The Children’s Memory Questionnaire - Revised

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Thesis submitted in partial fulfilment of the requirements of the

Professional Doctorate in Clinical Psychology

March 2014
Statement of Originality
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Acknowledgement

I would like to acknowledge the John and Daphne Keats Research Endowment which supported the Development of the Children’s Memory Questionnaire. I would also like to thank Dr Karen Drysdale and Dr Wayne Levick for their contribution to this project. In addition, I would like to thank my family; my mother and father Robyne and Paul Farnill, my children Sunee and India, and my husband Craig.

I would also like to acknowledge the Services for Australian Rural and Remote Allied Health for the award of a Clinical Psychology Scholarship.
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Abstract

Problems with memory functioning in children can result in impaired learning across a broad range of areas as the ability to store and retrieve information is important for skill acquisition. For children, an interruption in the natural flow of brain development, resulting in difficulties with memory and learning, has pervasive implications across all areas of social, emotional, academic, and behavioural development. Further, as skill development continues over a life span, deficits in memory can have a cumulative effect. A young childhood brain is susceptible to a range of influences which can cause deviations in its otherwise normal development. As childhood spans a number of important developmental phases and since memory plays a significant role in early development, it is essential that deficits are accurately identified so that early interventions can be developed. Observer rating scales appear to be a timely and cost effective way to screen for memory deficits with the aim of identifying children that may benefit from more formal assessments. There are a number of observer rating scales that have been explored in the available literature however so far, few have proven to be suitable for use as a screening tool or for clinical diagnostic application.

The Children’s Memory Questionnaire - Revised (CMQ-R) is a parent report scale aimed at assessing the memory skills of children. It was the aim of the present study to evaluate the CMQ-R as a reliable and effective measurement of memory functioning in children. In addition, a factor analysis was conducted to assess the CMQ-R’s ability to reflect the multidimensional nature of memory. Three hundred and seventy one children between the ages 5-12 participated in the study and parents of all 371 children completed the CMQ-R. Children in the school group at the ages 6, 8, 10 and 12 years also completed a formal assessment of memory which utilised selected subtests from the first and second editions of the Wide Range Assessment of Memory and Learning, in addition to selected subtests from
the Wechsler Intelligence Scale for Children Fourth Edition. CMQ-R scores were compared to formal memory test scores and the conclusions drawn were that the two assessments of memory were weakly correlated across a range of subscales and age groups. Validation studies often compare observer memory scales to more formal measures of memory assessment and these associations have historically been weak. These conclusions directed discussions to focus on whether or not the CMQ-R is more accurately defining every day memory, and whether or not every day memory is indeed being neglected when assessing memory in more formal testing situations. Limitations to the research study included a clinical group with fewer than expected participation numbers and with less than intended participants who experienced a primary memory deficit. It was recommended that future research focus on exploring the CMQ-R’s utility in screening for everyday memory abilities in context of the everyday memory literature.

Keywords: children’s memory, memory questionnaires, everyday memory
The Children’s Memory Questionnaire - Revised

A young developing brain is susceptible to a range of influences which can cause deviations in its otherwise normal development. Impairment that occurs during this early growth period coincides with key developmental stages of childhood and can have an adverse impact on cognitive, behavioural, social and emotional functioning. The impact that memory deficits in childhood can have on everyday operation cannot be overestimated. Memory is fundamental to learning. The ability to code, store and access information is a core element. Our ability for complex thought is reliant on systems of memory. Effective reasoning requires the ability to hold task relevant information in memory while simultaneously planning and problem solving (Yeates, 2000). Language acquisition, academic skills, fine and gross motor development and the development of interpersonal skills are all at risk when memory deficits exist (Alloway, & Alloway, 2010; Alloway, & Archibald, 2010; Maehler, & Schuchardt, 2009; Sonnenberg, Dupuis, & Rumney, 2010). In addition, neuropsychiatric disorders such as attention deficit hyperactivity disorder (Alloway, 2011; Barkley, 2006), autism spectrum disorder (Alloway, & Archibald, 2010) and specific learning disabilities (Alloway, & Alloway, 2013) have been associated with deficits in memory. In the school context, children with memory deficits have been shown to have significant difficulty progressing academically at the same rate as their peers (Alloway, & Alloway, 2010), and their social and emotional development may be hindered. Given that childhood spans a number of important developmental phases and that memory plays a significant role in early development, it is essential that deficits are accurately identified so that early interventions can be developed and the debilitating consequences of memory impairments in childhood can be remediated.
There are many contributing factors that can interfere with normal brain development and some of these may result in significant impairment in cognitive and adaptive skills. A foetal brain is particularly susceptible to environmental toxicants such as industrial poisons, pesticides and metals (Dietrich, et al., 2005; Grandjean, & Landrigan, 2006; Selevan, Kimmel, & Mendola, 2000; Weitzman, 2004), as well as neurotoxicants such as cocaine and alcohol (Rasmussen, Horne, & Witol, 2006; Yeates, 2009). Rauh, et al. (2010) suggest that this is due to the early foetus’s lack of drug metabolising capabilities that do not become effective until post birth, however Perera, et al. (1999) offer an alternative explanation, that it is in part due to the ineffective workings of the immature blood - brain barrier which can allow direct transference of toxicants from a mother to the foetus. While long latency periods between exposure and outcome render the study of environmental chemicals on the foetus complex and controversial, general consensus is that due to the complex sequence of neuronal processes that occur in this time of rapid and important growth, the developing brain is particularly vulnerable to environmental contaminants with prenatal alcohol abuse considered one of the largest causes of preventable brain injury in children (Rasmussen, et al., 2006).

Epilepsy (Al-Zwaini, 2011), low birth weight (Taylor, 2009), spina bifida (Fletcher, & Dennis, 2009), childhood cancer (Ris, & Abbey, 2009) and diabetes (Northan, Rankins, & Cameron, 2006) can also interfere with normal development of the childhood brain. The Australian Institute of Health and Welfare (2010), estimate that 6.2% of babies are born with low birth weight, 4 babies born per 10,000 experience neural tube defects such as spina bifida, and while childhood cancer and diabetes are uncommon, there is still a considerable number of children affected by them each year. Given that the systems of memory are located within the brain, damage to the brain in this early developmental period has serious implications for the effective development of memory and consequently the appropriate trajectory of
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childhood.

A more common disruption to normal brain development involves traumatic brain injury (Adelson, & Kochanek, 1998; Schneier, et al., 2006; Yeates, 2009). The Australian Institute of Health and Welfare collected data over a two year period, 1999-2000, and examined all hospitalisations within Australia involving traumatic brain injury (Fortune, & Wen, 1999). This study was repeated again in 2004-05 and it was concluded that hospitalisation rates for TBI as the primary diagnosis remained the same over these years (Helps, Henley, & Harrison, 2008). These studies determined that within Australia, falls account for 41% of closed head injury, transport accidents account for 29%, and assaults account for 14%. Of the 41% of falls for the 0-14 age group, 42% involved falling from a chair and 34% involved falling from a bed. 12% of falls were attributed to slipping, tripping or stumbling, and 10% of falls involved playground equipment such as a trampoline, climbing apparatus and swing. Of the transport related injuries for the 0-14 year age group, bicycle accidents accounted for 41%. Assault made up 15% of all TBI cases, and for children in the 0-14 age group assault by a blunt object explained 10% of cases with 36% of cases being classified as occurring by unspecified means.

The most common type of traumatic brain injury involves closed head injury, where the head is subjected to a hit or knock of severe enough strength that it causes the brain to oscillate within the skull. (Granacher, 2007; Parker, 1990). Rapid movement of the brain within the skull can result in neuronal pathways being stretched or severed. In addition, significant swelling can occur resulting in the brain pushing against the skull creating pressure (Blosser, & De Pompei, 2003; Catroppa, & Anderson, 2009). Current research proposes that memory can be located within a number of cerebral areas including temporal lobes, basal ganglia, and frontal regions (Catroppa, & Anderson, 2007). The proximity of the temporal lobes within the skull to bony protrusions located on the skull’s surface, can result in the brain
hitting some of these rough areas which may result in lacerations. Temporal lobe disruption is therefore often regarded as a significant contributor to memory problems following traumatic brain injury rendering memory particularly vulnerable to head trauma (Saloria, et al., 2005; Yeates, Taylor, Wade, Drotar, & Stancin, 2002). Levin and Eisenburg (1979) go as far as to conclude that memory is the most impaired cognitive domain in children with head injury.

In contrast to adult traumatic brain injury, traumatic brain injury in children occurs during a key developmental period and can disrupt important developmental processes (Anderson, 2009; Mandalis et al., 2007; Yeates, 2009). While head injuries vary in their severity, even mild to moderate injury can result in brain trauma and consequent long-term cognitive dysfunction, although there is debate within the literature regarding the degree of injury that leads to brain trauma and the consequent long term memory dysfunction (Adelson, & Kochanek, 1998; Catroppa, & Anderson, 2002; Saloria et al., 2005; Yeates, 2009). In the past, young children’s brains have been considered able to withstand substantial brain insult, a phenomenon referred to as neural/brain plasticity (Harvey, & Jordan, 2000). Brain plasticity refers to the ability of a young developing brain to reorganise itself for optimal functioning following injury. A common belief cited in early developmental neuropsychological studies is that the earlier in development the brain damage occurs, the better in terms of functional recovery (Stiles, 2000; Kennard, 1938; Lennenberg, 1967; Finger, LeVere, Almi, & Stein, 1988). However this view of plasticity has not gone unchallenged and careful scrutiny of the evidence for this apparent recovery is important for understanding the therapeutic implications for memory disorders.

Kennard (1938), compared brain injury on infant and adult monkeys. Specific motor pathways found in the cortex were removed at various ages and functional motor skills were then compared. This study concluded that complex motor functioning occurred in the absence of significant motor areas in the brain. It was concluded that this was due to other
areas of the cerebral cortex developing more complex patterns and systems for motor functioning and therefore taking over and compensating for the original loss. This early study drew awareness to the possibility that the brain has the capacity for extensive reorganisation of functional activity. Lenneberg (1967) extended this understanding by positing that brain systems are genetically predisposed for specific functions. When development progresses appropriately these systems commit to their predetermined function. However, if something interferes with this normal trajectory, such as brain damage, other areas can reorganise and different patterns of functioning can take place. Lenneberg reported that in the early stages of development the available systems are not yet entirely committed to their predisposed system of functioning. This results in a flexibility to alter their pathway if needed in order to compensate for an area not functioning well. Lenneberg further argued that this ability for change does not last long. As a brain matures, its neural resources gradually commit to specific functions, once committed these systems lose their flexibility for change. According to his view young brains have better potential outcomes following injury than older ones.

Not all the available literature supports these early theories. Indeed recent studies have concluded that young brains are particularly susceptible to damage and in fact have a worse prognosis the earlier the damage occurs (Spencer-Smith et al., 2011). Hermann, et al. (2002), using MRI, systematically explored the neurodevelopmental correlates of childhood onset epilepsy and brain structure as a function of age at onset of recurring seizures. This study concluded that the younger the child at onset of seizures, the greater risk for brain abnormalities and cognitive dysfunction. Further support can be found in O’Leary, et al. (1983). Neuropsychological data from 106 children of varying ages diagnosed with epilepsy were examined. It was concluded that children whose seizures began prior to 5 years old performed significantly worse on measurements of intelligence than those whose seizures began at a later age. An unfortunate limitation to this study was the failure to include control
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groups, which limited its ability to draw meaningful conclusions with regards to the severity of the cognitive deficits associated with seizures.

Studies into neural plasticity have continued to report mixed results and Stiles (2000) offers a distinct perspective to brain plasticity which may help to explain this. She suggests that normal brain development is a function of genetic predisposition, cortical self-organisation, and environmental input. She suggests that the brain does not follow a predetermined path to development that reorganises as a response to injury. Rather, normal brain development is dynamic and flexible and the adaptive re-organisation that is seen when brain injured individuals are examined is in fact normal neural organisation. Stiles suggests that brain plasticity is not a phenomenon that is triggered in response to injury rather it is the normal process of flexible self-organisation that is active and reciprocal and is a central feature of brain development. When injury disrupts this normal progression, specific neural resources are lost and while other areas of neural activity adapt and compensate there remains a consequent impairment of the system.

Stiles theory lends some support to the more recent data which suggests that children’s brains and specifically the systems of memory are particularly vulnerable to trauma (Anderson, 2009; Anderson, Catroppa, Rosenfeld, Haritou & Morse, 2000; Dennis, 1989), in contrast to adult traumatic brain injury, traumatic brain injury in children occurs during a period of large developmental growth. Traumatic brain injury can not only damage areas of the brain which impedes specific functions, but can also cause secondary problems by disrupting important developmental processes (Anderson, 2009; Yeates, 2009). Consequently, traumatic brain injury that occurs during the development of skills appears to have a bigger functional impact than when it occurs following the completion of skill development (Sonnenberg et al., 2010).
Problems with memory functioning in children can result in impaired learning across a broad range of areas, as the ability to store and retrieve information is important for skill acquisition (Yeates, 2000). For children, an interruption in the natural flow of brain development that results in difficulties with memory and learning, have pervasive implications across all areas of social, emotional, academic, and behavioural development (Anderson, 2009; Dennis, 1989). Catroppa and Anderson (2007) found that post injury memory skills were shown to be significant predictors of academic success 24 months later. Furthermore, as skill development continues over a life span, deficits in memory can have a cumulative effect (Anderson, et. al., 2000).

When considering effective interventions for individuals that are experiencing deficits in information processing systems, it is imperative that psychologists understand which aspects of the cognitive system are problematic and how this can impact on everyday life. Early theories of memory conceptualised it as unitary construct (Milner, Corkin, & Teuber, 1968), however it is currently accepted that memory consists of many distinct processes (Glietman, Fridlund, & Reisenberg, 1999). It is only when the strengths and weaknesses of specific features of memory are accurately identified, that psychologists can effectively link the evaluation of memory dysfunction to helpful remediation strategies.

**Systems of Memory**

**Short Term Memory**

Historically research into memory has treated it as a unitary construct (Putzke, Williams, Adams, & Boll, 1998). However neuropsychological studies exploring the nature of memory in amnesic patients have provided compelling evidence that memory consists of more than one system. In a famous case originally cited in Milner et al., (1968) and later described by Baddeley (1982), a man known as HM required an operation on the temporal lobes to aide in the management of epilepsy. During the post recovery period it was
discovered that while the epilepsy had responded well to treatment HM sustained serious difficulties with memory. HM retained his ability to rehearse new information in short term memory, and he remained able to access memories that prior to the operation were stored in long term memory. However, he was no longer able to transfer any new learning to permanent storage. This study and others like it (Hodges, 1995; O’Connor, Verfaellie, & Cermak, 1995), concluded that some individuals who were experiencing amnesia, were able to have intact long term memories despite an inability for new learning and to recall recent events. Conclusions such as these resulted in the proposal of two memory stores, and to the generation of further research investigating this concept.

The Modal Model (Atkinson, & Shiffrin, 1968) has dominated theoretical approaches for the past forty years. It posits that Memory can be divided into three principle components: The Sensory Register, Short Term Memory, and Long Term Memory. According to the Modal Model, the Sensory Register identifies all sensory input, it stores this information for a few seconds, before it is either passed on to short term memory or is forgotten. Once in short term memory active control processes occur such as determining where to direct attention, how to code new information, when to rehearse, and which retrieval cues to use. According to the Modal Model, short term memory has a limited capacity and a short duration. It is the system responsible for the temporary storage of information during the performance of cognitive tasks. By rehearsing information in short term memory it can be transferred into long term memory for further indefinite storage.
The Modal Model is not without its opposition and the debate on whether memory is a unitary or fractionised system continues. Melton (1963) offered an interesting critique on the topic of unitary versus compartmentalised memory systems and suggested that short term memory is more accurately identified as an active component of long term memory. Tulving (1966) argued that simply holding information in short term memory was not enough to ensure it proceeded into long term memory. Craik and Lockhart (1972) provided evidence to suggest that levels of processing, served as a more profitable explanation when attempting to understand memory. Bresler and Kelso (2001) argue that memory cannot be conceptualised as existing within independent structures, unitary or as dual systems, as brain functioning is reliant on complex coordination of widely distributed interconnected areas.

Despite the controversy, the two-system theory of memory persists. Baddeley and colleagues (Baddeley, & Hitch, 1974; Salame, & Baddeley, 1982; Vallar, & Baddeley, 1984; Baddeley, 2003), suggested replacing the short term memory store proposed by the Modal Model with a theory that incorporates three short term subsystems. The three component working memory model includes: The Phonological Loop, the Visual-Spatial Sketch Pad, and
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the Central Executive. The Phonological Loop consists of two components which include a storage system (the phonological store), and a process (the articulatory control). It is assumed that information in short term memory decays over time and therefore requires a rehearsal process in order to remain accessible. The phonological store contains verbal information for a brief duration before passing this information on to the articulatory control. The articulatory control can then refresh the verbal information by sub vocal rehearsal thus maintaining information in the store. It is posited that this phonological loop is essential in the acquisition of reading and language skills.

According to this theory, the Visual-Spatial Sketch Pad is the system responsible for processing visual and spatial information. Similar to the phonological loop, the visual spatial sketch pad has two components to it. It can convert visual information for phonological storage (grapheme to phoneme conversion) and can also refresh the information with sub vocal rehearsal. The phonological loop and the visual spatial sketch pad serve the Central Executive, the most important element of the three components. The Central Executive is responsible for the selection and operation of strategies and manages the division of attention.

![Diagram of Working Memory Model](image)

There is some disagreement in the literature as to whether Short Term Memory (STM) and Working Memory (WM) represent the same memory system or whether they are two distinct components. Baddeley’s original paper used the terms STM and WM interchangeably when referring to the entire short term system and when distinguishing between STM and LTM. In using the term WM, he acknowledged that the STM system did more than just store information, it also worked with that information to transform it. However over time researchers have begun to distinguish between the two terms. Using the term WM to refer to the whole short term system, reserving the term STM to refer to the storage component of the phonological loop (also referred to as verbal STM) and the visual-spatial sketchpad (also referred to as visual STM) (Gathercole, & Alloway, 2008). WM for the purpose of this paper refers to the active working component of the short term system, often defined as the ability to hold information short term, while performing a further operation with additional information. The term STM is used when referring to the short term passive storage of information in verbal and visual memory (Swanson, 2001).

Based on evidence primarily from patients with frontal lobe damage, Baddeley (1996) suggest that the central executive have four primary roles; focussing attention, dividing attention, switching attention, and linking the short term memory system with the long term memory system. Baddeley (2000) offered the Episodic Buffer as a fourth dimension in the working memory model to help explain how the central executive links short and long term systems of memory. In this theory, the episodic buffer is a temporary storage system that aides the central executive in consolidating information from different modalities. While the phonological loop stores verbal information and the visual spatial sketch pad stores visual spatial information, the episodic buffer can store all codes of information. By collaborating with the central executive, the episodic buffer can group similar pieces of information from
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different modalities which can form new cognitive representations. The episodic buffer can feed and retrieve from long term memory.

Figure 3. The Episodic Buffer (Baddeley 2000). Reproduced with permission from Elsevier.

Executive Functions

While Baddeley’s working memory model referred to the central executive as a unitary construct, subsequent research has demonstrated that this is too simplistic. The central executive is now referred to as the Executive Function and is more likely composed of multifaceted fractionised yet interrelated components (Anderson, 2011; Willoughby, Wirth, & Blair, 2012) and while it remains strongly associated with working memory, the executive functions are distinct from it. There is substantial controversy in the literature regarding a clear definition of executive functions and due to the complex and multiplicity of the construct, definitions are often broad and general. However, Barkley (2012) in an attempt to describe the executive functions in more specific terms has suggested that executive functions refer primarily to self-regulating behaviour; specifically, to modifying behaviour so as to attain a future goal. Lezak (1982) suggests that executive functions are mental capacities that are necessary for formulating goals, planning how to achieve them and carrying out the plans.
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effectively. Anderson (2011) describes the key elements of executive function as including:
anticipation and deployment of attention; impulse control and self-regulation; initiation of
activity; working flexibly and utilisation of feedback; planning ability and organisation;
selection of efficient problem solving strategies.

Attention processes are an essential component of the executive functions and
Barkley (1997) goes as far as to state that the executive system is a form of attention. This
association between attention and executive function can be deduced from the strong
association between sustained attention, inhibition, and shifting attention with future oriented
goal directed behaviour that is the core purpose of the executive functions. That working
memory has a limited capacity is well known. The strategy utilised to manage such
constraints is attention. Therefore the ability to direct, focus and divide attention is indeed a
crucial element of short term working memory and it is the executive functions that manage
this.

Long Term Memory

Once again a system that used to be considered a unitary storage system is now
understood to contain a number of subsystems and there is significant debate in the literature
as to just how many subsystems there are (Baddeley, 1984; Squire, 1992; Tulving, 2013).
Squire’s approach (1992) divided long term memory into two primary systems, Declarative
Memory and Non Declarative Memory. Declarative Memory refers to Memories that can be
consciously recalled and verbally declared: facts and events. Non Declarative Memory refers
to skills and habits, conditioning, and priming. Declarative Memory is further divided into
Episodic Memory and Semantic Memory. Episodic Memory stores autobiographical
memories. It contains information that provides context for the experiences recalled, such as
the when and where events happened. Episodic Memory Stores contain memories of our
personal experiences. In contrast, Semantic Memory contains general knowledge, including
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facts and words, information that is not related to experiences.

Non declarative Memory consists of procedural learning (having the skill set to drive a car), and priming (the ability to respond to something based on a past experience which cannot be readily recalled). It refers to performance that relies on past experiences however it occurs independently of conscious attempts to recall it.

Tulving (1983) offers an alternative explanation and his theory remains the foundation that current assessments of memory are based on. Tulving originally proposed that long term memory consists of three distinct memory systems: procedural, semantic and episodic. However in a revision of this he posits that all three systems form a hierarchy in which episodic memory is a subsystem of semantic memory and semantic memory is a subsystem of procedural memory (Tulving, 1985). In Tulving’s theory, procedural memory refers to how things are done and to the development of automatic skill sets, such as driving a car. It is reliant on a non-knowing consciousness and refers to the ability to sense and react without conscious awareness. Unlike semantic and episodic memory, procedural memory requires more than observing, it requires overt behavioural responding. In addition, procedural

**Figure 4.** Adaptation from Squire’s 1992 model of long term memory system.
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Memory does not describe events; rather it is a set of rules that allow for the knowledge of how to do things without containing information about where or when the skill was learnt.

Semantic memory refers to the acquired knowledge that individuals possess about the world, such as knowing what the capital of Australia is. Semantic memory relies on a knowing consciousness and refers to an awareness of internal and external experiences which contributes to an ability to represent states of the world that are not physically present.

Episodic memory refers to the ability to remember personally experienced episodes. It relies on a self-knowing consciousness which allows an individual to become aware of their own contribution in their existence and contributes to the ability to develop knowledge about personally experienced events. Episodic memory relates remembered events about past experiences to an individual’s self-identity in order to make the remembered event meaningful. When considering the assessment of memory, it is episodic memory that is most relevant as it is most amenable to measurement.

Memory can also be understood in terms of visual and verbal memory capacities. Verbal Memory refers to an ability to learn, store and retrieve verbal information. In contrast, Visual Memory refers to an ability to learn, store and retrieve visual information (Schwartz, 2014). Support for this distinction can be seen in research that explores non-verbal learning disabilities. Non-verbal learning disabilities (NVLD) are characterised by a pattern of visual cognitive abilities substantially weaker than verbal cognitive abilities. Included in the range of deficits for this disorder is a significant deficit in visuospatial working memory (Mammarella, Pazzaglia, & Cornoldi, 2008) and a stark difference between verbal and visual long term memory (Rourke, 1995). Lidell and Rasmussen (2005) compared children with non-verbal learning disorder to normally developing children using the visual and verbal subtests of the Children’s Memory Scale (CMS; Cohen, 1997) and concluded that those with NVLD scored significantly lower on tests of visual memory when compared to verbal
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memory. Mammarella, and Pazzaglia (2010) offer further support for this distinction. They investigated the visual memory deficits in children at risk of NVLD compared to controls who were matched for verbal abilities, age, gender and socio-economic status. Participants were exposed to four computerised tests from a visual working memory test battery. Results concluded that children with risk of NVLD failed in three out of four visual working memory tasks, these results were statistically significant when compared to controls. Further support for the verbal/visual distinction is available when considering individuals who experience specific language disorder. Specific Language Disorder is defined by delayed language acquisition for individuals who experience normal intellectual functioning, intact hearing, and normal non-verbal abilities (Ricco, Cash, & Cohen, 2007). Characteristic of this disorder is intact visual memory skills and impaired verbal memory skills - particularly with short term auditory memory as represented by the phonological loop which is involved in processing speech sounds (Baddeley, Gathercole, & Papagno, 1998).

Menghini, Carlesimo, Marotta, Finzi, & Vicari (2010) investigated the specific learning deficits associated with developmental dyslexia and concluded that individuals with this disorder have significant difficulties in both verbal and visual memory abilities. Typically, dyslexia is defined as a significant difficulty in acquiring the skills necessary to develop reading ability. It is commonly understood that dyslexia is a phonological disorder which is characterised by a difficulty processing the sounds of language. However there is an alternative hypothesis that individuals with dyslexia also experience a visual processing disability. Menghini and colleagues investigated the long term memory deficits in individuals with developmental dyslexia in order to determine if there is indeed any deficit in visual long term memory. Two groups of 60 children aged 8-15 years were compared. One group had a formal diagnosis of developmental dyslexia, the other group contained individuals with normal reading abilities. All children were assessed with a word list learning task (assessing
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verbal long term memory); this task involved orally presenting each child with a list of semantically unrelated words and requiring the children to repeat as many words as they can recall. Children were also assessed with a visual-object learning task (assessing visual long term memory); this task involved presenting each child with a visual representation of common objects followed by exposure to drawings which depicted a range of common objects. Children were then required to select the pictures that represented the previously shown objects. A visual-spatial learning task was also utilised (assessing visual-spatial long term memory skills). This involved showing children a page that was divided into four with visual depictions of common objects in each quarter. Children were later required to recall which position the object had held when it was previously presented. Results of the study concluded that children with dyslexia demonstrated a significant deficit in their ability to achieve across all three verbal and visual long term memory tasks compared to the normally reading children. The authors concluded that they concur with the much documented view that verbal long term memory deficits were a consequence of phonological processing difficulties. However they add that individuals with dyslexia also experience challenges with visual perception and visual spatial capacities.

Everyday Memory

Ulric Neisser (1978) in an address that he presented at the International Conference on Practical Applications of Memory identified the irony that there was over one hundred years of research into memory yet very little of the research explored memory as it applied to everyday life. Neisser acknowledged the significant contribution that memory research had provided with regards to furthering scientific understanding of the mechanisms of memory; memory models reflecting information storage and retrieval systems. However his scathing review also reported that these theoretical explanations did very little to further scientific understanding into the practical problems of memory as applied to every day experiences;
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every day memory studied in natural settings. Neisser stated that as long as memory theories continue to be based on the performance of individuals in formal laboratory settings, little will be little learnt about the natural behaviour of memory and its everyday uses. Neisser challenged his colleagues to remove the study of memory from the laboratory, and embark on a more realistic study of memory as it impacts activities of daily life. Neisser’s thesis sparked a growth in awareness that the memory skills studied in the laboratory may be very different to the memory skills required for everyday living (Conway, 1991; Efklides et al., 2002; Greneberg, Morris & Sykes, 1991; Vallat-Azouvi, Pradat-Diehl & Azouvi, 2012).

While formal testing of memory is useful to quantify individual cognitive capacity, it may be limited when attempting to generalise this information to describe individual coping, and may not accurately characterise memory as it is applied to the complexity of everyday memory functioning. Support for this line of thinking can be found in scientific studies which have repeatedly shown that individuals can perform well on laboratory based measures of memory yet continue to experience clinically significant deficits in memory skills when applied to day to day real life functioning (Shallice & Burgess, 1991; Lezak, 1995).

Memory as applied to real life and required for effective day to day performance is known as Everyday Memory (Anderson, 2014a; Magnusen & Hestrup, 2007; Stein, 2013). It has also been referred to as natural memory and in more recent times has been labelled functional memory (Anderson, 2014a; Anderson, 2014b). Examples of everyday memory for children and adolescents are: recalling names and phone numbers, remembering complex teacher instructions, and remembering to do homework (Chen et al., 2013). Further examples are: remembering items to buy while out shopping, remembering to complete a specific chore at a specific time, and remembering to ask someone something (Jones, 2011). The focus is on the functional role of memory in daily life. The measurement of everyday memory involves tasks that simulate day to day natural activities (Cornish, 2000). Recent studies have found
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that deficits in everyday memory can be found in children and adolescents with very low birth weight (Narberhaus et al., 2007), autism spectrum disorder (Jones, 2011), and developmental co-ordination disorder (Chen et al., 2013).

Stein (2013) assembled a collection of work which focussed on the constructive process of everyday memory. This collection of work emphasised that memory for everyday events involves interpretation and inference. Stein and colleagues asserted that it is during the process of understanding, that events take on meaning and significance which in turn shapes recall. Ceci and Bronfenbrenner (1991) in support of the everyday memory research articulated that human beings are constantly interacting with their environment and as a result, behaviour, development, and learning are influenced by this interactive process. It is suggested that this process cannot be easily measured or further understood with a well-structured neurological assessment. They further asserted that laboratory based findings when considered in isolation can mislead researchers as they do not fully consider behaviour in its practical application.

Anderson (2014a) theorised that an important component that is missing when reducing memory to a structural arrangement of retrieval and storage systems, is that memory, when engaged in everyday functioning, integrates judgement and inference and that these are essential elements when applying memory to real life every day tasks. Anderson proposed that the assumption that memory is separate to inference and judgement is inaccurate, and that it is this mistaken assumption in traditional memory research that has impeded advancement into the scientific endeavour to fully qualify memory and its complexity.

Crook and Larrabee (1988) argued that the environmental relevance of memory constructs and subsequent assessment is an important issue due to the nature of memory complaints. They suggested that typically, individuals present for memory testing either because they are having problems with memory in everyday life, or have suffered some form
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of head trauma that will eventuate in problems with memory in everyday life. Therefore understanding how memory deficits impact an individual’s ability for normal everyday functioning is of central relevance. Crook & Larrabee attempted to bridge the gap between laboratory based memory assessment and environmental studies of every day memory. They presented a preliminary study of every day memory using a battery of tests designed to simulate daily life tasks, however also took into account the factors of memory that the Weschler Memory Scale (WMS; Wechsler, 2009) measures, in addition to the specific tasks that the WMS used to assess these factors. For example in an attempt to reflect the Digit Recall test of the WMS in an everyday memory task, Crook and Larrabee developed a telephone dialling task that required participants to dial an area code, a local number and long distance number, reflecting a number recall task of three, seven and ten digit numbers. Immediate and delayed recall was assessed using facial recognition of real life people. Further tasks included a misplaced objects task, and a narrative recall test requiring a recall of factual events following the watching of a television news program. This study primarily explored the factors in the WMS and whether or not they were reflected in their current battery of every day memory tasks. They concluded that their assessment tapped into a general verbal and visual memory factor similar to the WMS, as well as two attentional factors and a psychomotor speed factor. Crooke and Larrabee concluded that the factorial dimensions of the WMS were also reflected in their assessment of everyday memory.

Similarly, Sunderland, Harris, & Baddeley (1983) compared formal test performance of individuals with head injury to self-descriptions of everyday memory functioning. They developed a list of 35 different types of everyday memory errors that they considered reflected three important elements; representation of a broad range of typical errors, reflecting the types of error that the majority of participants could potentially make, and based on current memory research. The 35 items were grouped into five categories: 1. Speech: eg.
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Forgetting the names of friends or relatives or calling them by the wrong names; 2. Reading and Writing: eg. Forgetting what the sentence you just read was about and having to re-read it; 3. Faces and Places: eg. Failing to recognise friends or relatives by sight; 4. Actions: eg. Forgetting to do some routine thing which you would normally do once or twice a day; 5. Learning New Things: eg. Unable to remember the name of someone you met for the first time recently. Participants and their spouses completed the form, each rating the memory errors of the participants. The results of these questionnaires were compared to the results of a battery of formal objective memory tests. Results concluded that the formal memory assessments accurately identified memory deficits in response to head injury however were unrelated to complaints regarding everyday memory skills.

Toplak, West and Stanovich (2013) explored performance based measures and rating scales as used for typically assessing executive function in clinical and neuropsychological assessments. The associations between these two styles of assessment were explored across 20 studies which included 13 child and 7 adult samples. Performance based tasks were typically characterised by highly standardised administration conditions with a single examiner. In contrast, rating scales were completed by informants and typically required a response on a Likert scale to questions about behaviours. The study reported that the most commonly used rating scale of executive function was the Behaviour Rating Inventory of Executive Function (BRIEF; Giola, Isquith, Guy, & Kenworthy, 2000). Toplak, West and Stanovich hypothesised that if performance based measures and rating scales of executive functions are assessing the same constructs, then the two should be strongly associated and statistical analysis should produce results indicating a strong positive correlation. However this was not the case. Correlations between performance based measures and rating scales of executive functions were low and the conclusion drawn was that the two different types of measures were assessing different aspects of cognitive functioning. The implication of this
result suggests that as the two types of assessment were measuring different domains they cannot be used interchangeably. Rather, each assessment style provides different types of important and valuable information. Further, it is considered possible that rating scales are more relevant than lab based assessments in terms of functional everyday outcome and may be better at predicting functional problems.

Ecological validity refers to the extent that a clinical assessment accurately represents performance outside of the laboratory. The ability to generalise the results that are found in clinical settings to every-day life is therefore considered to be an important element when studying everyday memory (Burges et al., 2006). In contrast, Banaji and Crowder (1989) criticized the everyday memory approach and suggested that studies that are high in ecological validity may be low in generalisability. They suggested that due to the multiplicity of uncontrolled variables in the study of everyday memory, generalisability is impaired. In addition, these researchers stated that while the study of memory in its natural environment may appear ecologically valid, when explored at a deeper level, everyday memory studies have not resulted in any new principles of memory, or new methods of data collection, or any further understanding of memory constructs, and thus compromises the value of scientific research. While they concurred that observational studies have merit in attempting to define the phenomena under study, such as social behaviour, they disputed the idea that the study of memory requires this. The view portrayed by these researchers has led to controversy within the field with some researchers indicating that there is little scientific merit in Benaji and Chowder’s arguments (Ceci, & Bronfenbrenner, 1991; Conway, 1991; Gruneberg, Morris, & Sykes, 1991). However, a third position on this particular debate suggests that the Benaji and Crowder’s critique was largely misunderstood citing that both sides of the controversy are arguing for the benefits of experimental control and generalisable results occurring for studies conducted outside of the laboratory (Roediger, 1991). Regardless of the debate there appears
to be growing interest in the importance of everyday memory and its contribution to the ecological validity of memory assessment, and there are many studies supporting the possibility that formal measures of assessment do not necessarily assess every day memory.

**Memory Deficits in Children**

Problems with memory functioning in children can result in impaired learning across a broad range of areas as the ability to store and retrieve information is important for skill acquisition (Yeates, 2000). For children, an interruption in the natural flow of memory development has pervasive implications across social, emotional, academic, and behavioural development (Anderson, 2009; Dennis, 1989), it appears to be associated with general intellectual ability (Alloway, & Alloway, 2010), and is predictive of academic achievement (Gathercole, & Alloway, 2006). Normal childhood development involves an incremental progression towards the acquisition of complex knowledge and skills, impairments in memory make this development slow and troublesome and have important consequences for children’s ability to acquire knowledge and develop skills at the appropriate rate. Impairments in memory have been associated with a range of acquired and developmental disorders of childhood.

Attention Deficit Hyperactivity Disorder (ADHD) is a developmental disorder characterised by a persistent pattern of inattention and/or hyperactivity-impulsivity (American Psychiatric Association, 2013). Children with ADHD typically experience difficulties with attention and in particular with persistence of effort sustaining their attention to tasks (Barkley, 2006). ADHD has been associated with a number of negative consequences and one of the most concerning is poor academic functioning (Alloway, 2011; Barkley, DuPaul, & McMurray, 1990; Gathercole, & Alloway, 2006.). While there are mixed results when considering if children with ADHD experience difficulties in long term memory (Ballesteros, Reales, & Garcia, 2007; Aloise, McKone, & Heubeck, 2004), on measures of working
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Many researchers have found significant differences between individual’s with ADHD and control groups on measures of working memory (Myatchin, Lemiere, Dankaerts, Lagae, 2012) with some finding particular deficits in the executive functions (Tillman, Eninger, & Bohlin, 2011), others in verbal working memory (Barkley, 2006) while more recent studies have provided a strong argument for specific deficits in visual working memory (Rhodes, Park, Seth, & Coghill, 2012; Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005). Tasks typically assessing verbal working memory include the oral repetition of mental computations, the repetition of verbal material across delayed trials and reciting digit spans (Barkley, 2006). The Digit Span subtest of the Wechsler Intelligence Scales for Children is considered a reasonable measure of verbal working memory (Ownby, & Matthews, 1985). Frazier, Demaree, & Youngstron (2004) in their meta-analysis of twelve studies that assessed verbal working memory and Digit Spans, concluded a significant deficit on this subtest for children with ADHD. Similarly, Zental and Smith (1993) explored the association between the Freedom from Distractibility Factor on the Wechsler Intelligence Scale for Children - Revised which includes a Digit Span subtest, with individuals with an ADHD diagnosis. After controlling for confounding cognitive variables Zentral and colleagues concluded comparable results. Hutchinson, Bavin, Efron, and Sciberras (2012) compared working memory profiles in school aged children with ADHD and specific language impairment to determine if difficulties with verbal working memory were distinct to individuals with ADHD or if they were due to a comorbid language disability. This study collated data from four groups of children between the ages of 6-9; Children with ADHD, children with language disability, children with comorbid language disability and ADHD, and a group of typically developing children. Conclusions drawn from this study indicated that children with ADHD,
specific language disability, and comorbid language disability and ADHD performed poorly on measures of working memory when compared to controls. However, while children with language disorder performed poorly on measures of verbal working memory (the phonological loop), children with ADHD did not. Further, for the comorbid group, scores on verbal working memory were no different than for the language disordered group suggesting that having the additional disorder of ADHD did not further reduce verbal working memory skills. These results argue that working memory is impaired in children with ADHD however it is not due to verbal working memory, rather is attributed to executive dysfunction and visual spatial memory. While studies are producing conflicting evidence as to which aspects of memory contribute the most to difficulties with ADHD the overall consensus within the academic literature is that deficits in short term working memory and ADHD are associated (Martinussen, et al., 2005).

Autistic spectrum disorders are characterized by impairments in social interaction and communication, and by restricted or repetitive behaviours and interests (American Psychiatric Association 2013). A number of studies have examined memory functions in people with Autism Spectrum Disorders and these have revealed that short-term memory is intact (Bennetto, Pennington, & Rogers, 1996) and long term semantic memory is intact, however episodic memory appears to be significantly impaired (Bowler, Gardiner, & Grice, 2000, Salmond et al., 2005). Salmond, Adlam, Gadian, and Vargha-Khadem (2011) compared the episodic memory deficits in four cohorts of children; children with Autism, children with Developmental Amnesia, children born prematurely, and a control group. All three groups were administered the Rivermead Behavioural Memory Test (RBMT; Wilson, Cockburn, & Baddeley, 1991) and a direct comparison of episodic and semantic memory was explored. The results indicated that all three experimental groups demonstrated a consistent pattern of episodic memory impairment and intact semantic memory. Lind and Bowler (2008) presented
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a case for the importance of autonoetic consciousness (a self-knowing awareness) for the effective functioning of episodic memory and it has been well documented that individuals with autism have a great deal of difficulty placing themselves in context of personal experiences and are less aware of themselves in relation to other people (Millward, Powell, & Messer, 2000). It is likely that this difficulty in self-awareness that is a fundamental characteristic in autism spectrum disorders is a major contributor to episodic memory impairment in individuals with this neurodevelopmental disorder.

Deficits in memory have also been associated with learning disorders and deficits in working memory are being discussed as a likely causal factor (Maehler, & Schuchardt, 2009; Maehler & Schuchardt, 2011). As previously indicated, working memory refers to the ability to store information for a brief period of time, while manipulating additional information. It requires the help of the short term storage systems and collaborates with the executive functions. When considering the skills that are necessary for effective reading, words must be processed via the phonological loop and stored in verbal working memory while utilising the executive functions to consider additional information in order to make decisions about meaning. Likewise for maths problems, children are required to hold numbers in memory for a brief time while completing a computation or additional manipulation with further information. Children with identified reading and maths disorders have been shown to perform poorly on tests of working memory (Maehler & Schuchardt, 2009; Watson & Gable 2012).

Swanson, Jerman, and Zheng (2008) explored improvements in math’s abilities as a function of improvements in working memory skills amongst children with and without math’s disability. This study utilised measures that typically assessed working memory (susceptibility to interference, naming speed, and phonological coding) and compared them to children’s math skills across three years. While results of this study concluded that executive
function had the greatest influence on problem solving, it was further concluded that children identified as at risk for serious math’s problems also showed less growth across the ages in working memory. Swanson (2003) explored the differences in working memory across various age groups for skilled and unskilled readers. Children with identified reading disabilities across four age groups, 7, 10, 13 and 20 were assessed with tasks that measured working memory. Results of this study concluded that poor reading skills were associated with poor working memory skills and strong reading skills were associated with strong working memory skills. Further the age related growth in working memory for skilled readers, was reflective of expected developmental progression, while poor readers demonstrated minimal age related changes.

Swanson and Jerman (2007) conducted a longitudinal study into whether or not children with reading disabilities, children with maths disabilities, children with both reading and maths disabilities, and children without learning disabilities varied in phonological memory and/or working memory. They assessed 84 children aged 11-17 three times at yearly intervals and a battery of memory measures were administered. The results of this study concluded that poor working memory was significantly correlated with children experiencing reading problems, and with children experiencing reading and maths problems and that this association remains even when deficits in phonological processing have been statistically controlled for. This is in contrast to the more traditional view that reading difficulties are primarily associated with a specific deficit in phonological processing (Shankweiler, & Crain, 1986). This is of significance when planning intervention strategies. Often the intervention for reading disorder is intensive focus on phonological processing without any emphasis on interventions that address deficits in working memory. The Swanson and Jerman study showed that poor working memory development is a major contributor to reading and maths disorders and therefore supports the idea that providing a convenient and accessible way to
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assess children’s memory abilities is essential if effective intervention strategies are to be provided. It was the aim of this study to develop a tool that is able to identify potential memory deficits in children.

While the majority of research into memory deficits in children with learning disorders has focused primarily on working memory, there are some studies that expose the consequences of long term memory deficits. Geary (2007) concluded that children who experienced significant difficulties with mathematics also experienced significant difficulties retrieving facts and recalling information from their long term memory, a theory that is supported by Andersson (2008). Reading disorders have traditionally been attributed to specific defects in working memory and in particular phonological processing (Swanson, 2001), however more recent studies are beginning to conclude that impairment occurs across a broader range of cognitive processes (Menghini, et al., 2010). Vicari, et al. (2005) suggested that individuals with reading disorders experienced impairment in implicit learning, while Waber, et al. (2003) contested this view. Menghini, et al. (2010), argued that reading disorders are not only restricted to deficits in short term memory; phonological processing and working memory, rather, are also resultant from deficits in long term memory. They explored the nature of long term memory deficits in reading disorders and concluded that for children with clinically diagnosed dyslexia, there was an associated clinically significant impairment in episodic long term memory capacity.

Impairments in children’s memory have been associated with a range of acquired and developmental disorders and it can be difficult for clinicians to discriminate between specific memory dysfunction and other contributing factors, such as difficulties with attention, language, and intellectual disability. The main avenue for clarification is formal assessment of memory, which requires assessment of a broader range of cognitive functions conducted by a specialist and can be a lengthy and expensive process. In addition, there is some
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controversy as to the appropriateness of assessing children’s memory skills with formal methods of assessment which may not be related to a child’s functional ability. While it can be difficult for health professionals to determine the significance of memory impairment in childhood disorders, it is critical to do so. Memory deficits affect learning and therefore the academic and social development of the child. Accurate and early identification of children with memory deficits can provide optimal opportunity to reduce the functional impact of the impairment, and significantly improve the quality of an individual’s life. It would therefore seem appropriate to develop a tool to aide in the process of early and accurate identification. An assessment tool, such as a memory questionnaire, could quickly and effectively screen children for whom further testing would be of benefit.

**Current Methods of Memory Assessment**

**Formal Assessment of Memory**

Formal assessment of memory involves thorough neuropsychological testing often including however not limited to, the Wide Range Assessment of Memory and Learning - 2nd edition (WRAML2: Sheslow & Adams, 2003), the Wechsler Memory Scale - Fourth Edition (WMS-IV: Wechsler 2009), or the Neuropsychological Assessment Battery - Memory Module (NAB-M: Stern & White 2003). The WRAML 2 is the preferred method of formal memory assessment due to its strong psychometric properties, its recently revised standardisation, and its breadth in age range (Hartman, 2007)

While the efficacy of the WRAML2 has been demonstrated consistently there still remains some concerns with using formal memory testing as a way to assess memory. Formal memory assessment is a timely and costly procedure, it only has the capacity to assess memory on the isolated occasion of assessment, and the administration of formal memory assessment is reserved for professionals who specialise in the area. This renders the
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WRAML2 as inaccessible to school age children who might require formal assessment. Further concerns are due to the previously mentioned ecological validity, which refers to a test’s ability to reflect real world performance. Formal testing of memory is useful to quantify individual cognitive capacity however it may be limited when attempting to generalise this information to describe individual coping, and may not be accurately characterising memory as it is applied to everyday functioning. Understanding how memory deficits impact an individual’s ability for normal everyday functioning is crucial when attempting to devise interventions that aide the natural progression of childhood.

Memory Questionnaires

Neisser’s 1978 disparagement of scientists who typically study memory in the laboratory sparked a growth in awareness that objective memory assessment may be measuring very different memory skills to the ones required for everyday living. However, while self-report memory questionnaires offer an inexpensive and time efficient way to assess memory, they are not without their flaws. When requiring an individual with a potential memory impairment to assess their own memory abilities it exposes the results to potential error as individuals may not accurately remember their own performance. This is particularly evident with individuals with amnesia who typically do not remember their incidences of memory failure and are often unaware of the extent of their deficits. In addition, young participants may not have developed the skills necessary for effective insight and may therefore be less reliable when required to estimate their own performance. Not surprisingly, Sunderland, et al. (1983), when examining the validity of the Everyday Memory Questionnaire (EMQ), concluded that it did not provide an accurate reflection of memory abilities when completed by the participant. However, the validity for the EMQ increased, when a relative on the participant’s behalf completed it. This is primarily due to self-report
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measures being limited by an individual’s capacity for introspection and their ability to
accurately judge their own skills. In contrast, recruiting a parent, carer or partner to rate their
observations of another’s memory skills allows for some objectivity and potentially more
accurate reporting. Studies have since replicated these findings. Gonzalez, et al., (2008),
engaged 400 children with normally developed memory abilities and 44 children with known
memory deficits all between the ages 6 - 16, and their parents. Parents completed a 27 item
questionnaire querying their child’s memory function in everyday scenarios and all children
participated in a selection of objective memory tasks. Clinical sensitivity was then examined
by comparing the results of children with known memory deficits to those of the normally
developing children. The conclusions of this study indicated that the total sample of children
with known memory deficits scored more than one deviation below the mean of the control
group on the memory questionnaire. Once more this supports the theory that memory
questionnaires are a viable way to measure memory abilities and that obtaining information
from carers is a valid addition to memory assessment procedures.

However there remain some difficulties with observer rating scales that must also be
given due consideration. When parents are required to rate their children’s memory they may
be biased in their views, they may provide environments that compensate for the children’s
memory difficulties which disguises true needs, and/or they may differ in their perceptions of
problematic behaviours. Despite these methodological concerns, observer rating
questionnaires have been established as an effective tool to assess a range of cognitive,
social/emotional and behavioural functions; for example the Behaviour Rating Inventory of
Executive Functions (BRIEF; Gioia, Isquith, Guy & Kenworthy 2000), the Achenbach
System of Empirically Based Assessment (Achenbach, & Rescorla, 2001) and the Conner’s
Rating Scales - Revised (Conners, 2001).
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Drysdale, Shores, & Levick (2004) modified the Everyday Memory Questionnaire (EMQ; Sunderland, et al., 1993) in order to relate it to the assessment of children, and developed the Children’s Memory Questionnaire (CMQ). They developed the CMQ as a screening instrument to identify children who required more formal neuropsychological assessment of memory. Two hundred and sixty one children ranging from ages 5-12 participated in the study. The school group contained 226 participants and the clinical group contained 35 participants who had each been referred to a learning disorders clinic for formal assessment. The parents of these children completed a memory questionnaire in relation to their children. At the ages 6, 8 and 10 years, children also participated in a formal assessment of memory. Total scores for the questionnaire were then compared to subtests of the formal memory assessment. Results of their study concluded that the CMQ accurately identified children who did have significant memory impairment. However, falsely identified 40% of children without a memory deficit, as having one, concluding that the CMQ was not a useful diagnostic aid for the groups used in the study. A potential explanation for this was provided which suggested that the small clinical sample may not have been a sufficient representation to provide a reasonable test of diagnostic indicators. It was further considered possible that the CMQ was assessing a different construct to the formal testing.

It is noted that prior to the commencement of this study the original CMQ data were reviewed. An analysis of item-level data from the CMQ revealed some redundancy in items and a need for some additional, child-specific items that might improve the instrument’s ability to separate normal and clinical groups. Items were further revised to improve applicability to children and several items were deleted and several added. The result was a revised CMQ of 36 items which was used in this study (Appendix A). The purpose of the present study was to re-evaluate the suitability of the revised CMQ as a feasible instrument that could substitute for formal memory assessment or at least be an effective screen in
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children who appear to have memory problems. It was determined that the inclusion of a larger clinical sample with a higher rate of memory disorders as a primary diagnosis would improve the likelihood of determining diagnostic indicators and a factor analysis would potentially identify any subcategories that the CMQ-R may be measuring. In addition, it was considered that a factor analysis would better explore if the CMQ-R reflects the multidimensional nature of memory.

The ultimate criteria for any acceptable assessment tool are its levels of validity and reliability. One way for the CMQ-R to be considered a valid children’s memory-screening tool, is for it to be shown to accurately screen for the same memory deficits that formal testing would identify. To test this, results of the CMQ-R were compared to results from a formal battery of memory assessment. Selected subtests from the WRAML, first and second edition (Sheslow & Adams, 1990; 2003) were be utilised. The WRAML was chosen as it is a well-known formal testing battery that is currently used in assessing children’s memory and it is an empirically supported and comprehensive measure of memory. It has been shown to have strong internal consistency, a factor analysis which supported the hypothesised three factor model, and strong correlation with other well-known tests of memory such as the Wechsler Memory Scale, Children’s Memory Scale, Test of Memory and Learning, and the California Verbal Learning Test-II (Atkinson, Konold, & Glutting, 2008). It was predicted that high correlations between the CMQ-R and the memory test would indicate that the CMQ-R is measuring similar components of memory as formal memory testing does.

Reliability refers to the degree to which a particular observation has provided a reliable score, one that can be repeated. The original CMQ study indicated that the instrument had good internal reliability (Cronbach alpha = .96), in addition the test re-test reliability was high ($r = .92, p < .01$). It was the intention of his study to repeat these analyses with the
amended CMQ. In addition, internal validity was assessed by computing factor analyses to identify any subgroups within the scale.
The Children’s Memory Questionnaire - Revised

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Abstract

The aim of the current study was to conduct a factor analysis of the Children’s Memory Questionnaire - Revised (CMQ - R) and evaluate it as a reliable and effective measurement of memory functioning in children. The CMQ - R is a 36 - item questionnaire designed to assess parents’ perceptions of their child’s memory. There were 371 children aged 5-12 years old who participated in this study. Three hundred and forty two children were recruited from schools and 29 were recruited from Kaleidoscope outpatient medical and allied health clinics. Parents of all 371 children completed the CMQ - R and the parents of 6, 8, 10 & 12 year olds in the school group completed a second CMQ - R approximately one month later. In the school group, children at these ages also participated in a formal assessment of memory. In the clinical group, all 29 children were tested. The results indicated that correlations between the CMQ - R and formal memory testing were low however these results improved slightly when age groups were separated with the highest correlation occurring for the 12 year olds. The school and clinical groups were compared on measures of the CMQ - R and results indicated that there was a significant difference in CMQ - R total between school and clinical groups. A factor analysis of the CMQ - R concluded three factors all with moderate to strong loadings and these reflected, although were not limited to, episodic memory, visual memory, and working memory/attention. The possibility was discussed that the CMQ - R was assessing different aspects of memory than formal testing, and that these are likely to be everyday memory abilities.
The Children’s Memory Questionnaire - Revised

The Children’s Memory Questionnaire (CMQ; Drysdale, Shores & Levick 2004) is a 34-item questionnaire designed to assess parents’ perceptions of their child’s memory. It is based on the Everyday Memory Questionnaire (EMQ; Sunderland et al. 1983), which was designed to test everyday memory abilities in adults. Drysdale, Shores & Levick (2004), modified the EMQ and devised the CMQ in order to relate it to the assessment of children. In their 2004 study they explored whether the CMQ was a reliable and effective measurement of memory functioning in children. This study explored the validity and reliability of a revised CMQ and examined the extent to which it reflected the multidimensional nature of memory and the relationship of observer rating to results of clinical memory assessment.

It is well recognised within the literature that the neuropsychological system of memory is primarily divided into two main features, the short term memory system and the long term memory system (e.g. Atkinson & Shriffrin, 1968; Baddeley, 1995; Schneider & Pressley, 2013). The short term memory system is responsible for holding information for brief periods of time, while simultaneously performing some kind of task. It includes the phonological processing loop; responsible for storing and refreshing verbal information, and the visuo-spatial sketch pad; responsible for storing and refreshing visual information. The process of engaging the subsystems within short term memory to work with and transform information is referred to as working memory, and the process of holding information passively without effort to transform this information is referred to as verbal or visual short term storage. The short term memory system operates closely with the executive functions which are responsible for organising information and directing attention,

The long term memory system is further divided into three primary subdivisions known as Procedural Memory, Semantic Memory and Episodic Memory (Tulving, 1983).
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Procedural memory refers to how things are done and to the development of automatic skill sets, such as driving a car. Semantic memory refers to the acquired knowledge that individuals possess about the world, such as knowing what the capital of Australia is. Episodic memory refers to the ability to remember personally experienced episodes. Episodic memory relies on a self-knowing consciousness which allows an individual to become aware of their sense of self and contributes to the ability to develop knowledge about personally experienced events. When considering the assessment of memory, it is episodic memory that is most relevant as it the easiest of the memory systems to formally assess.

Memory plays an important role in human development and is vital when considering the normal developmental progression of childhood. Memory develops during key developmental periods throughout childhood and it influences the way children negotiate the physical and social world. Children with poor memory abilities demonstrate difficulties in a range of key learning areas and it is therefore important that memory deficits in children are identified early and accurately, and that relevant interventions are established.

Many contributing factors can interfere with the normal development of memory systems which may result in significant impairment in cognitive and adaptive skills. Memory is particularly vulnerable to head trauma (Saloria, et al., 2005; Yeates, Taylor, Wade, Drotar, & Stancin, 2002). Levin and Eisenburg (1979) go as far as to conclude that memory is the most impaired cognitive domain in children with head injury. Current research proposes that the neuro-structure of memory is primarily located within the frontal regions and temporal lobes of the brain (Catroppa & Anderson, 2007). Given the proximity of the temporal lobes within the skull to bony protrusions located on the skull’s surface, incidences that cause the brain to oscillate within the skull can result in the brain hitting some of these rough areas which may result in lacerations (Granacher, 2007; Parker, 1990). Temporal lobe disruption is therefore often regarded as a significant contributor to memory problems.
In addition to head injury, children are at risk of developing memory problems as a result of various disorders and diseases. A foetal brain is particularly susceptible to environmental toxicants such as industrial poisons, pesticides and metals (Dietrich, et al., 2005; Grandjean & Landrigan, 2006; Selevan, Kimmel & Mendola, 2000) as well as neurotoxicants such as cocaine and alcohol (Rasmussen, Horne & Witol, 2006). Epilepsy (Al-Zwaini, 2011), low birth weight (Taylor, 2009), spina bifida (Fletcher & Dennis, 2009), and childhood cancer (Ris & Abbey, 2009) can also interfere with normal brain development and as a consequence may contribute to significant memory impairment. Further, there is a wide range of developmental disorders such as Dyslexia, Dyscalculia, Attention Deficit Hyperactivity Disorder, Autistic Spectrum Disorder, Executive Functioning Disorder and Motor Coordination Disorder that commonly present with complaints of memory impairment (Baron, 2004). It can be difficult for clinicians to discriminate between specific memory dysfunction and other neurological conditions and the main avenue for clarification is formal assessment of memory which also requires assessment of a broader range of cognitive functions. This requires a referral to a specialist and can be a lengthy and expensive process. While it may be difficult for health professionals to determine the significance of memory impairment in childhood disorders, it is critical to do so. Memory deficits affect learning and therefore the academic and social development of the child.

There remains some controversy in the memory literature regarding the ecological validity of assessing memory in a laboratory using contrived experiments that attempt to formally test the types of memory skills that are used in day to day life. Everyday memory research posits that memory skills studied in the laboratory are very different to the memory skills required for ever day living (Ceci & Bronfenbrenner, 1991; Conway, 1991; Efklides et al., 2002; Greneberg, Morris & Sykes, 1991). While formal testing of memory is useful to quantify individual cognitive capacity, it may be limited when attempting to generalise this
information to describe individual coping, and may not be accurately characterising memory as it is applied to everyday functioning. Ulric Neisser (1978) identified the irony that there was over one hundred years of research into memory yet very little of this research explored memory as it applied to everyday life. Neisser acknowledged the significant contribution that memory research had provided to furthering scientific understanding of the mechanisms of memory. However, he also reported that these theoretical explanations did very little to further scientific understanding of practical, every day memory problems in natural settings. Neisser argued that as long as memory theories continue to be based on the performance of individuals in formal laboratory settings, little will be learned about the natural behaviour of memory and its everyday uses. Neisser challenged his colleagues to remove the study of memory from the laboratory, and embark on a more realistic study of memory as it impacts activities of daily life. His thesis sparked a growth in awareness that the memory skills studied in the laboratory may be very different to the memory skills required for every day living.

Crook and Larrabee (1988) supported this assertion and argued that that the environmental relevance of memory constructs and subsequent assessment is an important issue due to the nature of memory complaints. They suggested that individuals present for memory testing either because they are having problems with memory in everyday life, or have suffered some form of head trauma that will eventuate in problems with memory in everyday life. Therefore understanding how memory deficits impact an individual’s ability for normal everyday functioning is of central relevance.

Sunderland, Harris, & Baddeley (1983) compared formal test performance of individuals with head injury to self-descriptions of everyday memory functioning. They developed a list of 35 different types of everyday memory errors. The 35 items were grouped into five categories: Speech - forgetting the names of friends or relatives or calling them by the wrong names; Reading and Writing - forgetting what the sentence you just read was
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about and having to re-read it; Faces and Places - failing to recognise friends or relatives by sight; Actions - forgetting to do some routine thing which you would normally do once or twice a day; and Learning New Things - unable to remember the name of someone you met for the first time recently. Participants and their spouses completed the form, each rated the memory errors of the participants. The results of these questionnaires were compared to the results of a battery of formal objective memory tests. Results concluded that the formal memory assessments accurately identified memory deficits in response to head injury however were unrelated to complaints regarding everyday memory skills.

Toplak, West and Stanovich (2013) explored performance based measures and rating scales as used for typically assessing executive function in clinical and neuropsychological assessments. The associations between these two styles of assessment were explored across 20 studies which included 13 child and 7 adult samples. Performance based tasks were typically characterised by highly standardised administration conditions with a single examiner. In contrast, rating scales were completed by informants and typically required a response on a Likert scale to questions about behaviours. The study reported that the most commonly used rating scale of executive function was the Behaviour Rating Inventory of Executive Function (BRIEF; Giola, Isquith, Guy, & Kenworthy, 2000). Toplak, West and Stanovich hypothesised that if performance based measures and rating scales of executive functions are assessing the same constructs, then the two should be strongly associated and statistical analysis should produce results indicating a strong positive correlation. However this was not the case. Correlations between performance based measures and rating scales of executive functions were low and the conclusion drawn was that the two different types of measures are assessing different aspects of cognitive functioning. The implication of this result suggests that as the two types of assessment are measuring different domains they cannot be used interchangeably. Rather, each assessment
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style provides different types of important and valuable information. Further, it is considered possible that rating scales are more relevant than lab based assessments in terms of functional everyday outcome and may be better at predicting functional problems.

In contrast, Banaji and Crowder (1989), criticised the everyday memory approach and suggested that studies that are high in ecological validity may be low in generalisability. They suggested that due to the multiplicity of uncontrolled variables in the study of everyday memory, generalisability is impaired. In addition, these researchers stated that while the study of memory in its natural environment may appear ecologically valid, when explored at a deeper level, everyday memory studies have not resulted in any new principles of memory, or any further understanding of memory constructs and thus compromises the value of scientific research.

Regardless of the debate accurate and early identification of children with memory deficits provides optimal opportunity to reduce the functional impact of the impairment and significantly improves the quality of an individual’s life. It would therefore seem appropriate to develop a tool to aide in the process of early and accurate identification. An assessment tool, such as a memory questionnaire, could quickly and effectively screen children for whom formal testing would be of benefit. In addition, a memory questionnaire may also provide important information about a child’s functional ability and may play a valuable role in understanding a child’s overall profile of strengths and weaknesses. While the debate continues between formal memory testing and rating scales, self-report, parent/ teacher rating questionnaires, and checklists are currently used in a range of child development areas (BRIEF; Gioia, Isquith, Retzlaff, 2010; CBCL; Achenbach, 2001) and this has been shown to be an economical and efficient way to gather data. Interestingly, the past 20 years have seen investigations into memory explore the effectiveness of self-report questionnaires. These
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have been developed in an attempt to more accurately reflect memory function in everyday life.

Sunderland and colleagues. (1983), when examining the validity of the Everyday Memory Questionnaire, concluded that it did not provide an accurate reflection of memory abilities when completed by the participant. However, the validity for the EMQ increased, when a relative on the participant’s behalf completed it. Studies have since replicated these findings (Gonzalez, et al., 2008), concluding that obtaining information from carers is a valid addition to memory assessment procedures. Drysdale, Shores & Levick (2004), modified the EMQ in order to relate it to the assessment of children and devised the Children’s Memory Questionnaire (CMQ). They developed the CMQ as a screening instrument to identify children who required more formal neuropsychological assessment of memory. Two hundred and sixty one children ranging from ages 5-12 participated in the study. The school group contained 226 participants and the clinical group contained 35 participants who had each been referred to a learning disorders clinic for formal assessment. The parents of these children completed a memory questionnaire in relation to their children. At the ages 6, 8 and 10 years, children also participated in a formal assessment of memory. Total scores for the questionnaire were then compared to subtests of the formal memory assessment. Results of their study concluded that the CMQ accurately identified children who did have significant memory impairment. However, falsely identified 40% of children without a memory deficit, as having one, concluding that the CMQ was not a useful diagnostic aid for the groups used in the study. A potential explanation for this was provided which suggested that the small clinical sample may not have been a sufficient representation to provide a reasonable test of diagnostic indictors, in addition the clinical group may have provided more meaningful information if the participants had a primary diagnosis of memory deficit. It is further considered possible that the CMQ was assessing a different construct to the formal testing.
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It is noted that prior to the commencement of this study the original CMQ data was reviewed. An analysis of item-level data from the CMQ revealed some redundancy in items and a need for some additional, child-specific items that might improve the instrument’s ability to separate normal and clinical groups. Items were further revised to improve applicability to children and several items were deleted and several added. The result was a revised CMQ of 36 items which was used in this study. The current study aimed to explore the CMQ-R further with a new sample group and with the inclusion of a factor analysis that will better explore the CMQ-R’s ability to reflect the fractionised nature of memory.

The ultimate criteria for any acceptable assessment tool are its levels of validity and reliability. To assess the CMQ-R’s validity, results of the CMQ-R were be compared to a selection of subtests from the Wide Range Assessment of Memory and Learning (Sheslow & Adams, 1990). The WRAML is a well-known formal testing battery that is currently used in assessing children’s memory. In addition to WRAML subtests, Digit Span from the Wechsler Intelligence Scale for Children, fourth edition will be included (Wechsler, 2003). It was predicted that high correlations between the CMQ-R and the formal memory test would indicate that the two are measuring similar components of memory. Reliability refers to the degree to which a particular observation has provided a reliable score, one that can be repeated. The original CMQ study indicated that the instrument had good internal reliability (Cronbach alpha = .96). This study intended to repeat these analyses with the CMQ-R.
METHOD

Participants

There were 371 children aged 5-12 years old who participated in this study. Three hundred and forty two children were recruited from schools and 29 were recruited from Kaleidoscope outpatient medical and allied health clinics. Kaleidoscope represents a network of paediatric services that support the Hunter New England Local Health District. Children from this group experienced a range of diagnoses which are listed in Table 1. There were 188 male and 183 female participants in total. The number of participants for each age group for both the school and clinical groups can be seen in Table 2.

Table 1.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traumatic Brain Injury</td>
<td>3</td>
</tr>
<tr>
<td>Hypothalamic Tumor</td>
<td>1</td>
</tr>
<tr>
<td>Frontal Cortical Dysplasia &amp; Epilepsy</td>
<td>1</td>
</tr>
<tr>
<td>Occipital Infant Seizures</td>
<td>1</td>
</tr>
<tr>
<td>Neurological complication from bone marrow transplant for Leukaemia</td>
<td>1</td>
</tr>
<tr>
<td>Perinatal Asphyxia Ataxia</td>
<td>1</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>1</td>
</tr>
<tr>
<td>Dyslexia</td>
<td>11</td>
</tr>
<tr>
<td>Attention Deficit Hyperactivity Disorder</td>
<td>3</td>
</tr>
<tr>
<td>Autism Spectrum Disorder</td>
<td>1</td>
</tr>
<tr>
<td>Attention Deficit Hyperactivity Disorder, Dyslexia &amp; Dyscalculia</td>
<td>2</td>
</tr>
</tbody>
</table>
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Attention Deficit Hyperactivity Disorder,
Developmental Learning Disorder, &

Dyslexia 2
Dyslexia & Dysgraphia 1
Total 29

Table 2.

Numbers of Participant Ages for each Gender

<table>
<thead>
<tr>
<th>Age</th>
<th>School Group</th>
<th>Clinical Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>7</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>Gender Total</td>
<td>164</td>
<td>178</td>
</tr>
<tr>
<td>Total Participants</td>
<td>342</td>
<td>29</td>
</tr>
</tbody>
</table>

Materials

The CMQ - R was used to seek information from parents on their children’s memory skills. It is a 36 - item questionnaire designed to assess parents’ perceptions of their child’s memory. The CMQ - R primarily presents statements that query everyday memory, such as “Forgets where he/she has put something”. The CMQ -R requires parents to assess their child’s memory based on five possible options; 1. Never or almost never happens, 2. Happens less than once a week, 3. Happens once or twice in a week, 4. Happens about once a day, 5. Happens more than once a day.

The Wide Range Assessment of Memory and Learning (WRAML: Sheslow & Adams, 1990), is a widely used tool for assessing memory function. Selected subtests from the WRAML formed part of the memory assessment that was used for validity testing. The
subtest Visual Learning was selected from the original WRAML and Verbal Learning, including delayed recall and recognition, Story Memory, including delayed recall and recognition, and Finger Windows were selected from the WRAML2. In addition the Digit Span subtest from the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler 2003) was included as a verbal memory span task. To assess general cognitive ability and to assess for any potential IQ bias, the subtests Vocabulary and Matrix Reasoning from the WISC-IV were administered.

Procedure

Ethics approval was obtained from the University of Newcastle Human Research Ethics Committee (HREC) on 10th September 2009 (reference number: H-2009-0286).

Ten primary schools from the Port Stephens and Newcastle area took part in the study. Recruitment involved teachers distributing an information letter, consent form, and memory questionnaire to all students in their class who were within the required age groups. Letters outlined the study and its requirements, and invited families to participate. Parents who were willing to participate were instructed to return the signed consent form and completed CMQ - R to their child’s class teacher. Twenty nine children were recruited from Kaleidoscope outpatient medical and allied health clinics, including those at the John Hunter Children’s Hospital and Child and Family Team. Children attending Kaleidoscope outpatient services were already participating in psychometric testing as part of clinical assessments that was not related to this study. Therefore, clinicians sought parents’ consent to use their child’s data as part of this research project. Clinicians provided parents with envelopes containing information and consent forms as well as the CMQ -R. Clinicians indicated to parents that the information related to a research project for which researchers were recruiting children attending child health facilities. Clinicians also indicated that participation was entirely voluntary. It was left up to the parent to consider the material provided and decide whether
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or not they would participate. Families that decided to participate completed the forms and returned them in the reply paid envelopes provided.

All children within the age range whose caregiver consented to participation were included in the school/control group with the exception of those with previously diagnosed medical or educational difficulties that could give rise to concern about memory function. Difficulties for which children were excluded included learning difficulties, intellectual disability, ADHD, epilepsy, spina bifida, premature birth and severe sensory impairment.

Once consent forms and parent questionnaires were returned, children in the school group at ages 6, 8, 10 & 12 were withdrawn from class and assessed individually at their schools. Assessment sessions lasted approximately 60 minutes. For participants recruited from allied health clinics, all 29 children were tested and testing took place at various child health services across the Hunter New England Health District. To assess test-retest reliability, parents from the school groups initially completed the CMQ -R form and then again when their child was seen for memory and IQ testing approximately three-four weeks later. One hundred and thirteen participants completed and returned a second CMQ - R. The CMQ - R took approximately 10 minutes for parents to complete.

RESULTS

School Group

The Kolmogorov-Smirnov test for normality was used on the CMQ - R total scores. Results of this indicated that the data were not normally distributed \((p < 0.01)\). Therefore non-parametric tests were employed. Mean CMQ - R scores for each age group can be seen in Table 3. A Kruskal – Wallis non parametric comparison determined that there were no significant differences between ages \((\chi^2 = 8.08, df = 7, p = 0.32)\).
Table 3.

Mean and Standard Deviation for CMQ Total Scores According to Age Groups.

<table>
<thead>
<tr>
<th>Age</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>56.27</td>
<td>23.75</td>
<td>36-126</td>
</tr>
<tr>
<td>6</td>
<td>59.27</td>
<td>25.69</td>
<td>36-153</td>
</tr>
<tr>
<td>7</td>
<td>61.52</td>
<td>24.08</td>
<td>36-143</td>
</tr>
<tr>
<td>8</td>
<td>56.06</td>
<td>18.41</td>
<td>36-105</td>
</tr>
<tr>
<td>9</td>
<td>60.51</td>
<td>24.12</td>
<td>36-126</td>
</tr>
<tr>
<td>10</td>
<td>53.50</td>
<td>19.59</td>
<td>36-122</td>
</tr>
<tr>
<td>11</td>
<td>57.18</td>
<td>19.98</td>
<td>36-123</td>
</tr>
<tr>
<td>12</td>
<td>49.12</td>
<td>11.46</td>
<td>36-78</td>
</tr>
</tbody>
</table>

The median total score for the CMQ - R school group when all ages were combined was 49, scores ranged from 36-153, IQR = 22.00, and the distribution was positively skewed ($M = 57.15$, $SD = 21.67$). Figure 1. shows the distribution of the CMQ - R total scores for the school group. Frequency of occurrence of higher CMQ - R scores (those reflecting greater impairment) is listed in Table 4.
Figure 1. Distribution of the School Group CMQ Total Scores

Table 4.

Frequency of Occurrence of Higher CMQ-R Scores* in the School Sample

<table>
<thead>
<tr>
<th>Score equal to or greater than</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>3.4</td>
</tr>
<tr>
<td>100</td>
<td>6.7</td>
</tr>
<tr>
<td>95</td>
<td>7.3</td>
</tr>
<tr>
<td>90</td>
<td>8.5</td>
</tr>
<tr>
<td>85</td>
<td>10.6</td>
</tr>
<tr>
<td>80</td>
<td>14.1</td>
</tr>
<tr>
<td>75</td>
<td>16.4</td>
</tr>
<tr>
<td>70</td>
<td>19.6</td>
</tr>
</tbody>
</table>

* higher score = greater impairment
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CMQ -R total scores for males, with age groups combined, ranged from 36 – 153. The median score was 49, IQR = 22, $M = 58.10$, $SD = 22.19$. Scores for females, age groups combined, ranged from 36 – 143. The median score was 49, IQR = 22.50, $M = 56.28$, $SD = 21.19$. A Mann-Whitney $U$ test concluded no significant difference between gender ($U = 13601.50$).

When considering the individual CMQ - R items, all ages combined, the highest scoring item was Item 4., “Forgets to take things with him/her or leaves things behind and has to go back for them” ($M = 2.43$). The lowest scoring item was Item 9., “Fails to recognise by sight people that she/he meets frequently, e.g. relatives or friends” ($M = 1.12$). When exploring CMQ -R items with the age groups separated, the results were similar and there were no significant differences. The highest scoring item was achieved by 8 year olds and was Item 4., ($M = 2.64$). The lowest scoring item was achieved by 9 year olds and was for Item 9., ($M = 1.04$).

To identify if there are any separable dimensions that may serve as subscales for the CMQ -R, a Factor Analysis was conducted using maximum likelihood method to extract factors followed by a varimax rotation for independent factors. Extraction based on eigenvalues of less than 1 concluded that items naturally fell within a four factor structure. A Kolmogorov-Smirnov test for normality was conducted on the factors. Results of this concluded that the data were not normally distributed ($p < 0.05$). Therefore non parametric tests were used. A Spearman’s non parametric comparison was then applied to the factors and this determined a weak correlation for factors one and two (test statistic = 0.062, $p = 0.250$) and no correlation for any other factor combination. Therefore the varimax rotation was justified and there was no need to continue with an oblique (oblimin) rotation. The data were also tested for linearity which concluded that correlational tests of association were appropriate.
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Based on an examination of the scree plot test and eigenvalues, and given that the fourth factor held only one item which loaded comparatively across all factors, it was decided to conduct a further analysis extracting three factors. Table 5. demonstrates each factor along with the corresponding items and their loadings. Results of this analysis indicated that factor one explained 49% of the overall variance. Factor two explained 6.5% of the overall variance and factor three explained 3.8% of the variance. These three factors when combined explained 59.7% of the total variance. When examining a Cronbach’s alpha to determine if the reliability of any of the factors could be improved it was deemed that further removal of items did not increase reliability for any of the factors extracted, therefore all items for each factor were retained. The first factor contains primarily although not exclusively items that relate to episodic memory. While there are a few exceptions, such as “seems not to listen to what people say to him”, episodic memory is considered the most appropriate explanation for this factor. The second factor is interpreted as primarily relating to visual memory and while once again there are items that do not reflect visual memory such as “seems to forget something she has just said”, visual memory most accurately reflects the majority of items in this factor. The third factor relates primarily to working memory and attention, however it is noted that this factor also contains a strong focus on verbal memory. For each factor the loadings remained strong.
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Table 5.

Factors and their Corresponding Items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Factors</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Forgets to take things with him/her or leaves things behind and has to go back for them.</td>
<td>.750</td>
</tr>
<tr>
<td>1.</td>
<td>Forgets where she/he has put something.</td>
<td>.713</td>
</tr>
<tr>
<td>15.</td>
<td>Loses things.</td>
<td>.709</td>
</tr>
<tr>
<td>6.</td>
<td>Forgets a change in the daily routine such as a change in the place where something is kept.</td>
<td>.689</td>
</tr>
<tr>
<td>14.</td>
<td>Forgets what s/he was told a few minutes ago.</td>
<td>.630</td>
</tr>
<tr>
<td>28.</td>
<td>Forgets what she/he was told a few hours or more ago.</td>
<td>.616</td>
</tr>
<tr>
<td>13.</td>
<td>Forgets some or all of what s/he did yesterday or a few days ago.</td>
<td>.610</td>
</tr>
<tr>
<td>8.</td>
<td>Forgets to do things they said they would do or had arranged to do.</td>
<td>.601</td>
</tr>
<tr>
<td>21.</td>
<td>Sets off to do something then seems to forget what it was s/he wanted to do.</td>
<td>.587</td>
</tr>
<tr>
<td>33.</td>
<td>It seems that if s/he does not do things as soon as they think of them they will forget them.</td>
<td>.580</td>
</tr>
<tr>
<td>16.</td>
<td>Forgets to tell someone something important such as a passing on an important message.</td>
<td>.550</td>
</tr>
<tr>
<td>12.</td>
<td>Forgets when it was that something happened, eg. Whether it was yesterday or last week.</td>
<td>.534</td>
</tr>
</tbody>
</table>
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20. Seems not to listen to what people say to him/her (not just being oppositional). .522

3. Forgets the name of someone s/he met for the first time recently. .508

**FACTOR 2: Visual Memory**

27. Forgets the names of friends or relatives they know quite well. .699

26. Gets lost or turns in the wrong direction in places s/he has often been to before. .667

31. Fails to recognise well known television characters or other famous people by sight. .626

29. Seems to forget something she has just said. .578

34. Does not recognise places she has often been to before. .572

19. Fails to recognise someone she met for the first time recently. .551

9. Fails to recognise by sight people that she meets frequently eg. relatives or friends. .532

24. Unknowingly tells someone a story or joke she has told that person before. .526

32. Forgets the names of common things or uses the wrong names for them. .517

7. Gets lost in places she has only been once or twice before. .501

36. Finds television shows or movies that are suitable for their age difficult to follow. .468
To assess the Test-Retest Reliability for the CMQ - R, a Spearman’s correlation was used to compare the questionnaires that parents completed across the two occasions. Results of this indicated strong test-retest reliability \( r = 0.87, \ p < 0.05 \). Internal consistency was also computed and a Cronbach’s alpha concluded strong reliability (Cronbach’s alpha = 0.97).

Scores for the cognitive tests were within the average range. Table 6. demonstrates the \( M \) and \( SD \) for the individual subtests across the different ages.

**FACTOR 3: Working Memory and Attention**

- 22. Requires information to be repeated several times before they grasp what they are doing. \( .760 \)
- 30. Has difficulty learning new things by hearing instructions. \( .694 \)
- 10. Loses track of what someone is trying to tell him/her. \( .633 \)
- 5. Has trouble completing multi step instructions. \( .620 \)
- 17. Slow to learn new routines. \( .606 \)
- 35. Gets the details of what someone told him/her mixed up and confused. \( .579 \)
- 23. Other people report that his/her memory is poor. \( .521 \)
- 11. Slow to pick up a new skill such as a game or working some new gadget. \( .475 \)
- 2. Forgets new school work that they seemed to know yesterday. \( .475 \)
- 18. Unintentionally repeats something s/he has just said or says the same thing several times. \( .460 \)
- 25. S/he complains that they have a poor memory. \( .420 \)
The school groups were tested with a formal assessment of memory at 6, 8, 10 and 12 year age groups. For the school group a total of 136 participants were tested.

Mean memory test age-scaled scores can be seen in Table 7. Means ranged from 8.97 – 11.41. The lowest mean score was for the subtest Verbal Learning Delayed Recall in the 8 year age group. The highest mean score was for the subtest Finger Windows in the 6 year age group.

Table 7.

<table>
<thead>
<tr>
<th>School Group</th>
<th>6yrs</th>
<th>8yrs</th>
<th>10yrs</th>
<th>12yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Learning</td>
<td>9.80</td>
<td>2.78</td>
<td>9.55</td>
<td>3.42</td>
</tr>
<tr>
<td>Visual Learning</td>
<td>10.95</td>
<td>2.52</td>
<td>11.95</td>
<td>2.46</td>
</tr>
<tr>
<td>Digit Span</td>
<td>8.97</td>
<td>2.73</td>
<td>9.57</td>
<td>2.65</td>
</tr>
<tr>
<td>Story memory</td>
<td>10.36</td>
<td>2.16</td>
<td>10.05</td>
<td>2.86</td>
</tr>
<tr>
<td>Finger Windows</td>
<td>11.41</td>
<td>2.30</td>
<td>10.63</td>
<td>2.11</td>
</tr>
<tr>
<td>Verbal Learning Delayed</td>
<td>9.80</td>
<td>3.51</td>
<td>8.97</td>
<td>4.12</td>
</tr>
</tbody>
</table>
To determine the validity of the CMQ -R, correlations were computed between CMQ -R scores and the individual memory subtests (a correlation matrix can be seen in Appendix C). Results produced a negative correlation as high scores on the CMQ -R represent poor memory abilities in contrast to the memory tests for which high scores represent well developed memory abilities. Two tailed tests were conducted using Bonferroni adjusted alpha levels of 0.006 per test (0.05/8). When all age groups were combined, results indicated that there were significant although low correlations for Verbal Learning (r = -0.235, p = 0.001), Verbal Learning Recognition (r = -0.276, p = 0.001), Story Memory (r = -0.237, p = 0.001),and Story Memory Delayed (r = -0.321, p = 0.001). There were no significant correlations between CMQ -R totals and Visual Learning, Verbal Learning Delayed, Finger Windows, Digit Span, and Story Memory Recognition. When the age groups were separated and the memory test subtests were compared to CMQ -R total scores, there was a significant correlation between the CMQ -R and Story Memory Delayed at the 12 year age group only (r = -0.415, p = 0.001). It is noted that the 12 year old age group had the largest number of participants in it and it is possible that this result is due to an over representation of children at this age.

The argument has been made that memory does not consist of a single dimension and as the correlations between the total CMQ -R score and memory tests were generally weak it was considered that factors of the CMQ -R may produce a stronger correlation. Therefore, to determine if the CMQ -R is reflecting various dimensions of memory the three factors of the
CMQ -R that were identified by the factor analysis were each independently compared to the memory test subtests. Factor 1 produced a significant correlation with Verbal Learning Recognition ($r = -0.245$, $p = 0.001$), and Story Memory Delayed ($r = -0.256$, $p = 0.001$). Factor 2 did not produce any significant correlations. Factor 3 correlated significantly with Verbal Learning ($r = -0.273$, $p = 0.000$), Story Memory ($r = -0.272$, $p = 0.000$), Verbal Learning Recognition ($r = -0.260$, $p = 0.000$), and Story Memory Delayed ($r = -0.345$, $p = 0.000$). Results of this analysis generally did not improve correlations.

When each of the factors were correlated with the memory subtests for each age group, there was a significant correlation for the ten year age group only for Factor 3 and Story Memory Delayed ($r = -0.524$, $p = 0.002$).

**Clinic Group**

The Kolmogorov-Smirnov test for normality was used on the CMQ -R total scores for the clinic group. Results of this indicated that the data were not normally distributed ($p < 0.05$). Therefore non-parametric tests were employed. A Kruskal – Wallis non parametric comparison determined that there were no significant differences between ages ($\chi^2 = 4.25$, $df = 5$, $p = 0.51$). Mean CMQ -R total scores for each age group can be seen in Table 8.

Table 8.

<table>
<thead>
<tr>
<th>Clinic Group</th>
<th>Age</th>
<th>$M$</th>
<th>$SD$</th>
<th>Range</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>62.33</td>
<td>10.26</td>
<td>51-71</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>91.33</td>
<td>46.78</td>
<td>38-143</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>82.00</td>
<td>19.34</td>
<td>54-114</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>89.00</td>
<td>13.89</td>
<td>80-105</td>
<td>3</td>
</tr>
</tbody>
</table>
The total mean score for the CMQ -R clinical group when all ages were combined was 86.66 ($SD = 31.74$). Figure 2. displays the clinical group distribution for total CMQ -R scores. Scores ranged from 38 - 169, and the distribution was positively skewed.

**Figure 2. Distribution of the Clinical Group CMQ-R Total Scores**

CMQ -R total scores for males when all ages were combined ranged from 38 – 143. The mean score was 84.53 ($SD = 28.74$). Scores for females ranged from 55 – 169. The mean score was 96.80 ($SD = 46.33$). A Mann-Whitney U test concluded no significant difference between gender ($U = 15146.50$).
When considering the individual CMQ-R items for the clinic group, all ages combined, the highest scoring item was Item 5., “Has trouble completing multi step instructions” ($M = 3.52$). The lowest scoring item was Item 9., “Fails to recognise by sight people that she/he meets frequently, e.g. relatives or friends” ($M = 1.30$) and Item 31., “Fails to recognise well known television characters or other famous people by sight”. When exploring CMQ-R items with the age groups separated, the results were varied however there were no meaningful patterns apparent. The highest scoring item mean was 3.67 and was achieved by 6 year olds for Item 27., “Forgets the names of friends or relatives they know quite well or calls them the wrong name”, by 9 year olds for Item 5., “Has trouble completing multi step problems”, by 10 year olds for Item 1., “Forgets where he/she has put something”, and by 11 year olds for Item 2., “Forgets new schoolwork that they seemed to know yesterday.

Scores for the cognitive tests were within an average range. Table 9. demonstrates the mean and standard deviation for the individual subtests across the different ages.

Table 9.

<table>
<thead>
<tr>
<th>Age</th>
<th>Vocabulary</th>
<th>Matrix Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>1.72</td>
</tr>
<tr>
<td>7</td>
<td>10.83</td>
<td>2.37</td>
</tr>
<tr>
<td>8</td>
<td>8.32</td>
<td>2.06</td>
</tr>
<tr>
<td>9</td>
<td>9.12</td>
<td>2.22</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>1.00</td>
</tr>
<tr>
<td>11</td>
<td>9.64</td>
<td>2.99</td>
</tr>
<tr>
<td>12</td>
<td>8.74</td>
<td>2.91</td>
</tr>
</tbody>
</table>
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All 29 clinical group participants were assessed with the formal memory tests. Due to insufficient participant numbers in the clinical group comparisons could not be made between ages. Mean and standard deviations can be seen in Table 10. Means ranged from 8.10 – 10.95. The lowest mean score was for the subtest Digit Span ($M = 8.10$). The highest mean score was for the subtest Story Memory Recognition ($M = 10.95$). It is noted that within the clinical group the highest participation was for children with dyslexia ($n = 11$). Given that poor performance on measures of number recall such as Digit Span are often associated with poor reading skills, it is possible that this result is reflective of an over representation of dyslexia in the clinical group.

Table 10.

*Mean and Standard Deviations for Memory Subtests.*

<table>
<thead>
<tr>
<th>Subtests</th>
<th>$M$</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Learning</td>
<td>9.41</td>
<td>2.12</td>
</tr>
<tr>
<td>Visual Learning</td>
<td>9.85</td>
<td>3.88</td>
</tr>
<tr>
<td>Story Memory</td>
<td>10.61</td>
<td>1.88</td>
</tr>
<tr>
<td>Finger Windows</td>
<td>9.47</td>
<td>3.22</td>
</tr>
<tr>
<td>Digit Span</td>
<td>8.10</td>
<td>2.81</td>
</tr>
<tr>
<td>Verbal Learning Delayed</td>
<td>8.30</td>
<td>2.48</td>
</tr>
<tr>
<td>Verbal Learning Del. Recognition</td>
<td>8.96</td>
<td>2.92</td>
</tr>
<tr>
<td>Story Memory Delayed</td>
<td>10.16</td>
<td>2.16</td>
</tr>
<tr>
<td>Story Memory Del. Recognition</td>
<td>10.95</td>
<td>1.66</td>
</tr>
</tbody>
</table>
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To further assess the validity of the CMQ -R, correlations were computed between CMQ -R scores and the memory tests for the clinical group. Once again, due to the multidimensional nature of memory, the CMQ -R total scores were compared to each of the clinical memory test subtests scores. Tests were conducted using Bonferroni adjusted alpha levels of 0.006 per test (0.05/8). When all age groups were combined, results indicated that there were no significant correlations.

School and Clinical Comparisons

A comparison of the CMQ -R totals for school and clinical groups, using a Mann-Whitney U Test revealed a significant difference \((U = 1857.5, p = 0.00)\). Between-groups independent t-tests were conducted on each of the memory subtests using Bonferroni adjusted alpha levels of 0.006 per test (0.05/8). The results concluded that the only significant difference was found for Verbal Learning Recognition \(t (207) = 2.943, p = 0.004\).

DISCUSSION

The goal of this present study was to build on the earlier work of Drysdale et al. (2004) by collecting a new sample and exploring the CMQ -R using factor analysis. Due to the fractionised nature of memory it was considered that a factor analysis on the CMQ -R might produce subgroupings that may reflect various elements of memory, and that these may provide stronger correlations with formal memory assessment than an overall CMQ -R score. Results of this analysis concluded moderate to strong loadings for three main factors and these factors were consistent with theoretical concepts of memory. Factor 1 represented episodic memory, Factor 2 represented visual memory and Factor 3 represented working memory and attention. Of particular note is that the third factor which indicates that the CMQ-R is identifying attention difficulties in children. Attention may be an element of memory that may not be so easily assessed in formal memory assessments as the one to one nature of formal memory assessment provides an environment for the child in which directing
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focus and attention may be easier to maintain. In contrast, poor attentional capacity may be easier to assess when parents are using the CMQ -R as they are reflecting on their observations of their child’s difficulties.

A comparison of each of these factors with the memory tests, resulted in only weak correlations. Factor 1 correlated with Verbal Learning Recognition, and Story Memory Delayed. Factor 2 did not produce any significant correlations, and Factor 3 produced a weak correlation with Verbal Learning, Story Memory, Verbal Learning Recognition, and Story Memory Delayed. That the factors are reflective of theoretical conceptualisations of memory suggests that the CMQ -R is indeed measuring elements of memory. However as the correlations between the factors and the formal memory test were weak, there is some support for the theory that the CMQ - R is assessing a different aspect of memory than formal memory tests are.

It was anticipated that with a more robust clinical sample, the CMQ -R would be able to accurately reflect variations in participants’ memory abilities as identified by formal memory tests. However, while this was the original intention of the study, a clinical sample of this nature was not obtained. The clinical group provided a lower than expected sample size and contained less than intended primary memory deficits. The premise that the CMQ -R would reflect formal memory assessment was still explored and it was partially supported with significant correlations in the school sample for the subtests Verbal Learning, Verbal Learning Recognition, Story Memory, and Story Memory Delayed, though these correlations were consistently weak. In contrast, correlations on the clinical sample did not produce any significant results. Further, an analysis of the CMQ -R subscales was conducted which resulted in the CMQ - R proving high internal validity. Consistent with the Drysdale study, test-retest reliability for the CMQ -R was strong, suggesting that parents’ assessment of their child’s abilities as assessed by the CMQ -R were reliable. Given that the comparisons
between the CMQ-R scores and formal memory testing resulted in some significant yet weak correlations it was considered possible that this lack of correspondence suggests that the CMQ-R may indeed be measuring different memory constructs than formal memory assessments. Further, it was considered plausible that the CMQ-R may be measuring everyday memory, and that formal memory assessment may not be measuring the memory skills that are required for effective everyday functioning.

Kladis and colleagues (2004) stated that formal testing and everyday memory are unique constructs, Sunderland and colleagues (1983) presented a strong case supporting the view that objective memory assessments say little about the everyday requirements of memory function, and Toplak et al. (2013) posited that laboratory testing and rating scales offer important yet different information. Therefore the use of traditional lab based memory assessments may be an inappropriate measurement of validity when exploring memory questionnaires.

Interestingly, while the results of this research suggest that the CMQ-R is not reflecting measures of formal memory assessment, when the CMQ-R results were compared across clinical and school groups there was a significant difference. This suggested that the CMQ-R is able to identify differences between the school and clinical group. It is possible that the CMQ-R may be identifying elements of attention that may be more noticeable in a natural home environment. However, given that the CMQ-R is based on the Everyday Memory Questionnaire (Sunderland, et al., 1983), and that the CMQ-R’s factors are consistent with current concepts of memory, it is not unreasonable to suggest that the CMQ-R is identifying everyday memory.

A major limitation to this study was the low participation rates and the lower than expected memory deficits in the clinical group. However, while the inclusion of a larger clinical group may be an improvement, it is considered that future research would benefit
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more from exploring the CMQ - R in the context of the everyday memory literature. It has been argued that formal memory assessment does not offer an accurate or meaningful view of an individual’s everyday experience with memory impairments. Similarly the CMQ - R does not appear to reflect memory as it is assessed with formal measurements. In addition, this study supports prior research which indicates only a modest relationship between observer rating scales and more objective memory tests. Therefore the results of this study conclude that the CMQ - R is potentially a viable contributor to everyday memory research and rather than attempting to establish the CMQ - R as a screening tool to aide formal memory assessment, future studies could further explore the specific elements of everyday memory and investigate further the CMQ- R’s relationship with these.
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References


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*Lancet, 368*, 2167-2178.


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**Extended Discussion**

It has been established that memory plays a significant role in early development, and that problems with memory functioning in children can result in impaired learning across a broad range of areas. It is also noted that many acquired and developmental conditions of childhood that may present with memory impairment (Baron, 2004), may in fact be due to problems in attention, learning, or behaviour and it can be difficult for clinicians to accurately distinguish between these. It is essential that memory deficits are accurately identified so that early interventions can be developed however the time and cost involved in formal measures of memory assessment make it an unattainable resource for many families and children. Further, there is some controversy within the literature as to the ecological validity of formal objective memory assessment.

The goal of this present study was to build on the earlier work of Drysdale, et al. (2004) by collecting a new sample and exploring the CMQ-R using factor analysis. Due to the fractionised nature of memory it was considered that a factor analysis on the CMQ-R might produce subgroupings that may reflect various elements of memory, and that these may provide stronger correlations with formal memory assessment than an overall CMQ-R score.

An analysis of the CMQ-R concluded high internal validity. Consistent with the Drysdale study, test-retest reliability for the CMQ-R was also strong. A factor analysis concluded moderate to strong loadings for three main factors and these factors were consistent with theoretical concepts of memory; factor one represented episodic memory, factor two represented visual memory and factor three represented working memory/attention. Factor one primarily consisted of forgetting to do things, forgetting routines, forgetting things that had been told to him/her and losing things. It contained questions such as “Forgets to take things with him/her or leaves things behind and has to go back for them”, “Forgets where
CHILDREN’S MEMORY QUESTIONNAIRE

she/he has put something”, and “sets off to do something then seems to forget what it was he/she wanted to do”. Factor two primarily consisted of forgetting things that involve visually identifying people places and things and includes questions such as Forgets the names of friends or relatives they know quite well. Gets lost or turns in the wrong direction in places she/he has been to before, and fails to recognise well known television characters or other famous people by sight. Factor three is primarily concerned with working memory and attention and consists of questions such as “Requires information to be repeated several times before they grasp what they are doing”, and “Has difficulty learning new things by hearing instructions and loses track of what someone is trying to tell her”.

Of particular note is that the third factor which indicated that the CMQ-R was identifying attention difficulties in children. Attention may be an element of memory that is not as great a problem in formal memory assessments due to the one to one nature of testing which may facilitate the maintenance of focus and attention (unless the attentional problems are severe). In contrast, poor attentional capacity may be easier to assess when parents are using the CMQ-R as they are reflecting on their observations of their child’s difficulties in their normal environment.

A comparison of each of the CMQ-R factors with the memory tests resulted in significant correlations. Given that the factors reflected theoretical conceptualisations of memory there is support that the CMQ-R is indeed measuring elements of memory. However as the correlations between the factors and the formal memory test were weak, there is also some support for the notion that the CMQ-R is assessing a different aspect of memory than formal memory tests.

It was anticipated that with a more robust clinical sample, the CMQ-R would be able to accurately reflect variations in participants’ memory abilities as identified by formal memory tests. However, while this was the original intention of the study, a clinical sample
of this nature was not obtained. The clinical group provided a lower than expected sample size and contained less than intended primary memory deficits. However, the premise that the CMQ-R would reflect formal memory assessment was still explored and it was partially supported with significant correlations in the school sample for the subtests Verbal Learning, Verbal Learning Recognition, Story Memory, and Story Memory Delayed, though these correlations were consistently weak. In contrast, correlations on the clinical sample did not produce any significant results, although it is noted that this may be due to its small sample size.

Comparisons between the CMQ-R scores and formal memory testing resulted in significant yet weak correlations. One explanation for this lack of correspondence is that the CMQ-R may indeed be measuring different components of memory to the formal memory tests and it was considered a reasonable hypothesis that the CMQ-R may be measuring everyday memory, and that formal memory assessment may not be measuring the very memory skills that are required for effective everyday functioning. Interestingly, when the CMQ-R results were compared across clinical and school groups there was a significant difference, indicating that the CMQ-R is identifying some kind of difference between the two groups. Given that the CMQ-R is based on The Everyday Memory Questionnaire (Sunderland, et al., 1983), that the CMQ-R’s factors are consistent with current concepts of memory, and that the significant correlations between the CMQ-R and formal memory tests were consistently weak, it is not unreasonable to suggest that the CMQ-R is identifying everyday memory.

It has been argued that formal memory assessment does not offer an accurate or meaningful view of an individual’s everyday experience with memory impairments. Sunderland, et al. (1983) offered support for this argument by comparing formal test performance of individuals with head injury, and relating this to self-descriptions of everyday
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memory functioning. Results of this study concluded that the formal memory assessments accurately identified memory deficits in response to head injury however were unrelated to complaints regarding everyday memory skills. One possible explanation for this lack of correspondence could be that the questionnaire had poor validity. However, while the objective and subjective measures of memory did not correlate, the questionnaire was able to accurately separate the group with head injury from the control group. This suggests that the questionnaire was valid however may have been measuring a different form of memory than the formal assessment.

Toplak, West and Stanovich (2013) explored performance based measures and rating scales as used for typically assessing executive function in clinical and neuropsychological assessments. Correlations between performance based measures and rating scales of executive functions were low and the conclusion drawn was that the two different types of measures are assessing different aspects of cognitive functioning. This suggests that as the two types of assessment are measuring different domains they cannot be used interchangeably and that each assessment style provides different types of important and valuable information. Similarly, Barkley (2012), compared laboratory based assessment to observational studies in relation to executive functioning. He surmised that neuropsychological tests of executive function have consistently shown poor to moderate reliability and little ecological validity. Further, he stated that tests of executive function share 0-10% of their variance with executive function ratings or observations. It is Barkley’s view that this is due to the inadequacy of a clinical assessment to capture the complexity of goal-directed self-regulation of emotion and motivation, or the social reciprocity that impacts and interacts with behaviour. Barkley discusses a brain-behaviour relationship that is relevant in predicting how well people function in everyday life and
CHILDREN’S MEMORY QUESTIONNAIRE concludes that laboratory tests of executive function are not sampling the same constructs as executive function ratings or direct evaluations in daily life.

The everyday memory literature argues that the ability to effectively apply memory to everyday life is influenced by the interaction and subsequent feedback of human behaviour with the environment, and to separate these elements and attempt to assess them individually provides inaccurate information (Anderson, 2014a; 2014b, Ceci & Bronfenbrenner, 1991; Stein, 2013). Further, it is considered possible that rating scales are more relevant than lab based assessments in terms of functional everyday outcome and may be better at predicting functional problems. Sunderland and colleagues presented a strong case in support of the view that objective memory assessments say little about the everyday requirements of memory function and Kladis, et al. (2004) stated that formal testing and everyday memory are unique constructs. This suggests that the use of formal tests which occur in a clinician’s office may be an inappropriate measurement of validity when exploring memory questionnaires. Similarly the CMQ did not reflect memory as it was assessed with formal measurements.

It is noted that there are developmental changes in memory which were not reflected in the questionnaire results. It is considered that this is due to the questionnaire having limited validity in relation to formal memory assessment. The lack of change in questionnaire results is probably due to the parents’ expectations of their child’s memory performance and this is one of the problems of questionnaire reporting. Parents are likely to respond to the CMQ-R questions in relation to what they consider to be normal/average for a child of a certain age.

This study was limited due to the low participation rates and the lower than expected memory deficits in the clinical group and future studies may benefit from the inclusion of a greater number of clinical participants who have sustained neurological damage and/ or
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disease that typically results in memory impairment. However, while the inclusion of a larger more robust clinical group may be an improvement to this study, it is considered that future research would benefit from exploring the CMQ-R in the context of the everyday memory literature. This study supports prior research which indicates only a modest relationship between observer rating scales and more objective memory tests. Results conclude that the CMQ-R is potentially a viable contributor to everyday memory research and rather than attempting to establish the CMQ-R as a screening tool to aide formal memory assessment, it may be within the context of the everyday memory research that the CMQ-R has relevance in the scientific analysis of memory. It is therefore recommended that further research explore the specific elements of everyday memory and investigate further the CMQ-R’s relationship with these.
References


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impact on social development at 8 years of age. *Brain Injury, 24*, 1003-1007.


CHILDREN’S MEMORY QUESTIONNAIRE

Taylor, G. H. (2009). Children with very low birthweight or very preterm birth. In, K. Yeates, 
_Pediatric Neuropsychology: Research, Theory and Practice_ (2nd ed.). New York: 
Guilford Press.

working memory components and ADHD symptoms from a developmental 


Tulving, E. (2013). _Memory Consciousness and the Brain: The Tallinn Conference_. Hoboken: 
Taylor & Francis.


Vallat-Azouvi, C., Pradat-Diehl, P., & Azouvi, P. (2012). The working memory questionnaire: 
A scale to assess everyday life problems related to deficits of working memory in 
brain injured patients. _Neuropsychological Rehabilitation_, 22, 634-649.

Watson, S., Gable, R. (2012). Unravelling the complex nature of mathematics learning 
disability: Implications for research and practice. _Learning Disability Quarterly_, 36, 
178-187.

(WISC-IV)_ . San Antonio, TX: Pearson.


Appendix A

The Children’s Memory Questionnaire
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Children's Memory Questionnaire

<table>
<thead>
<tr>
<th>Child's Name:</th>
<th>Date of Birth:</th>
<th>Male/Female:</th>
<th>Completed by:</th>
<th>Date:</th>
<th>School:</th>
<th>Class:</th>
</tr>
</thead>
</table>

The Questionnaire is best completed by the parent who spends most time with the child.

Below is a list of problems children might experience with memory. Please rate how often your child experiences these problems by circling the number for the description that best matches your child.

1 = Never or almost never happens; 2 = Happens less than once a week; 3 = Happens about once a week; 4 = Happens once or twice in a week; 5 = Happens more than once a day

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Forgets where she/he has put something</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Forgets new schoolwork that they seemed to know yesterday</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Forgets the name of someone she/he met for the first time recently</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Forgets to take things with him/her or leaves things behind and has to go back for them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Has trouble completing multi-step instructions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Forgets a change in the daily routine such as a change in the place where something is kept, or in the time something happens</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Gets lost in places she/he has only been once or twice before</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Forgets to do things they said they would do or had arranged to do</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Fails to recognize by sight people that she/he meets frequently, e.g. relatives or friends</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Loses track of what someone is trying to tell him/her</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Slow to pick up a new skill such as a game or working some new gadget</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>Forgets when it was that something happened, e.g. whether it was yesterday or last week</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>Forgets some or all of what she/he did yesterday or a few days ago</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Forgets what she/he was told a few minutes ago</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>Loses things</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>Forgets to tell someone something important such as passing on an important message</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>Slow to learn new routines</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>Unintentionally repeats something she has just said or says the same thing several times</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19</td>
<td>Fails to recognize someone she/he met for the first time recently</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>Seems not to listen to what people say to him/her (and not just being oppositional)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21</td>
<td>Sets off to do something, then seems to forget what it was she/he wanted to do</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22</td>
<td>Requires information to be repeated several times before they grasp what they are being asked to do</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23</td>
<td>Other people (teachers, friends, relatives, etc) report that his/her memory is poor</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24</td>
<td>Unknowingly tells someone a story or joke she/he has told that person before</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>25</td>
<td>S/he complains that they have a poor memory (not simply making excuses)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>26</td>
<td>Gets lost or turns in the wrong direction in places she/he has been to before</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>27</td>
<td>Forgets the names of friends or relatives they know quite well or calls them the wrong name</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>28</td>
<td>Forgets what she/he was told a few hours or more ago</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>29</td>
<td>Seems to forget something she/he has just said</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>Has difficulty learning new things by hearing instructions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>31</td>
<td>Fails to recognize well known television characters or other famous people by sight</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>32</td>
<td>Forgets the names of common things or uses the wrong names for them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>33</td>
<td>It seems that if she/he does not do things as soon as they think of them they will forget them altogether</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>34</td>
<td>Does not recognize places she/he has often been to before</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>35</td>
<td>Gets the details of what someone told him/her mixed up and confused</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>36</td>
<td>Finds television shows or movies (suitable for their age) difficult to follow</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix B

Information and Consent Forms for Participants
CHILDREN'S MEMORY QUESTIONNAIRE

RESEARCH PROJECT

Information Statement

Research Project Chief Investigator:
Dr Wayne Levick (Senior Clinical Neuropsychologist, John Hunter Children's Hospital)

Contact Details:
John Hunter Children's Hospital
Locked Bag 1
Hunter Region Mail Centre NSW 2310
Telephone: 49213752

Co-investigator:
Dr Karen Drysdale (Lecturer, School of Psychology, University of Newcastle)

Student researcher/Intern Clinical Psychologist: Ms Rebekah Hedges

Research Assistant: Ms Brooke Sinderberry (PhD candidate)

Contact Details:
School of Psychology
University of Newcastle
Callaghan
Telephone: 49217120

Dear Parent/Guardian,

We would like to invite you and your child to assist us in the development of a children’s memory questionnaire. Many children are at risk of developing memory problems as a result of various disorders, injuries or diseases including epilepsy, head injury, and diabetes. Memory problems affect learning and therefore the academic and social development of the child. When children are at risk of memory problems it is vital that they are detected early so children can be thoroughly assessed and remediation and/or rehabilitation undertaken. The Children’s Memory Questionnaire we are developing will be completed by the parents/carers of children at risk, to assist doctors and other health professionals in the early detection of memory problems.

Part of this research will form Rebekah Hedges’ research thesis for her Doctor of Psychology degree. Ms Hedges is an intern clinical psychologist currently enrolled at the University of Newcastle.

If you have previously received a request to be involved in this study and to complete the Questionnaire and have previously done so, please discard this material.

How you can help

The reason we seek your help is that we need to know about the memory of normal, healthy children before we can tell if a child at risk of memory problems does actually have them i.e. we need to know what is normal before we can tell what is not normal.

We also need to know about the memory of children who have developmental or medical conditions or histories that could be associated with memory problems. Therefore, we ask that before you complete the memory questionnaire that you check the Medical Check Form. This will enable us to group the questionnaire results for comparison of children who are not expected to have any memory problems and those who may have such problems.
We need to make some checks on our questionnaire to be sure that it is a good one. To make one of these checks (that the questionnaire is stable and reliable) we also ask you to complete the questionnaire on a second occasion, about 3 to 4 weeks later. If you agree, a second copy will be provided for you when required.

It is possible that when you complete the Questionnaire it may draw your attention to difficulties your child is experiencing that you had not previously considered. If this occurs you should discuss your concerns with your family doctor.

**How your child can help**

We ask your child's help to check that the Questionnaire gives useful information about memory. To check for this we need to carry out tests of your child’s memory which we can then compare with the questionnaire. If the results of the assessment and questionnaire are similar then we know that the questionnaire is a useful one. We also need to briefly assess some aspects of your child's knowledge and reasoning to check that the questionnaire is about memory and not about these other sorts of abilities. To provide this check an appropriately qualified person (Ms Hedges or Ms Sinderberry) will assess your child at school in an individual session lasting about 60 minutes over the next few weeks. The assessment involves puzzle-solving and knowledge of words and remembering pictures, designs, short stories, sentences, and words/numbers. These tasks have been designed to be suitable and enjoyable for children.

An information sheet designed for children is included for your child to read or for you to use as a basis for explaining the project to younger children.

To complete this check of the Questionnaire we do not need to test all of the children for whom a Questionnaire has been completed. We will test only those children in the 6, 8 and 10 year age groups.

**Confidentiality**

Individual results of assessments and questionnaires will be confidential and only available to the research personnel involved. The questionnaires, assessment results, and consent forms will be locked in files at the John Hunter Children's Hospital. The questionnaires and test forms will be retained for five years. A summary of the outcomes of the study will be sent to participating schools for distribution to all participants. The results of this study may be presented in the scientific arena through presentation at conferences or publication. Only group results will be presented or published; individual participants will not be identified.

**Voluntary Participation**

We have permission from your school's principal to ask for your participation in this research project. If you decide not to participate in this study it will in no way prejudice your child's academic standing or relationship with the school. Participation in the study is entirely voluntary. You may withdraw yourself and your child from the study at any time without explanation and without notice.

**Further Information**

Please contact Dr Wayne Levick (see contact details above) if you require any further information about this research project.

**Complaints Procedure**

This research has been approved by the Hunter New England Human Research Ethics Committee, Hunter New England Health, Reference Number: 09/02/18/5.12.

Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to Dr Nicole Gerrand, Professional Officer (Research Governance and Ethics), Hunter New England Human Research Ethics Committee, Hunter New England Health, Locked Bag 1, New Lambton NSW 2305, telephone (02) 49214950, email hnehrec@hnehealth.nsw.gov.au.
CHILDREN’S MEMORY QUESTIONNAIRE

CHILDREN’S MEMORY QUESTIONNAIRE

RESEARCH PROJECT

Consent Form

Your consent to participate in this project will be given by your completing the questionnaire and returning it to the school or to the researchers with this consent form.

For your child’s agreement, and your permission for his/her participation in the cognitive assessment to be conducted at the school, please complete the following.

I have discussed with my child her/his participation in this study and what is required of him/her. My child has agreed to participate in the study.

I give my permission for my daughter/son

First Name ____________________________

Family Name ___________________________

Date of Birth __________________________

to participate in the research project described in the information sheet provided. I understand that the project will be carried out as described in the Information Sheet, a copy of which I have retained. I have had all questions answered to my satisfaction.

I understand that by signing this form, I give my consent freely. I also understand that:

1. Participation in the study is voluntary,

2. I may withdraw myself and my child from the study at any time without explanation and without notice,

3. All information will be treated respectfully and confidentially and be available only to the research personnel involved in the study,

4. This research has been approved by the Hunter New England Human Research Ethics Committee of Hunter New England Health, Reference Number: 09/0218/5.12.

Signed __________________________________

Child’s School ____________________________

Child’s Class _____________________________

PLEASE RETURN THE SIGNED COPY OF THE CONSENT FORM AND THE COMPLETED QUESTIONNAIRE TO YOUR CHILD’S SCHOOL. KEEP THE OTHER CONSENT FORM AND THE INFORMATION SHEET AS YOUR OWN COPIES.
### Correlation Matrix for CMQ-R scores and WRAML Memory Subtests.

<table>
<thead>
<tr>
<th>Groups</th>
<th>6yrs</th>
<th>8yrs</th>
<th>10yrs</th>
<th>12yrs</th>
<th>a</th>
<th>B</th>
<th>a</th>
<th>B</th>
<th>a</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Learning</td>
<td>-.053</td>
<td>-.225</td>
<td>-.318</td>
<td>.225</td>
<td>-.415</td>
<td>-.072</td>
<td>-.225</td>
<td>-.938</td>
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<tr>
<td>Visual Learning</td>
<td>-.220</td>
<td>.370</td>
<td>-.214</td>
<td>-.622</td>
<td>.000</td>
<td>-.953</td>
<td>-.263</td>
<td>-.572</td>
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<td></td>
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<tr>
<td>Story Memory</td>
<td>-.278</td>
<td>-.292</td>
<td>-.395</td>
<td>.360</td>
<td>-.315</td>
<td>.919</td>
<td>-.252</td>
<td>-.120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finger Windows</td>
<td>-.196</td>
<td>-.532</td>
<td>-.134</td>
<td>.295</td>
<td>.11</td>
<td>.769</td>
<td>-.268</td>
<td>.365</td>
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</tr>
<tr>
<td>Verbal Learning Delayed</td>
<td>-.240</td>
<td>.225</td>
<td>-.270</td>
<td>.363</td>
<td>-.159</td>
<td>-.346</td>
<td>-.186</td>
<td>-.787</td>
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<tr>
<td>Verbal Learning</td>
<td>-.217</td>
<td>-.999</td>
<td>-.366</td>
<td>-.006</td>
<td>-.040</td>
<td>.258</td>
<td>-.300</td>
<td>-.849</td>
<td></td>
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<tr>
<td>Recognition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Story Memory Delayed</td>
<td>-.148</td>
<td>.405</td>
<td>-.407</td>
<td>.301</td>
<td>-.311</td>
<td>-.346</td>
<td>-.415*</td>
<td>-.465</td>
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<td></td>
</tr>
<tr>
<td>Story Memory</td>
<td>-.257</td>
<td>-.225</td>
<td>-.101</td>
<td>-.045</td>
<td>-.262</td>
<td>-.346</td>
<td>-.213</td>
<td>.036</td>
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</table>

### Correlation Matrix for CMQ-R scores and Memory Subtests with Ages Combined.

<table>
<thead>
<tr>
<th>CMQ-R</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Learning</td>
<td>-.235*</td>
<td>-.404</td>
</tr>
<tr>
<td>Visual Learning</td>
<td>-.130</td>
<td>-.314</td>
</tr>
<tr>
<td>Story Memory</td>
<td>-.237*</td>
<td>.000</td>
</tr>
<tr>
<td>Finger Windows</td>
<td>.030</td>
<td>.210</td>
</tr>
<tr>
<td>Verbal Learning Delayed</td>
<td>-.164</td>
<td>-.276</td>
</tr>
<tr>
<td>Verbal Learning</td>
<td>-.276*</td>
<td>-.312</td>
</tr>
<tr>
<td>Recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Story Memory Delayed</td>
<td>-.321*</td>
<td>-.176</td>
</tr>
<tr>
<td>Story Memory</td>
<td>-.108</td>
<td>-.136</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.006 level (2-tailed).

Bonferroni adjusted alpha levels (0.05/8).

a = School Group

b = Clinic Group
Appendix D

Authors Instructions for the Journal of Applied Neuropsychology: Child

**Aims and Scope.** *Applied Neuropsychology: Child* publishes clinical neuropsychological articles concerning assessment, brain functioning and neuroimaging, neuropsychological treatment, and rehabilitation in children and adolescents. In contrast to other journals, *Applied Neuropsychology: Child* is solely focused on clinical applications with children and adolescents. Full-length articles addressing current professional, educational, and ethical concerns, reviews of current conclusions from the scientific literature concerning the nature, assessment, course, or treatment of child and adolescent neuropsychological dysfunctions, reviews of books and tests, and brief communications are included. Case studies of child and adolescent patients carefully assessing the nature, course, or treatment of clinical neuropsychological dysfunctions in the context of scientific literature, are suitable for the Grand Rounds section. Preference is given to papers of greatest clinical relevance to others in the field.

**Editorial Style and References.** Manuscripts should be prepared according to the *Publication Manual of the American Psychological Association* (APA; 6th ed., 2001). References should be double-spaced, with text citations corresponding accurately to the references in the reference list. Journal names must be spelled out, and chapters from edited books must have a page range provided.