial 4 =

Total Score (0-40)

2 - Story Memory

Trial 1

Say: I am going to read you a short story. Listen carefully and when I have finished tell me as much about the story as you can remember. Try to use the same words as I used. Okay?

Read the story below and then say: Now tell me the story.

Trial 2

Say: I'm going to read the same story again. When I have finished, I want you again to tell me the story as detailed as possible. *Read the story below and then say,* Now tell me the story again.

Scoring: 1 point for verbatim recalled in bold. Record alternative Reponses or variations in Response column.

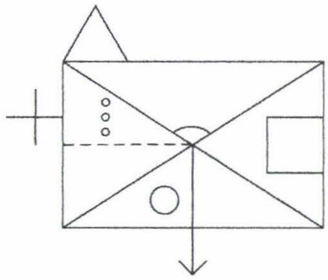
Story	Responses	Trial 1 Score (0 or 1)	Trial 2 Score (0 or 1)	Trial 1+2 Score (0-2)
1. On Saturday				
2. was Mary's				
3. birthday party				
4. and she invited 5. six friends. 6. They played				
7. some games				
8. ate some				
9. chocolate cake				
10. and later,				
11. Mary opened				
12. her presents.				

Total Score (Trial 1 + 2) (0-24)	

3 - Figure Copy ⏱ Time Limit: 5 minutes

Fold this page over and present the next one (figure copy drawing page). Present the figure on the stimulus card and say: Can you copy this figure for me as exactly as you can and as fast as possible. Ok? Go.

Scoring: For each figure part; 1 point for drawing and 1 point for placement. Give 0.5 points for distorted or incomplete drawing or poor placements



Item		Correct Drawing (0 or 1)	Correct Placement (0 or 1)	Score (0 - 2)
1	rectangle			
2	diagonal cross			
3	horizontal broken line			
4	three small circles			
5	Circle			
6	curved line			
7	triangle			
8	square			
9	outside cross			
10	arrow			

Total Score (0-20)	

Figure Copy Drawing Page

4 - Line Orientation ⏱ Time Limit: 20 seconds/Item

Present the sample item and say: **The two lines down here** *(indicate)* **are the same as two of the lines up here** *(indicate).* **Can you tell me the number or point to the ones that are the same?**

Item	Response	Correct Response	Score (0-2)	Item	Response	Correct Response	Score (0-2)
sample		1, 7		6.		1, 6	
1.		10, 12		7.		3, 10	
2.		4, 11		8.		5, 8	
3.		6, 9		9.		1, 3	
4.		8, 13		10.		11, 13	
5.		2, 4					

Total Score (0-20)	

5 - Picture Naming ⏱ Time Limit: 20 seconds/Item

For each card say: **What's this?** *Give the semantic cue only if the picture is clearly misperceived.*

Scoring: 2 points for each item that is correctly named spontaneously or 1 point

Item		Semantic Cue	Responses	Score (1 or 2)
1	Plane	Flies people to different places		
2	Chair	Furniture to sit on		
3	Butterfly	An animal that flies		
4	Guitar	A music instrument		
5	Hammer	A workshop tool		
6	Lamp (Light)	An object used to make light		
7	Scissors	A tool used for cutting		
8	(Sun)-Glasses	An object used to see better		
9	Penguin	An animal that lives in the cold		
10	Strawberry	A small and sweet fruit		

Total Score (0-20)	

6 - Semantic Fluency ⏱ Time limit: 2 minutes

Say: **Now can you tell me the names of all the animals that you can think of as fast as possible. Ready? Go.**

Scoring: 1 point for each correct response.

1. ________	11. ________	21. ________	31. ________
2. ________	12. ________	22. ________	32. ________
3. ________	13. ________	23. ________	33. ________
4. ________	14. ________	24. ________	34. ________
5. ________	15. ________	25. ________	35. ________
6. ________	16. ________	26. ________	36. ________
7. ________	17. ________	27. ________	37. ________
8. ________	18. ________	28. ________	38. ________
9. ________	19. ________	29. ________	39. ________
10. ________	20. ________	30. ________	40. ________

Total Score (0-40)	

7 - Digit Span

Say: **I am going to say some numbers, and I want you to repeat them after me. Ok?** *Read the numbers at the rate of 1 per second. Discontinue after failure of both strings in any set.*

Scoring: 1 point for each of the strings correct and 0 points for both strings failed.

	First String	String Score (0 or 1)	Second String	String Score (0 or 1)	String 1+2 Score (0-2)
1.	4-9		5-3		
2.	8-3-5		2-4-1		
3.	7-2-4-6		1-6-3-8		
4.	5-3-9-2-4		3-8-4-9-1		
5.	6-4-2-9-3-5		9-1-5-3-7-6		
6.	2-8-5-1-9-3-7		5-3-1-7-4-9-2		
7.	8-3-7-9-5-2-4-1		9-5-1-4-2-7-3-8		
8.	1-5-9-2-3-8-7-4-6		5-1-9-7-6-2-3-6-5		

Total Score (0-16)	

8 - Coding ⏱ Time Limit: 90 seconds

Say: **Look at these boxes** *(point to the key on top of the next page).* **For each one of these numbers is a symbol that goes with it. Down here are numbers, but no symbols. I want you to fill in the symbol that goes with each number.** *Demonstrate the first three.*

Say: **Now I'd like you to fill in the rest up to here** *(point to end of shaded area)* **for practice** *Correct any errors being made and make sure that the task is correctly understood.*

Say: **Now when I say go I'd like you to continue filling in the symbols as fast as you can without skipping any number. Go from line to line. Ready? Go.**

Redirect examinee if he or she becomes distracted. If the examinee is unable to understand the task move on to next subtest and score 0.

Scoring: 1 point for each item correctly coded within the 90 seconds (do not score the sample items).

1	2	3	4	5	6	7	8	9
⊂	⊣	=	┘	×	⊃	+	┌	⊢

4	6	1	9	5	2	7	9	3	4	2	8	1	7

9	2	6	5	1	8	3	5	2	7	3	9	5	4

1	8	4	3	7	2	6	4	9	3	1	5	8	9

6	4	9	3	7	1	2	6	5	1	4	8	2	7

5	1	4	9	2	4	7	5	8	3	9	6	8	3

Total Score (0-64)	

9 - List Recall

Say: Do you remember the shopping list that I read to you at the beginning? Can you tell me as many of the items on the list as you can remember?

Scoring: 1 point for each word correctly recalled.

List (do not read)	Response	Score (0 or 1)
Milk		
Lettuce		
Paper		
Honey		
Butter		
Soap		
Fruit		
Bread		
Sugar		
Bacon		

Total Score (0-10)	

10 - List Recognition

Say: Now I'm going to read to you some things that were on that shopping list and some that were not. I want you to tell me which ones were on the list.

List	Circle	List	Circle	List	Circle	List	Circle
Bread	***Y N***	***Milk***	***Y N***	Jam	Y N	***Honey***	***Y N***
Cheese	Y N	***Fruit***	***Y N***	***Bacon***	***Y N***	Toast	Y N
Spinach	Y N	Yoghurt	Y N	***Sugar***	***Y N***	***Lettuce***	***Y N***
Soap	***Y N***	***Butter***	***Y N***	Salt	Y N	Cream	Y N
Juice	Y N	Tissues	Y N	***Paper***	***Y N***	Ham	Y N

Total Score (0-20)	

11 - Story Recall

Say: **Do you remember the short story I read to you earlier? Can you tell me that story again as detailed as possible.**

Scoring: 1 point for verbatim recalled in bold. Record alternative responses.

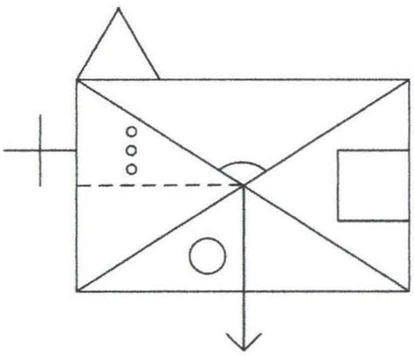
Story	Responses	Delayed Score (0 or 1)
1. On **Saturday**		
2. was **Mary's**		
3. **birthday party**		
4. and she **invited**		
5. **six friends.**		
6. They **played**		
7. some **games**		
8. **ate** some		
9. **chocolate cake**		
10. and **later,**		
11. **Mary opened**		
12. **her presents.**		

Total Score (0-12)	

12 - Figure Recall

Present the next page (figure recall drawing page) and say. **Do you remember the figure I asked you to copy a little while ago? I want you to draw as much as you can remember of that figure. If you remember some parts but you are not sure where they go just put them somewhere. Try to draw as much as you can. Ok? Go.**

Scoring: For each figure part; 1 point for drawing and 1 point for placement.

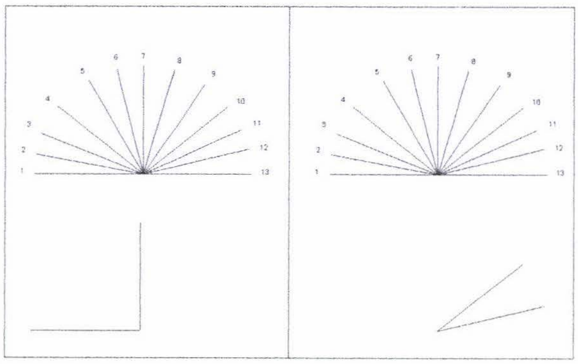


Item		Correct Drawing (0 or 1)	Correct Placement (0 or 1)	Score (0 - 2)
1	rectangle			
2	diagonal cross			
3	horizontal broken line			
4	three small circles			
5	Circle			
6	curved line			
7	triangle			
8	square			
9	outside cross			
10	arrow			

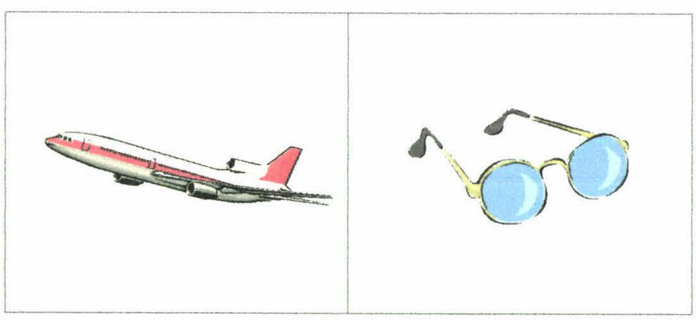
Total Score (0-20)	

Sample Items of RBANS-C Subtest:

1. Subtest 4 - Line Direction



2. Subtest 5 - Picture Naming



Appendix C: RBANS (Form A)

1 List Learning

Trial 1

Say ***I am going to read you a list of words. I want you to listen carefully and, when I finish, repeat back as many words as you can. You don't have to say them in the same order that I do—just repeat back as many words as you can remember, in any order. Okay?***

Trials 2–4

Say ***I am going to read the list again. When I finish, repeat back as many words as you can, even if you have already said them before. Okay?***

Record responses in order.

Scoring: 1 point for each word correctly recalled on each trial.

List	Trial 1	Trial 2	Trial 3	Trial 4
Market				
Package				
Elbow				
Apple				
Story				
Carpet				
Bubble				
Highway				
Saddle				
Powder				

Number Correct	+	+	+	=	
	Total Trial 1	Total Trial 2	Total Trial 3	Total Trial 4	Total Score Range=0–40

2 Story Memory

Trial 1

Say ***I am going to read you a short story. I'd like you to listen carefully and, when I finish, repeat back as much of the story as you can remember. Try and use the same wording, if you can. Okay?***

Read the story below, then say ***Now repeat back as much of that story as you can.***

Trial 2

Say ***I am going to read that same story again. When I finish, I want you to again repeat back as much of the story as you can remember. Try to repeat it as exactly as you can.***

Read the story below, then say ***Now repeat back as much of that story as you can.***

Scoring: 1 point for *verbatim* recall of bold, italic words or alternatives, shown below in color within parentheses. Record intrusions or variations in the Responses column.

Story	Responses	Trial 1 Score (0 or 1)	Trial 2 Score (0 or 1)	Item Score (0–2)
1. On ***Tuesday,***				
2. ***May***				
3. ***Fourth,***				
4. in ***Cleveland,*** Ohio,				
5. a ***3 alarm***				
6. ***fire*** broke out.				
7. ***Two***				
8. ***hotels***				
9. and a ***restaurant***				
10. were ***destroyed***				
11. before the ***firefighters (firemen)***				
12. were able to ***extinguish it (put it out).***				

Total Score (Trial 1 + Trial 2) Range=0–24	

3 Figure Copy

Time Limit: 4 minutes

Fold this page back and present the Figure Copy Drawing Page along with the stimulus. Ask the examinee to make an exact copy of the figure. Tell the examinee that he or she is being timed, but that the score is based on the exactness of his or her copy.

Scoring: 1 point for correctness and completeness (drawing), and 1 point for proper placement. See Appendix 1 in Stimulus Booklet A for complete scoring criteria and scoring examples.

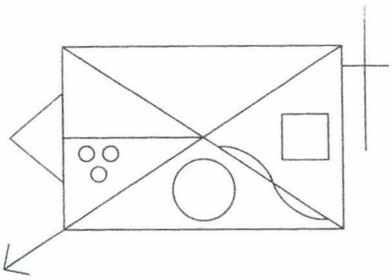


Figure Copy Criteria

(Fold back for use.)

Item	Drawing (0 or 1)	Placement (0 or 1)	Score (0, 1, or 2)	Scoring Criteria
1. rectangle				**Drawing:** lines are unbroken and straight; angles 90 degrees; top/bottom lines 25% longer than sides **Placement:** not rotated more than 15 degrees
2. diagonal cross				**Drawing:** lines are unbroken and straight and should approximately bisect each other **Placement:** ends of lines should meet corners of the rectangle without significant overlap or measurable distance between the ends of the lines and the corners
3. horizontal line				**Drawing:** line is unbroken and straight; should not exceed 1/2 the length of the rectangle **Placement:** should bisect left side of the rectangle at approximately a right angle and intersect the diagonal cross
4. circle				**Drawing:** round, unbroken and closed; diameter should be approximately 1/4–1/3 height of rectangle **Placement:** placed in appropriate segment; not touching any other part of figure
5. 3 small circles				**Drawing:** round, unbroken and closed; equal size; triangular arrangement; not touching each other **Placement:** in appropriate segment; not touching figure; triangle formed not rotated more than 15 degrees
6. square				**Drawing:** must be closed; 90 degree angles; lines straight and unbroken; height is 1/4–1/3 height of rectangle **Placement:** in appropriate segment; not touching any other part of figure; not rotated more than 15 degrees
7. curving line				**Drawing:** 2 curved segments are approximately equal in length and symmetrical; correct direction of curves **Placement:** ends of line touch diagonal; do not touch corner of rectangle or intersection of diagonal lines
8. outside cross				**Drawing:** vertical line of the outside cross is parallel to side of rectangle; >1/2 the height of rectangle; horizontal line crosses vertical at 90 degree angle and is between 20–50% of length of vertical line **Placement:** horizontal line of outside cross touches rectangle higher than 2/3 the height of rectangle, but below top; does not penetrate the rectangle
9. triangle				**Drawing:** angle formed by 2 sides of triangle is between 60–100 degrees; sides are straight, unbroken and meet in a point; distance on vertical side of rectangle subsumed by triangle is approximately 50% of the height of vertical side **Placement:** roughly centered on the left vertical side of the rectangle
10. arrow				**Drawing:** straight and unbroken; lines forming arrow are approximately equal in length and not more than 1/3 length of staff **Placement:** must protrude from appropriate corner of rectangle such that staff appears to be continuation of diagonal cross
		Total Score Range=0–20		

4 Line Orientation

Time Limit: 20 seconds/item

Present the sample item, and say ***These two lines down here*** (indicate) ***match two of the lines on top. Can you tell me the numbers, or point to the lines that they match?*** Correct any errors and make sure the examinee understands the task. Continue with Items 1–10.

Scoring: 1 point for each line correctly identified.

Item	Responses	Correct Responses	Score (0, 1, or 2)
Sample		1, 7	
1.		10, 12	
2.		4, 11	
3.		6, 9	
4.		8, 13	
5.		2, 4	

Item	Responses	Correct Responses	Score (0, 1, or 2)
6.		1, 6	
7.		3, 10	
8.		5, 8	
9.		1, 3	
10.		11, 13	
		Total Score Range=0–20	

5 Picture Naming

Time Limit: 20 seconds/item

Ask the examinee to name each picture. Give the semantic cue only if the picture is obviously misperceived.

Scoring: 1 point for each item that is correctly named spontaneously or following semantic cue.

Item	Semantic Cue	Responses	Score (0 or 1)
1. chair	a piece of furniture		
2. pencil	used for writing		
3. well	you get water from it		
4. giraffe	an animal		
5. sailboat	used on the water (if "boat," query "what kind")		
6. cannon	a weapon, used in war		
7. pliers	a tool		
8. trumpet	a musical instrument ("cornet" okay)		
9. clothespin	used to hold laundry on a line		
10. kite	it's flown in the air		
		Total Score Range=0–10	

6 Semantic Fluency

Time Limit: 60 seconds

Say ***Now I'd like you to tell me the names of all of the different kinds of fruits and vegetables that you can think of. I'll give you one minute to come up with as many as you can. Ready?***

Scoring: 1 point for each correct response.

1. ______	11. ______	21. ______	31. ______
2. ______	12. ______	22. ______	32. ______
3. ______	13. ______	23. ______	33. ______
4. ______	14. ______	24. ______	34. ______
5. ______	15. ______	25. ______	35. ______
6. ______	16. ______	26. ______	36. ______
7. ______	17. ______	27. ______	37. ______
8. ______	18. ______	28. ______	38. ______
9. ______	19. ______	29. ______	39. ______
10. ______	20. ______	30. ______	40. ______

Total Score
Range=0–40

7 Digit Span

Say ***I am going to say some numbers, and I want you to repeat them after me. Okay?***
Read the numbers at the rate of 1 per second. Only read the second string in each set if the first string was failed. Discontinue after failure of both strings in any set.

Scoring: 2 points for the first string correct, 1 point for the second string correct, and 0 points for both strings failed.

Item First String	String Score (0 or 2)	Second String	String Score (0 or 1)	Item Score (0–2)
1. **4–9**		**5–3**		
2. **8–3–5**		**2–4–1**		
3. **7–2–4–6**		**1–6–3–8**		
4. **5–3–9–2–4**		**3–8–4–9–1**		
5. **6–4–2–9–3–5**		**9–1–5–3–7–6**		
6. **2–8–5–1–9–3–7**		**5–3–1–7–4–9–2**		
7. **8–3–7–9–5–2–4–1**		**9–5–1–4–2–7–3–8**		
8. **1–5–9–2–3–8–7–4–6**		**5–1–9–7–6–2–3–6–5**		

Total Score
Range=0–16

8 Coding

Time Limit: 90 seconds

Say ***Look at these boxes*** (indicate key). ***For each one of these marks there is a number that goes with it. Down here there are marks, but no numbers. I want you to fill in the number that goes with each mark.***

Demonstrate the first three. Say ***Now I would like you to fill in the rest of these boxes up to the double lines*** (indicate) ***for practice.*** Correct any errors as they are made. Make sure that the examinee understands the task and has correctly completed the sample items before you begin timing.

Say ***Now I would like you to continue to fill in the numbers that match the marks. Go as quickly as you can without skipping any. When you reach the end of the line, go on to the next one. Ready? Go ahead.***

Redirect the examinee to the task if he or she becomes distracted. If the examinee is unable to comprehend the task, the subtest score is 0.

Scoring: 1 point for each item correctly coded within 90 seconds (*do not* score the sample items).

Note: Familiarize yourself with these instructions before administering this subtest.

⊂	∧	=	┘	∨	⊃	+	⊥	⊢
1	2	3	4	5	6	7	8	9

SAMPLE

=	⊢	⊂	∧	+	┘	⊥	⊃	∨	=	⊢	∧	⊃	+

⊥	⊃	∨	⊢	=	∧	⊂	+	┘	∧	⊥	⊂	+	┘

⊃	⊢	∧	=	∨	⊂	┘	+	⊥	=	⊃	∧	⊢	⊂

+	⊂	⊢	┘	=	⊢	+	∧	⊃	⊂	┘	⊥	+	⊢

⊂	+	⊢	⊃	∧	=	⊥	┘	⊂	=	+	∨	⊥	∧

∧	=	┘	⊢	+	∨	⊥	┘	∧	⊃	∨	⊥	⊂	┘

+	⊂	┘	⊃	∧	=	⊂	+	⊥	∨	┘	∧	⊃	=

9 List Recall

Say ***Do you remember the list of words that I read to you in the beginning? Tell me as many of those words as you can remember now.***

Scoring: 1 point for each word correctly recalled.

List (Do not read.)	Response	Score (0 or 1)
Market		
Package		
Elbow		
Apple		
Story		
Carpet		
Bubble		
Highway		
Saddle		
Powder		

Total Score
Range=0–10

10 List Recognition

Say ***I'm going to read you some words. Some of these words were on that list, and some of them weren't. I want you to tell me which words were on the list.*** For each word, ask ***Was __________ on the list?***

Scoring: 1 point for each word correctly identified. Circle the letter corresponding to examinee's response (y = yes, n = no); bold, capitalized (**Y, N**) letter indicates correct response.

List	Circle One	List	Circle One	List	Circle One	List	Circle One
1. **Apple**	**Y** n	6. sailor	y **N**	11. **Bubble**	**Y** n	16. **Saddle**	**Y** n
2. honey	y **N**	7. velvet	y **N**	12. prairie	y **N**	17. **Powder**	**Y** n
3. **Market**	**Y** n	8. **Carpet**	**Y** n	13. **Highway**	**Y** n	18. angel	y **N**
4. **Story**	**Y** n	9. valley	y **N**	14. oyster	y **N**	19. **Package**	**Y** n
5. fabric	y **N**	10. **Elbow**	**Y** n	15. student	y **N**	20. meadow	y **N**

Total Score
Range=0–20

11 Story Recall

Say: ***Do you remember that story about a fire that I read to you earlier? Tell me as many details from the story as you can remember now.***

Scoring: 1 point for each verbatim recall of bold, italic words or alternatives, shown below in color within parentheses. Record intrusions or variations in the Responses column.

Story (Do not read.)	Responses	Item Score (0 or 1)
1. On ***Tuesday,***		
2. ***May***		
3. ***Fourth,***		
4. in ***Cleveland,*** Ohio,		
5. a ***3 alarm***		
6. ***fire*** broke out.		
7. ***Two***		
8. ***hotels***		
9. and a ***restaurant***		
10. were ***destroyed***		
11. before the ***firefighters (firemen)***		
12. were able to ***extinguish it (put it out).***		
	Total Score Range=0–12	

12 Figure Recall

Say ***Do you remember that figure that I had you copy? I want you to draw as much of it as you can remember now. If you remember a part, but you're not sure where it goes, put it anywhere. Try to draw as much of it as you can.***

Now, present the Figure Recall Drawing Page.

Scoring: 1 point for correctness and completeness (drawing), and 1 point for proper placement. See Appendix 1 in Stimulus Booklet A for complete scoring criteria and scoring examples.

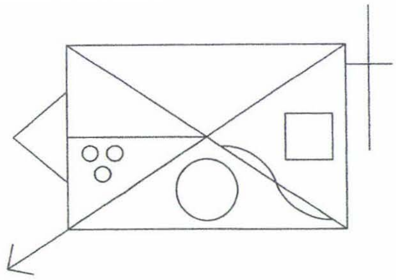


Figure Recall Criteria

(Fold back for use.)

Item	Drawing (0 or 1)	Placement (0 or 1)	Score (0, 1, or 2)	Scoring Criteria
1. rectangle				**Drawing:** lines are unbroken and straight; angles 90 degrees; top/bottom lines 25% longer than sides **Placement:** not rotated more than 15 degrees
2. diagonal cross				**Drawing:** lines are unbroken and straight and should approximately bisect each other **Placement:** ends of lines should meet corners of the rectangles without significant overlap or measurable distance between the ends of the lines and the corners
3. horizontal line				**Drawing:** line is unbroken and straight; should not exceed 1/2 the length of the triangle **Placement:** should bisect correct side of the rectangle at approximately a right angle and intersect the diagonal cross
4. circle				**Drawing:** round, unbroken and closed; diameter should be approximately 1/4–1/3 height of triangle **Placement:** placed in appropriate segment; not touching any other part of figure
5. 3 small circles				**Drawing:** round, unbroken and closed; equal size; triangular arrangement; not touching each other **Placement:** in appropriate segment; not touching figure; triangle formed not rotated more than 15 degrees
6. square				**Drawing:** must be closed; 90 degree angles; lines straight and unbroken; height is 1/4–1/3 height of rectangle **Placement:** in appropriate segment; not touching any other part of figure; not rotated more than 15 degrees
7. curving line				**Drawing:** 2 curved segments are approximately equal in length and symmetrical; correct direction of curves **Placement:** ends of line touch diagonal; do not touch corner of square or intersection of diagonal lines
8. outside cross				**Drawing:** vertical line of the outside cross is parallel to side of rectangle; >1/2 the height of rectangle; horizontal line crosses vertical at 90 degree angle and is between 20–50% of length of vertical line **Placement:** horizontal line of outside cross touches rectangle higher than 2/3 the height of rectangle, but below top; does not penetrate the rectangle
9. triangle				**Drawing:** angle formed by 2 sides of triangle is between 60–100 degrees; sides are straight, unbroken and meet in a point; distance on vertical side of rectangle subsumed by triangle is approximately 50% of the height of vertical side **Placement:** roughly centered on the vertical side of the rectangle
10. arrow				**Drawing:** straight and unbroken; lines forming arrow are approximately equal in length and not more than 1/3 length of staff **Placement:** must protrude from appropriate corner of rectangle such that staff appears to be continuation of diagonal cross
		Total Score Range=0–20		

Appendix D: Standard Tests Administered

1. Words (Learning & Delayed Recall) Subtest of Children's Memory Scale

(Interference trial 5 and immediate response trial 6 have been excluded)

	Trial 1	Trial 2	Trial 3	Trial 4	Delay
Car					
Forest					
Dog					
Night					
Paper					
Hand					
Metal					
Rock					
Line					
Window					
Farmer					
Watch					
Sound					
Bark					

Adapted from Cohen (1997)

2. Stories (1 & 2) Subtests of Children's Memory Scale

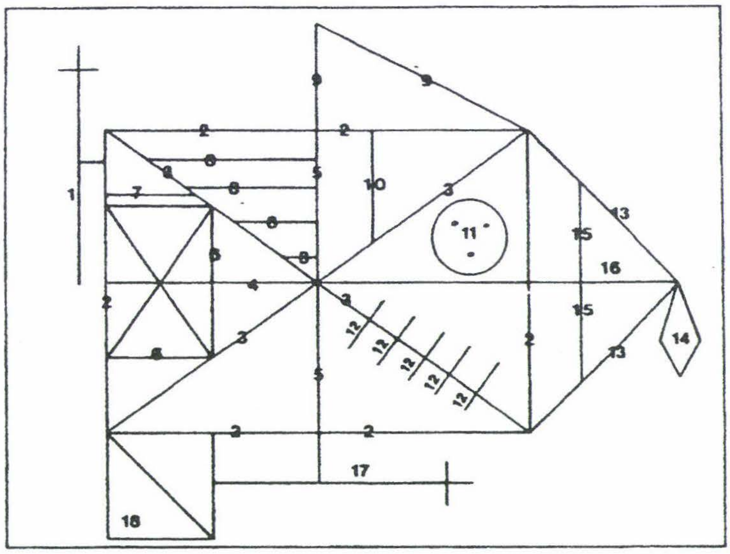
(5-8) Story 1 Segments	**Response**	**Points**	**Memory**	**Recall**
A **mother cat** *(mother kitty; kitten)* had **five brown** and **white** kittens *(baby cats or kittens, little cats)*.		**(6)**		
One **morning** *(day, once upon a time, Sunday)* she **took** *(they went)* the **kittens** (*var.*) for a **walk** (*indication of travel*).		**(4)**		
The **kittens** (*var.*) **looked** *(searching)* for **someone** to **play** with.		**(4)**		
They **found** *(saw)* some **butterfly(ies)** in the **field** *(var.)*.		**(3)**		
A **dog** came and **barked** *(var.)* **at them** *(var.)*.		**(3)**		
The **mother** *(var.)* cat *(var.)* **did not like** *(dislike)* the **dog** *(var.)*.		**(4)**		
The **cat** *(var.)* **hissed** *(sissed or var.)* **at the dog** and the **dog** *(var.)* **ran away**.		**(5)**		
(5-8) Story 2 Segments	**Response**	**Points**	**Memory**	**Recall**
On a **sunny** *(Indicate day time)* **day** in **June**, **four boys** *(var.)* **built** a **clubhouse** *(var.)*		**(7)**		
near *(indicating proximity)* a **stream** *(var.)* in the **woods** *(var.)*.		**(3)**		
The **boys** *(they)* **cut down** *(indicating cutting)* **dead** *(var.)* trees *(var.)*		**(4)**		
and **used** (var.) **scrap wood**.		**(3)**		
They built *(indicating the boys built)* a **table** (var.) and **found** (var.) some **old** (var.) **chairs** to **sit** on.		**(6)**		
When the **boys** *(they)* were **finished working** *(done)*		**(1)**		
their **parents** *(var.)* **took them** *(indicating going somewhere & buying something)* for **ice cream cones**.		**(4)**		

(9-12) **Story 3 Segments**	**Response**	**Points**	**Memory**	**Recall**
Lisa and **Melissa** were **walking past***(indication of walking)* the **grocery** *(var.)* **store** *(var.)* **on their way** *(indication of destination)* to **school**,		**(7)**		
When **two** *(couple)* **men** *(var.)* ran out *(indicating coming out)* with a *(indicating they were carrying something)* **money bag**		**(6)**		
The **men** *(thieves, they, robbers,etc)* **jumped into** *(indicating entering)* a **brown car** and **drove away** *(indicating leaving)* **very fast** *(indicating speed)*.		**(6)**		
When the police came, **Lisa told them** *(indicating reporting)* the **color** *(or description of car color) of* the **car** *(var.)*		**(5)**		
Melissa told the police *(indicating reporting)* that **one man** *(indicating description)* was **short** and the **other** *(indicating differentiating)* was **tall**.		**(6)**		
Because the girls *(indicating the need of both reports)* were **in** *(indicating being there)* the **right place** *(var.)* the **right time**, the **men** *(robbers, culprits)* were **caught** *(var.)*		**(6)**		
one month later and the **money** *(var.)* was **returned** *(var.)*.		**(5)**		

(9-12) **Story 4 Segments**	**Response**	**Points**	**Memory**	**Recall**
Jessica had taken *(indicating acquisition)* the **lifeguard class** *(var.)* at **school**.		**(5)**		
One *(var.)* **Saturday morning** in **March**, **she** *(Jessica)* **was walking** *(indicating travel)* by **Bear Lake**		**(8)**		
and **saw** *(indicating discovery)* **two men** *(var.)* **fishing** in a **motorboat** *(var.)*.		**(5)**		
The **men** *(var.)* **steering** *(var.)* the **boat** *(var. or it)* **did not see** *(indicating missing)* a **warning marker** *(var.)* and **hit** *(indicating collision)* a **rock**		**(8)**		
that was **underwater** *(var.)*. The **boat** *(var.)* began to **sink** *(var.)*.		**(3)**		
Jessica *(girl, she)* **jumped in** *(var.)* and **helped** *(var.)* the **men** *(var.)* **swim to shore** *(var.)*.		**(5)**		
After hearing the story *(var.)*, the **park ranger** *(var.)* **offered** *(var.)* **Jessica** (*girl, her)* a **summer** *(var.)* **job** as a **lifeguard**.		**(7)**		

Adapted from Cohen (1997)

3. Rey-Osterrieth Complex Figure Test



REY–OSTERRIETH COMPLEX FIGURE TEST
FORM A (Rey Figure)

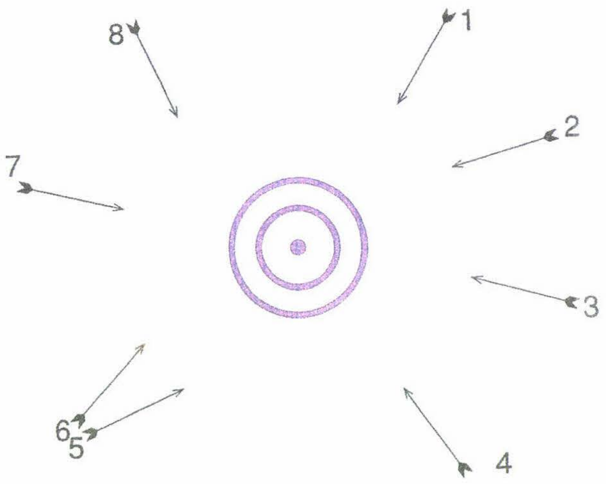
Details:	COPY	DELAY
1. Cross upper left corner, outside of rectangle	____	____
2. Large rectangle	____	____
3. Diagonal cross	____	____
4. Horizontal midline of 2	____	____
5. Vertical midline	____	____
6. Small rectangle, within 2 to the left	____	____
7. Small segment above 6	____	____
8. Four parallel lines within 2, upper left	____	____
9. Triangle above 2 upper right	____	____
10. Small vertical line within 2, below 9	____	____
11. Circle with three dots within 2	____	____
12. Five parallel lines with 2 crossing 3, lower right	____	____
13. Sides of triangle attached to 2 on right	____	____
14. Diamond attached to 13	____	____
15. Vertical line within triangle 13 parallel to right vertical of 2	____	____
16. Horizontal line within 13, continuing 4 to right	____	____
17. Cross attached to low center	____	____
18. Square attached to 2, lower left	____	____
TOTAL SCORE	____	____

Scoring:
Consider each of the eighteen units separately, and appraise accuracy of each unit and relative position within the whole of the design. For each unit count as follows:

Correct	placed properly	2 points
	placed poorly	1 point
Distorted or incomplete but recognizable	placed properly	1 point
	placed poorly	½ point
Absent or not recognizable		0 points
Maximum		36 points

Rey (1941, cited in Spreen and Strauss, 1998)

4. Arrows Subtest of NEPSY



Point to the target. Say

Pause for the child to respond.

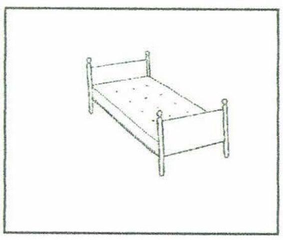
If the child points to only one arrow, say

(Korkman, Kirk, & Kemp, 1998)

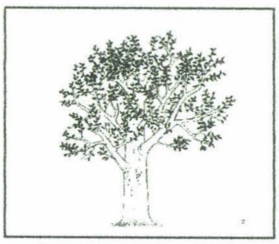
4. Boston Naming Test

Instructions: The child is presented with a picture and is asked to name it. A semantic cue is given if picture cannot be named spontaneously.

Sample Items:



Semantic Cue: A Piece of Furniture



Semantic Cue: Something That Grows Outdoors

Kaplan (1983)

5. Verbal Fluency Subtest of NEPSY

L Verbal Fluency

...panded

Time Limit
60 seconds per item

Discontinue Rule
Ages 5–6: Administer Items 1 and 2 only.
Ages 7–12: Administer all items.

	All Ages		Ages 7–12 only	
Time Interval	Semantic		Phonemic	
	1. Animals	2. Food or Drink	3. S words	4. F words
5–12 1"–15"				
16"–30"				
31"–45"				
46"–60"				
Total Words				

Qualitative Observations

- O Body Movement (with words produced)
- O Increasing Voice Volume

Total Score (Ages 5–6) [ ] Semantic Items

[ ] Phonemic Items

Total Score (Ages 7–12) [ ] Semantic + Phonemic

6. Digit Span Subtest of WISC-III (forward trial only)

12. Digit Span

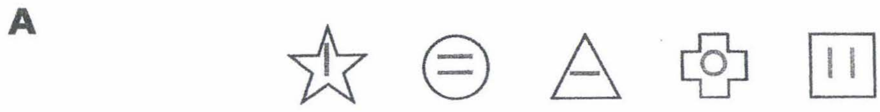
For both Digits Forward and Digits Backward, administer both trials of each item even if Trial 1 is passed. Discontinue after failure of **both** trials of any item.
Administer Digits Backward even if Digits Forward score is 0.

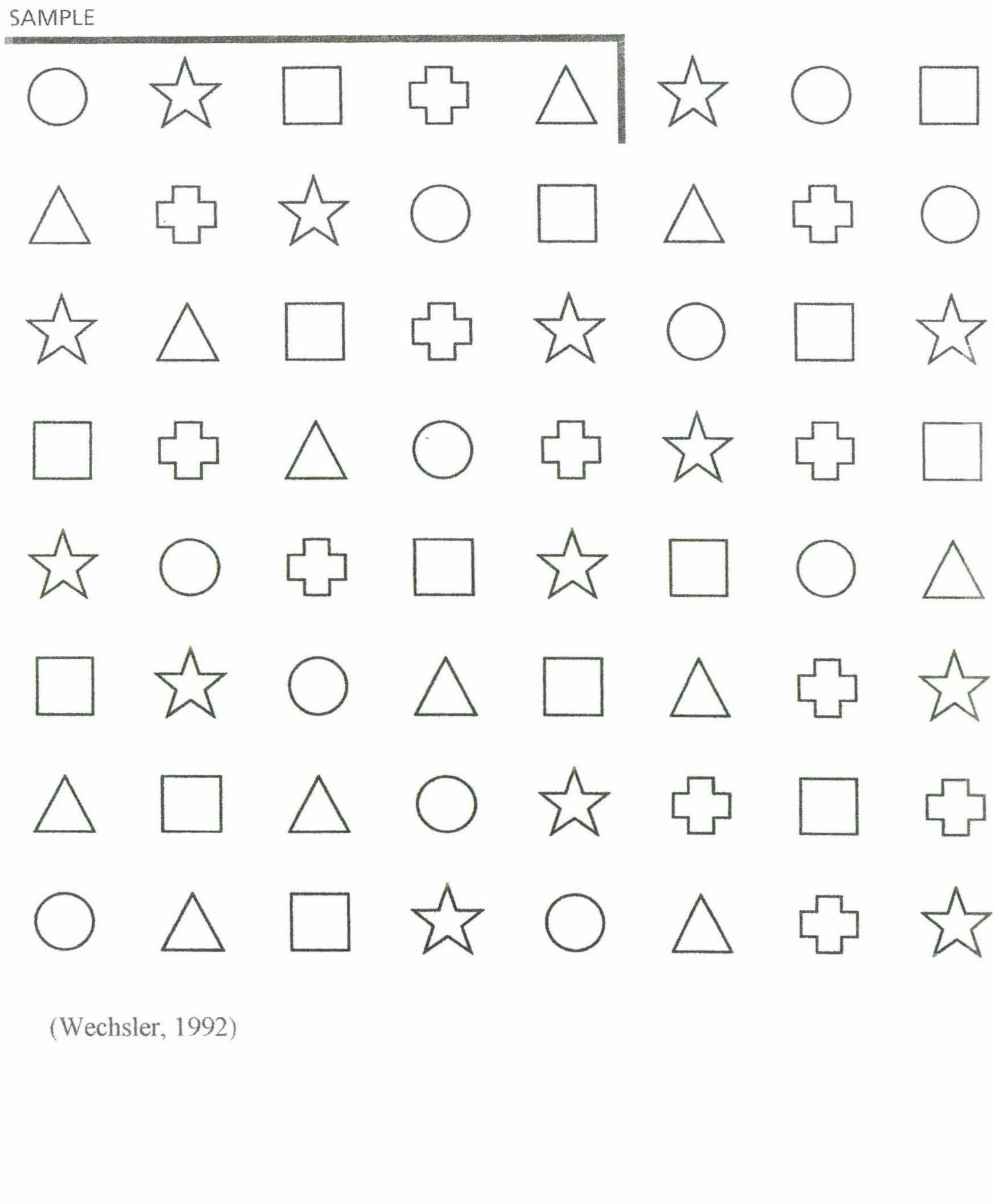
Digits Forward	Trial 1/Response	Trial Score	Trial 2/Response	Trial Score	Item Score 0, 1, or 2
All Ages 1.	2 – 9		4 – 6		
2.	3 – 8 – 6		6 – 1 – 2		
3.	3 – 4 – 1 – 7		6 – 1 – 5 – 8		
4.	8 – 4 – 2 – 3 – 9		5 – 2 – 1 – 8 – 6		
5.	3 – 8 – 9 – 1 – 7 – 4		7 – 9 – 6 – 4 – [illegible]		
6.	5 – 1 – 7 – 4 – 2 – 3 – 8		9 – 8 – 5 – 2 – 1 – [illegible]		
7.	[illegible]		2 – 9 – 7 – 6 – 3 – 1 – [illegible]		
8.	[illegible]		4 – 2 – 6 – 9 – 1 – [illegible]		

Digits Forward Score
(Maximum = 16)

(Wechsler, 1992)

7. Coding Subtest of WISC-III **(Form A - 5 to 8 year olds)**





(Wechsler, 1992)

(Form B - 9 to 16 year olds)

B

SAMPLE

2	1	4	6	3	5	2	1	3	4	2	1	3	1	2	3	1	4	2	6	3

1	2	5	1	3	1	5	4	2	7	4	6	9	2	5	8	4	7	6	1	8

7	5	4	8	6	9	4	3	1	8	2	9	7	6	2	5	8	7	3	6	4

5	9	4	1	6	8	9	3	7	5	1	4	9	1	5	8	7	6	9	7	8

2	4	8	3	5	6	7	1	9	4	3	6	2	7	9	3	5	6	7	4	5

2	7	8	1	3	9	2	6	8	4	1	3	2	6	4	9	3	8	5	1	8

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(Wechsler, 1992)

Appendix E: Raw Data

Table 10. Raw Data of all RBANS-C Subtests Including Ages and Means for All Children

No.	Years	List Learning	Story Memory	Figure Copy	Line Orientation	Picture Naming	Verbal Fluency	Digit Span	Coding	List Recall	List Recognition	Story Recall	Figure Recall	Age
1		29	21	18	16	20	19	7	12	6	20	10	16	5.9
2		18	17	17	12	20	15	6	11	3	20	10	11	5.3
3		23	19	19	17	20	17	7	13	5	20	9	9	6.2
4	5 - 7	19	22	17	15	20	14	6	17	7	20	12	12	5.2
5		26	17	19	16	20	13	9	15	5	20	8	13	5.3
6		28	18	18	14	20	14	8	12	8	19	9	16	6.2
7		8	8	19	17	20	9	6	10	0	20	0	14	5.6
8		25	16	19	17	20	16	7	13	6	19	9	18	6.1
9		30	21	19	16	20	28	15	22	7	20	12	17	7.5
10		25	21	19	18	20	34	7	16	6	19	12	16	7.3
11	7 - 8	20	22	18	17	20	18	7	23	5	20	12	12	7.5
12		17	15	17	15	20	28	7	21	7	19	12	17	7.5
13		23	21	19	16	20	21	7	20	7	19	11	16	7.6
14		27	21	20	18	20	22	8	22	7	20	11	18	8.3
15		20	18	20	20	20	16	8	17	7	18	9	14	8.7
16	8 - 9	24	18	20	17	20	14	7	22	6	20	12	17	8.5
17		28	19	20	19	20	33	6	20	10	20	12	14	8.2
18		27	17	18	17	19	22	7	20	7	20	11	12	8.7
19		26	19	19	15	20	21	7	28	5	19	11	12	8.8
20		26	21	20	20	20	12	7	22	8	20	12	18	9.7
21		25	17	18	16	20	18	5	16	5	17	10	11	9.6
22	9 - 10	31	22	19	17	20	26	8	15	6	20	12	12	9.5
23		31	19	20	19	20	21	8	36	7	19	12	14	9.3
24		32	24	19	17	20	25	8	30	9	20	12	13	9.5
25		21	15	16	17	20	20	7	13	6	20	7	16	10.5
26		33	23	20	18	20	23	7	26	9	20	12	17	10.6
27		32	19	20	17	20	28	8	31	6	20	12	18	10.3
28	10 - 11	25	24	20	20	20	31	7	36	8	20	12	18	10.3
29		26	20	20	17	20	32	8	36	9	20	12	19	10.5
30		25	19	20	16	20	22	8	27	7	19	12	13	10.7
	Mean	**25**	**19.1**	**18.9**	**16.87**	**19.97**	**21.07**	**7.43**	**20.73**	**6.47**	**19.57**	**10.57**	**14.77**	**8.13**

▭ indicates children with possible cognitive deficits (no. 2, 21 and 24 were identified by questionnaire to have cognitive difficulties)

<u>Table 11</u>. Raw Data for 15 Children Retested with Standardized Assessment Battery including Means and Ages.

		CMS		Rey Complex Figure	NEPSY	Boston Naming Test	NEPSY	WISC-III		CMS			Rey Complex Figure Test	Age
No.	Years	Word List Learning	Stories Immediate	Copy	Arrows		Verbal Fluency	Digit Span	Coding	Words Lists Delayed Recall	Words Lists Delayed Recognition	Stories Delayed	Recall	
1	5 - 7	29	36	21	16	29	20	8	46	7	29	33	17	5.5
2		23	33	27	20	32	29	9	46	6	28	29	18	5.3
6		33	45	27.5	20	33	25	15	47	8	30	44	16	5.5
7		24	38	26	17	36	29	6	41	6	30	26	15.5	5.6
9	7 - 8	37	41	30.5	22	40	31	10	35	9	38	42	14.5	7.5
11		38	47	34	25	41	33	6	42	8	36	43	20.5	7.5
12		38	70	35	26	44	26	8	32	8	37	60	22	7.5
18	8 - 9	42	67	31	24	42	37	8	35	8	38	59	16.5	8.2
19		39	71	34.5	26	46	36	11	46	7	37	66	21.5	8.7
20	9 - 10	36	73	29.5	23	45	32	9	44	7	38	65	13.5	8.8
21		29	36	21	16	29	20	8	46	7	29	33	17	9.6
24		23	33	27	20	32	29	9	46	6	28	29	18	9.5
25		33	45	27.5	20	33	25	15	47	8	30	44	16	10.5
27	10 - 11	24	38	26	17	36	29	6	41	6	30	26	15.5	10.3
30		37	41	30.5	22	40	31	10	35	9	38	42	14.5	10.7
	Mean	**33.9**	**52.1**	**29.6**	**21.9**	**38.8**	**29.8**	**9**	**41.4**	**7.4**	**34.1**	**46.7**	**17.5**	

Table 12. Standard Scores for Children Retested with Standardized Assessment Battery

		CMS [1]		Rey Complex Figure [2]	NEPSY [3]	Boston Naming Test [2]	NEPSY [3]	WISC-III [a]		CMS [1]			Rey Complex Figure Test [2]	Age
No.	Years	Word List Learning	Stories Immediate	Copy	Arrows		Verbal Fluency	Digit Span	Coding	Words Lists Delayed Recall	Words Lists Delayed Recognition	Stories Delayed	Recall	
1	5 - 7	16	14	12	13	11	12	14	14	15	14	14	13	5.5
2		7	12	14	9	11	15	10	13	13	9	12	11	5.3
6		12	13	14	15	12	16	15	14	13	12	13	14	5.5
7		5	11	12	15	12	13	10	12	9	7	10	11	5.6
9	7 - 8	15	15	13	12	8	7	18	10	14	13	16	11	7.5
11		10	13	12	10	10	8	7	9	10	13	10	11	7.5
12		8	9	11	10	9	7	9	9	6	9	6	9	7.5
18	8 - 9	19	16	14	15	12	11	7	15	12	9	14	12	8.2
19		18	13	13	10	11	10	14	12	9	8	14	9	8.7
20	9 - 10	13	15	15	15	11	7	10	9	11	12	13	12	8.8
21		10	13	12	14	11	8	8	11	7	9	12	7	9.6
24		15	14	13	13	10	12	10	10	11	13	13	9	9.5
25		8	12	12	15	10	8	10	9	9	8	11	10	10.5
27	10 - 11	11	15	13	14	11	11	13	12	9	11	14	11	10.3
30		12	16	11	11	10	9	11	11	9	12	14	7	10.7
	Mean	11.93	13.4	12.73	12.73	10.6	10.27	11.1	11.33	10.47	10.6	12.4	10.47	

[1]Cohen, 1997; [2] Spreen and Strauss, 1998; [3] Korkman et al., 1998; [a] Wechsler, 1992

Table 13. Raw Data for List Learning Items for entire Sample including Ages.

No.	Years	Ages	List Learning Item 1	2	3	4	5	6	7	8	9	10
1	5 - 7	5.9	3	4	3	3	2	0	4	3	3	4
2		5.3	2	2	2	1	3	1	1	2	1	2
3		6.2	4	2	3	3	1	3	1	1	1	4
4		5.2	2	1	0	2	1	1	2	2	2	3
5		5.3	4	3	3	2	2	2	2	2	3	3
6		6.2	3	3	4	3	2	1	2	3	3	4
7		5.6	3	2	2	2	0	1	1	2	2	1
8		6.1	4	2	2	4	0	2	3	1	3	4
9	7 - 8	7.5	2	4	4	4	3	2	4	3	3	3
10		7.3	3	3	1	2	2	3	1	4	3	3
11		7.5	1	2	4	2	0	2	2	4	1	2
12		7.5	3	2	2	1	0	2	1	1	3	2
13		7.6	3	4	3	2	1	2	3	2	1	2
14	8 - 9	8.3	3	3	3	3	2	2	2	1	3	3
15		8.7	2	2	3	3	1	0	1	4	2	2
16		8.5	1	4	3	4	4	2	1	1	0	4
17		8.2	2	3	2	3	2	2	3	4	3	4
18		8.7	4	3	2	2	3	3	3	3	1	3
19		8.8	3	4	4	3	3	1	0	2	3	3
20	9 - 10	9.7	3	2	4	3	1	2	4	1	2	4
21		9.6	3	4	2	1	2	1	2	4	3	3
22		9.5	3	4	3	2	2	3	3	4	3	3
23		9.3	4	3	2	3	4	2	2	4	2	4
24		9.5	4	4	3	3	2	2	2	2	4	4
25		10.5	1	2	2	1	3	2	3	1	1	1
26	10 - 11	10.6	4	4	4	3	2	4	3	4	3	2
27		10.3	4	4	4	4	1	3	2	2	4	4
28		10.3	4	4	3	3	1	2	2	1	3	2
29		10.5	4	2	3	4	0	2	3	2	2	4
30		10.7	3	4	3	3	3	1	3	1	2	2

Table 14. Raw Data for Story Memory Items for entire Sample with Ages.

No.	Years	Ages	Story Memory Item 1	2	3	4	5	6	7	8	9	10	11	12
1	5 - 7	5.9	0	2	1	2	2	2	2	2	2	2	2	2
2		5.3	0	2	1	1	2	1	1	2	2	1	2	2
3		6.2	2	2	2	1	1	1	1	2	1	2	2	2
4		5.2	2	2	2	2	1	2	2	2	2	1	2	2
5		5.3	1	1	2	1	2	2	1	2	2	1	1	1
6		6.2	0	2	1	2	2	0	2	2	2	2	2	2
7		5.6	2	2	1	0	0	0	1	0	0	0	1	1
8		6.1	2	2	2	2	1	1	1	1	1	1	1	1
9	7 - 8	7.5	2	2	2	1	2	2	2	1	1	2	2	2
10		7.3	2	2	2	1	1	2	2	2	2	1	2	2
11		7.5	2	1	2	2	2	2	2	2	1	2	2	2
12		7.5	2	1	2	1	1	1	1	1	2	1	1	1
13		7.6	1	1	2	1	2	2	2	2	2	2	2	2
14	8 - 9	8.3	1	2	2	2	2	2	2	2	2	0	2	2
15		8.7	2	2	2	1	1	1	1	1	1	2	2	2
16		8.5	2	2	2	2	2	1	1	1	1	1	1	1
17		8.2	1	2	1	2	2	1	1	1	2	2	2	2
18		8.7	0	2	2	0	2	1	1	1	2	2	2	2
19		8.8	2	2	2	1	1	2	2	2	2	1	1	1
20	9 - 10	9.7	2	2	2	2	2	2	2	1	1	1	2	2
21		9.6	1	1	2	1	0	1	1	2	2	2	2	2
22		9.5	2	2	2	2	2	1	1	2	2	2	2	2
23		9.3	2	2	2	2	2	2	2	1	1	1	1	1
24		9.5	2	2	2	2	2	2	2	2	2	2	2	2
25		10.5	2	1	2	1	1	1	1	1	1	0	2	2
26	10 - 11	10.6	1	2	2	2	2	2	2	2	2	2	2	2
27		10.3	2	2	2	2	1	1	1	1	1	2	2	2
28		10.3	2	2	2	2	2	2	2	2	2	2	2	2
29		10.5	2	2	2	0	2	1	1	2	2	2	2	2
30		10.7	2	2	1	2	1	1	1	1	2	2	2	2

Table 15. Raw Data for Figure Copy Items for entire Sample with Ages.

No.	Years	Ages	Figure Copy Item 1	2	3	4	5	6	7	8	9	10
1	5 - 7	5.9	2	1	2	2	2	1	2	2	2	2
2		5.3	2	1	2	2	2	1	2	2	2	2
3		6.2	2	2	1	2	2	1	2	2	1	2
4		5.2	2	2	2	2	2	1	2	2	2	2
5		5.3	1	2	1	2	2	2	2	2	2	1
6		6.2	2	2	2	2	1	2	2	2	2	2
7		5.6	2	2	2	1	2	2	2	2	2	2
8		6.1	2	2	2	2	2	2	2	2	2	2
9	7 - 8	7.5	2	2	2	2	2	2	2	2	1	2
10		7.3	2	2	2	2	1	2	2	2	2	2
11		7.5	2	2	1	2	2	2	2	2	2	2
12		7.5	2	2	1	2	2	2	2	2	1	2
13		7.6	2	2	1	2	2	2	1	2	1	2
14	8 - 9	8.3	2	2	1	2	2	2	2	2	2	2
15		8.7	2	2	2	2	2	2	2	2	2	2
16		8.5	2	2	2	2	2	2	2	2	2	2
17		8.2	2	2	2	2	2	2	2	2	2	2
18		8.7	2	2	2	2	2	2	2	2	2	2
19		8.8	2	2	2	2	1	2	2	2	1	2
20	9 - 10	9.7	2	2	2	2	2	2	2	2	1	2
21		9.6	2	2	2	2	2	2	2	2	2	2
22		9.5	2	2	1	2	1	2	2	2	2	2
23		9.3	2	2	2	2	2	2	2	2	1	2
24		9.5	2	2	2	2	2	2	2	2	2	2
25		10.5	2	2	2	2	1	2	2	2	2	2
26	10 - 11	10.6	2	1	2	2	1	2	1	2	2	1
27		10.3	2	2	2	2	2	2	2	2	2	2
28		10.3	2	2	2	2	2	2	2	2	2	2
29		10.5	2	2	2	2	2	2	2	2	2	2
30		10.7	2	2	2	2	2	2	2	2	2	2

Table 16. Raw Data for Line Orientation Items for entire Sample with Ages.

No.	Years	Ages	Line Orientation Item																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	5 - 7	5.9	1	0	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1
2		5.3	1	0	1	1	0	0	1	0	0	0	1	1	1	0	0	1	1	1	1	1
3		6.2	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1
4		5.2	0	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1	1	1
5		5.3	1	0	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1
6		6.2	1	0	1	1	0	0	1	1	1	0	1	1	0	0	1	1	1	1	1	1
7		5.6	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1
8		6.1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
9	7 - 8	7.5	0	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1
10		7.3	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
11		7.5	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
12		7.5	1	1	1	1	0	0	1	0	0	1	1	1	1	1	0	1	1	1	1	1
13		7.6	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	8 - 9	8.3	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15		8.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16		8.5	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
17		8.2	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18		8.7	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19		8.8	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1
20	9 - 10	9.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21		9.6	1	1	1	0	1	0	1	1	1	0	1	1	1	0	0	1	1	1	1	1
22		9.5	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1
23		9.3	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24		9.5	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
25		10.5	1	1	0	1	1	0	1	1	1	1	1	1	1	0		1	1	1	1	1
26	10 - 11	10.6	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27		10.3	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
28		10.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29		10.5	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
30		10.7	0	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1

Table 17. Raw Data for Picture Naming Items for entire Sample with Ages.

No.	Years	Ages	Picture Naming Item 1	2	3	4	5	6	7	8	9	10
1	5 - 7	5.9	2	2	2	2	2	2	2	2	2	2
2		5.3	2	2	2	2	2	2	2	2	2	2
3		6.2	2	2	2	2	2	2	2	2	2	2
4		5.2	2	2	2	2	2	2	2	2	2	2
5		5.3	2	2	2	2	2	2	2	2	2	2
6		6.2	2	2	2	2	2	2	2	2	2	2
7		5.6	2	2	2	2	2	2	2	2	2	2
8		6.1	2	2	2	2	2	2	2	2	2	2
9	7 - 8	7.5	2	2	2	2	2	2	2	2	2	2
10		7.3	2	2	2	2	2	2	2	2	2	2
11		7.5	2	2	2	0	2	2	2	2	2	2
12		7.5	2	2	2	2	2	2	2	2	2	2
13		7.6	2	2	2	2	2	2	2	2	2	2
14	8 - 9	8.3	2	2	2	2	2	2	2	2	2	2
15		8.7	2	2	2	2	2	2	2	2	2	2
16		8.5	2	2	2	2	2	2	2	2	2	2
17		8.2	2	2	2	2	2	2	2	2	2	2
18		8.7	2	2	2	2	2	2	2	2	2	2
19		8.8	2	2	2	2	2	2	2	2	2	2
20	9 - 10	9.7	2	2	2	2	2	2	2	2	2	2
21		9.6	2	2	2	2	2	2	2	2	2	2
22		9.5	2	2	2	2	2	2	2	2	2	2
23		9.3	2	2	2	2	2	2	2	2	2	2
24		9.5	2	2	2	2	2	2	2	2	2	2
25		10.5	2	2	2	2	2	2	2	2	2	2
26	10 - 11	10.6	2	2	2	2	2	2	2	2	2	2
27		10.3	2	2	2	2	2	2	2	2	2	2
28		10.3	2	2	2	2	2	2	2	2	2	2
29		10.5	2	2	2	2	2	2	2	2	2	2
30		10.7	2	2	2	2	2	2	2	2	2	2

Table 18. **Raw Data for Digit Span Items for entire Sample with Ages.**

No.	Years	Ages	Digit Span Item 1	2	3	4	5	6	7	8	9	10
1	5 - 7	5.9	1	1	1	1	1	1	0	1	0	0
2		5.3	1	1	1	1	1	1	0	0	0	0
3		6.2	1	1	1	1	1	1	0	1	0	0
4		5.2	1	1	1	1	1	1	0	0	0	0
5		5.3	1	1	1	1	1	1	1	1	0	1
6		6.2	1	1	1	1	1	1	1	1	0	0
7		5.6	1	1	1	1	1	1	0	0	0	0
8		6.1	1	1	1	1	1	1	0	0	0	0
9	7 - 8	7.5	1	1	1	1	1	1	1	1	1	1
10		7.3	1	1	1	1	1	1	1	0	0	0
11		7.5	1	1	1	1	1	1	1	0	0	0
12		7.5	1	1	1	1	1	1	0	1	0	0
13		7.6	1	1	1	1	1	1	1	0	0	0
14	8 - 9	8.3	1	1	1	1	1	1	1	1	0	0
15		8.7	1	1	1	1	1	1	1	1	1	0
16		8.5	1	1	1	1	1	1	1	0	0	0
17		8.2	1	1	1	1	1	1	0	0	0	0
18		8.7	1	1	1	1	1	1	1	0	0	0
19		8.8	1	1	1	1	1	1	0	1	0	0
20	9 - 10	9.7	1	1	1	1	1	0	1	1	0	0
21		9.6	1	1	1	1	0	1	0	0	0	0
22		9.5	1	1	1	1	1	1	1	1	0	0
23		9.3	1	1	1	1	1	1	1	1	0	0
24		9.5	1	1	1	1	1	1	1	0	0	1
25		10.5	1	1	1	1	1	1	0	1	0	0
26	10 - 11	10.6	1	1	1	1	1	1	1	0	0	0
27		10.3	1	1	1	1	1	0	1	0	1	1
28		10.3	1	1	1	1	1	1	1	0	0	0
29		10.5	1	1	1	1	1	1	1	1	0	0
30		10.7	1	1	1	1	1	1	1	1	0	0

Table 19. Raw Data for List Recall Items for entire Sample with Ages.

No.	Years	Ages	List Recall Item									
			1	2	3	4	5	6	7	8	9	10
1	5 - 7	5.9	1	1	1	1	0	0	1	1	0	0
2		5.3	1	1	0	0	0	0	0	0	1	0
3		6.2	1	1	0	0	1	1	0	0	0	1
4		5.2	1	1	1	0	0	1	0	1	1	1
5		5.3	0	1	0	1	0	1	1	0	1	0
6		6.2	1	1	1	0	0	1	1	1	1	1
7		5.6	0	0	0	0	0	0	0	0	0	0
8		6.1	1	0	0	1	1	1	1	1	0	0
9	7 - 8	7.5	1	1	1	1	1	0	0	1	1	0
10		7.3	1	1	0	1	0	1	0	1	1	0
11		7.5	0	1	1	1	0	0	1	1	0	0
12		7.5	1	1	1	0	1	0	0	1	1	1
13		7.6	1	1	0	1	0	0	1	1	1	1
14	8 - 9	8.3	1	0	1	0	0	1	1	0	1	1
15		8.7	1	1	1	1	1	0	0	1	0	1
16		8.5	1	1	1	0	1	1	0	0	0	1
17		8.2	1	1	1	1	1	1	1	1	1	1
18		8.7	1	1	1	0	1	1	1	1	0	0
19		8.8	1	1	1	0	0	0	0	1	1	0
20	9 - 10	9.7	1	0	1	1	0	1	1	1	1	1
21		9.6	1	1	0	0	1	0	0	1	0	1
22		9.5	1	0	1	0	1	1	1	0	1	0
23		9.3	1	0	1	1	0	1	1	1	0	1
24		9.5	1	1	1	1	1	1	1	0	1	1
25		10.5	1	1	0	1	0	0	0	1	1	1
26	10 - 11	10.6	1	1	1	1	0	1	1	1	1	1
27		10.3	1	1	1	1	0	1	0	0	0	1
28		10.3	1	1	1	1	1	0	1	0	1	1
29		10.5	1	1	1	1	0	1	1	1	1	1
30		10.7	0	1	1	1	1	0	1	0	1	1

Table 20. Raw Data for List Recognition Items for entire Sample with Ages.

No.	Years	Ages	List Recognition Item 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	5 - 7	5.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2		5.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3		6.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4		5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5		5.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6		6.2	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7		5.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8		6.1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
9	7 - 8	7.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10		7.3	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11		7.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12		7.5	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13		7.6	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	8 - 9	8.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15		8.7	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
16		8.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17		8.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18		8.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19		8.8	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
20	9 - 10	9.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21		9.6	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1
22		9.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23		9.3	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24		9.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25		10.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26	10 - 11	10.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27		10.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28		10.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29		10.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30		10.7	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 21. Raw Data for Story Recall Items for entire Sample with Ages.

No.	Years	Ages	Story Recall Item 1	2	3	4	5	6	7	8	9	10	11	12
1	5 - 7	5.9	0	0	1	1	1	1	1	1	1	1	1	1
2		5.3	1	1	0	1	1	1	1	0	1	1	1	1
3		6.2	0	1	0	0	0	1	1	1	1	1	1	1
4		5.2	1	1	1	1	1	1	1	1	1	1	1	1
5		5.3	0	0	0	1	0	1	1	1	1	1	1	1
6		6.2	0	1	0	1	1	0	1	1	1	1	1	1
7		5.6	0	0	0	0	0	0	0	0	0	0	0	0
8		6.1	0	1	1	0	0	1	1	1	1	1	1	1
9	7 - 8	7.5	1	1	1	1	1	1	1	1	1	1	1	1
10		7.3	1	1	1	1	1	1	1	1	1	1	1	1
11		7.5	1	1	1	1	1	1	1	1	1	1	1	1
12		7.5	1	1	1	1	1	1	1	1	1	1	1	1
13		7.6	0	1	1	1	1	1	1	1	1	1	1	1
14	8 - 9	8.3	1	1	0	1	1	1	1	1	1	1	1	1
15		8.7	1	1	1	1	1	1	1	0	0	0	1	1
16		8.5	1	1	1	1	1	1	1	1	1	1	1	1
17		8.2	1	1	1	1	1	1	1	1	1	1	1	1
18		8.7	0	1	1	1	1	1	1	1	1	1	1	1
19		8.8	1	1	1	1	1	1	1	1	0	1	1	1
20	9 - 10	9.7	1	1	1	1	1	1	1	1	1	1	1	1
21		9.6	1	1	1	0	0	1	1	1	1	1	1	1
22		9.5	1	1	1	1	1	1	1	1	1	1	1	1
23		9.3	1	1	1	1	1	1	1	1	1	1	1	1
24		9.5	1	1	1	1	1	1	1	1	1	1	1	1
25		10.5	0	0	1	1	1	1	1	1	1	0	0	0
26	10 - 11	10.6	1	1	1	1	1	1	1	1	1	1	1	1
27		10.3	1	1	1	1	1	1	1	1	1	1	1	1
28		10.3	1	1	1	1	1	1	1	1	1	1	1	1
29		10.5	1	1	1	1	1	1	1	1	1	1	1	1
30		10.7	1	1	1	1	1	1	1	1	1	1	1	1

Table 22. Raw Data for Figure Recall Items for entire Sample with Ages.

			Figure Recall Item									
No.	Years	Ages	1	2	3	4	5	6	7	8	9	10
1	5 - 7	5.9	2	2	2	2	0	2	2	2	2	0
2		5.3	2	2	2	1	0	0	0	0	2	0
3		6.2	2	2	0	0	2	1	0	0	0	2
4		5.2	2	2	2	0	2	0	0	0	2	2
5		5.3	2	2	0	1	0	2	2	2	2	0
6		6.2	2	2	1	1	1	2	2	2	2	1
7		5.6	2	2	2	2	0	2	0	2	2	0
8		6.1	2	2	2	2	1	2	2	2	2	1
9	7 - 8	7.5	2	2	2	2	2	2	2	1	0	2
10		7.3	2	2	2	0	2	2	2	2	0	2
11		7.5	2	2	0	1	0	0	2	2	2	1
12		7.5	2	2	2	2	2	0	2	2	2	1
13		7.6	2	2	0	2	2	0	2	2	2	2
14	8 - 9	8.3	2	2	2	2	2	0	2	2	2	2
15		8.7	2	2	0	0	2	2	2	2	0	2
16		8.5	2	2	2	2	2	0	2	2	1	2
17		8.2	2	2	2	2	0	0	2	0	2	2
18		8.7	2	2	1	2	0	0	2	2	0	1
19		8.8	2	2	2	2	0	0	2	0	2	0
20	9 - 10	9.7	2	2	2	2	0	2	2	2	2	2
21		9.6	2	2	1	2	0	0	0	2	0	2
22		9.5	2	2	0	1	2	0	2	0	2	1
23		9.3	2	2	2	2	2	0	2	0	0	2
24		9.5	2	2	2	2	0	0	2	2	0	1
25		10.5	2	2	2	2	0	0	2	2	2	2
26	10 - 11	10.6	2	2	2	2	2	2	2	2	1	0
27		10.3	2	2	2	2	2	2	2	0	2	2
28		10.3	2	2	2	2	2	2	0	2	2	2
29		10.5	2	2	2	2	2	2	2	2	1	2
30		10.7	2	2	2	0	2	2	1	0	0	2

No raw data tables have been included for Semantic Fluency and Coding as these subtest were graded according to as many correct items as possible each child could answer instead of getting a specific number of items correct.