INDIVIDUAL AND DEVELOPMENTAL DIFFERENCES
IN CHILDREN’S WORKING MEMORY
AND ORAL LANGUAGE

by

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ABSTRACT

The relationship between working memory and oral language production in Kindergarten children was examined to determine whether specific language processes are associated with a developing working memory system. Two main issues were investigated: (1) whether children's oral language production results from differences in short-term memory capacity or if an executive memory system plays a role; (2) if information processed in the working memory system is general or specific to language demands of oral language production.

Correlational and general linear modelling analysis showed that variation in children’s oral language production is explained by differences in an executive working memory system rather than by short-term memory capacity. Results indicate the working memory system that underlies oral language production is best conceptualised as multidimensional, in which visual working memory underlies the language system associated with narrative language tasks and a more generalized working memory system underlies the language system associated with expository tasks.

Keywords: working memory, oral language production
To my parents,
Klaus and Renate - for inspiring me
to always set my sights high and
convincing me to never give up.
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CHAPTER 1
INTRODUCTION

Much cognitive activity rests on the ability of individuals to maintain temporarily, as well as transform, information relevant to a task within working memory (Baddeley & Hitch, 1974; Turner & Engle, 1989; Just & Carpenter, 1992). Working memory is defined here as a flexible workspace for the storage of incoming information while the same or other information is being simultaneously manipulated (Just & Carpenter, 1992; Swanson & Berninger, 1994). Most current models of memory distinguish working memory from the simple storage properties of short-term memory (Anderson, 1983; Baddeley, 1986; Baddeley & Hitch, 1974; Daneman, 1987; Daneman & Carpenter, 1980, 1983). Short-term memory has traditionally been viewed as a temporary buffer, in which a limited number of items can be maintained using simple strategies such as rehearsal or chunking. In contrast, working memory is often considered to be a more flexible computational arena, with a limited amount of attentional resources required for the processing and manipulating of information and for storing the partial and final products of these processes. Thus, working memory functions as an executive space where products of cognitive processes are retained and reintegrated with other information to generate a representation of the task at hand.

Recent research suggests that individual differences in working memory capacity are associated with variations in the expressive language abilities of young children, however, the nature of these relations remains unclear. In a study of children's early
language and short-term memory development, Adams and Gathercole (1996) found that the spontaneous speech of 3-year-old children with large memory capacities contained greater variation in vocabulary, longer mean length of utterance (calculated using bound morphemes as the unit of analysis), and a broader range of syntactical constructions than did the spontaneous speech of their same-age peers with small memory capacities. A further study, involving 4- and 5-year-old children showed that differences in short-term memory abilities were associated with differences in narrative oral language skills (Adams & Gathercole, 1996). Thus, evidence suggests that there is a significant association between language development and short-term memory skills.

In other studies, evidence of verbal memory deficits have been found in children with impaired language development (Haynes & Naidoo, 1991; Kamhi, Catts, Mauer, Apel & Gentry, 1988; Kirchner & Klatzky, 1985; Taylor, Lean & Schwartz, 1989). For instance, Gathercole and Baddeley (1990) showed that language-delayed children had impaired memory skills, as assessed by non-word repetition performance, relative to two control groups, one matched on language age and one matched on non-verbal abilities. Importantly, their findings suggest that the memory impairments were not explicable in terms of deficits in speech perception or articulatory output abilities.

Whereas this body of research has demonstrated a link between memory and early language processes, the specific nature of the processes that underlie this relationship is unclear. Several issues regarding the relationship between working memory and oral language production need to be resolved.
One issue concerns whether individual and age variation in young children’s oral language production is best explained by developmental or individual differences in short-term memory capacity or whether an executive working memory system also plays a role. The model of working memory proposed by Baddeley and Hitch (1974) and more fully developed in 1986 (for more recent versions of this model, see Baddeley, 2000) has the potential to inform research on this issue. Baddeley’s model proposes three primary components of a working memory system: the central executive, the phonological loop, and the visuo-spatial sketchpad. The central executive is a limited capacity supervisory system that “schedules” and controls processing operations and holds incoming information for processing while storing the products of processing for use and/or integration with previous or yet to be received information (Baddeley, 1986). It provides the interface with information stored in long-term memory, and controls the processing of two “slave” systems: the phonological loop and the visuo-spatial sketchpad. Unlike the central executive that extends its influence across different modalities, these two subcomponents are dedicated to specific information processing domains, namely verbal information (the phonological loop) and visual-spatial information (the visuo-spatial sketchpad).

In Baddeley’s view, short-term memory and working memory are separate constructs. The processing space allocated to working memory is particularly important to higher-level cognition. Logically then, increased working memory capacity is expected to be a more important factor in explaining developmental and individual differences in complex forms of language production, than short-term memory, which is expected to play a more important role in less demanding aspects of language production.
A second issue concerns whether the information processed in the working memory system is general or whether the system is specific to language demands of oral language production. A number of information processing researchers utilize the idea of a global resource such as Baddeley’s central executive to explain the control of memory. Support for this model comes primarily from studies of comprehension of language (Just & Carpenter, 1992) and reading material by adolescents (Swanson & Alexander, 1998) and adults (Salthouse, 1990). In these studies, measures of both visual spatial and verbal working memory were found to predict performance on these language tasks. A competing model of working memory asserts that multiple components in a working memory system are defined by the kind of task-specific information processed (Daneman & Carpenter, 1980; Daneman & Tardiff, 1987). Research in support of a task-specific working memory system is provided by studies of print processing among older children and adults that show that reading comprehension is better predicted by performance on Sentence Span (a verbal task) than by Math and Spatial Span (non-verbal) tasks (Daneman & Carpenter, 1980). Whether the working memory system that underlies language production is best conceptualised as a generalized processing resource or a domain specific resource requires investigation.

The purpose of this study is to examine (1) whether young children’s oral language production results from individual differences in short-term memory capacity or whether an executive memory system plays a role and (2) whether the information processed in the working memory system is general or specific to language demands of oral language production. There are five specific research questions that are addressed.
First, the relationship between working memory and oral language production in children at various ages will be examined to determine whether specific language processes are associated with a developing working memory system. Age variation in working memory capacity is expected to predict developmental variation in children's ability to perform complex language tasks. Specifically, correlations obtained between measures of working memory and higher-order language skills (e.g., structural complexity) are expected to be significantly higher than correlations found between measures of working memory and lower-order language skills (e.g., syntactical complexity). Moreover, these findings are expected to be consistent across language tasks.

Second, in keeping with the idea that the working memory system operates independently from short-term memory, the magnitude of the association found between working memory and language production on complex language tasks are expected to be greater than the magnitude of the associations obtained between short-term memory and language production.

Third, it is of interest to determine whether individual differences in children's working memory capacity predict variation in children's ability to perform on complex language tasks independent of the variance in oral language production attributable to differences in age. It is expected that after controlling for the effects of age, working memory capacity will be more highly correlated with oral language measures tapping high-order language processes (e.g., structural complexity) than lower-order language processes (e.g., syntactic complexity) on both narrative and expository tasks.
Fourth, a general capacity model of working memory assumes that language production demands activation of several generalized processes which are prioritised by the executive, prior to output. Because the coordination of resources by the working memory executive is a function of domain general demands, independent of verbal ability, evidence for a domain general working memory system is found when correlations of similar magnitude are obtained between verbal and visual working memory and language production on both expository and narrative tasks. Alternatively, evidence for a domain-specific model of working memory will be found if variation in the pattern of correlations obtained vary across expository and narrative tasks, and/or across verbal and visual spatial working memory measures.

Lastly, it is expected that the language elicited from children with large working memory capacities will reflect deeper understanding and cognitive processing than the oral language production of children with smaller working memory capacities. This hypothesis will be tested by asking the children questions about the content of the stories that they create from describing events in a wordless picture book. Children with larger working memory capacities are expected to be better at taking multiple perspectives (of the characters within the story) because these children have more resources available to them to process the visual input required for this perspective taking.
CHAPTER 2
LITERATURE REVIEW

Recent research suggests working memory capacity is associated with variation in the expressive language abilities of young children (Adams & Gathercole, 1996; Blake et al., 1994; Kail, 1990; Kushnir & Blake, 1996). It has often been suggested that children's early progress in producing complex sentences is constrained by memory span. As early as 1964, Brown and Bellugi proposed that utterance length is controlled by a span limitation that grows less restrictive with age as a consequence of both neurological growth and practice. The explanation proposed by Brown and Bellugi (1964) asserts that there is a general restriction on the number of items of information a child can keep track of in a single mental act. The increase in a child's processing capacity with age results from neurological growth, or from the acquisition of more efficient information-processing strategies.

Brown (1973) pointed to a specific limit on the number of semantic relations a child is able to program into a single sentence, although he then stressed that the basis for this limit was linguistic rather than memorial. Children at first express complex meanings with a single word, eventually joining a second word to specify the meaning more precisely, then expanding 2-word utterances into 3-word, and so on. The notion that complex underlying structure can be found within 2-word, or even 1-word utterances of children has found support among several researchers (e.g., Bloom & Lahey, 1978; Greensfield & Smith, 1976). One implication arising from this assertion is that although
children may possess the semantic knowledge to intend complex meanings, limitations operate to prevent the expression of those meanings in a syntactically complex way.

Braine (1974) opposed such a “rich” interpretation of children’s early word combinations, denying that there is evidence of a constraint on length. Instead, he attributed the 1-word and 2-word utterances to children’s pragmatic tendency to label a single salient feature of an action, and to children’s low probability of multiple rule use.

Braine (1974) notes that mastery of rules is a matter of degree. In his words,

One can easily distinguish between initial mastery, which occurs when the rule can be demonstrated to exist by analysis of a corpus or by other tests, and final mastery, which occurs when the child uses the rule on essentially every occasion that its use is called for. Final mastery requires, over and above initial mastery, that the child have a sentence production program that incorporates the effect of the rule as an automatic routine (1974, p.456).

In general, linguistic and memorial factors may be viewed as interacting to determine the complexity of sentences. More specifically, as new linguistic structures are added, other productive factors, namely memory, linguistic encoding skills, and speech production abilities also play a significant role. As Ramer states,

Productive and memory abilities are developing concurrently with linguistic knowledge, allowing for the realization of greater utterance length which is needed to express or perform with newly acquired linguistic information (1977, p.159).

The outcome is an age-graded progression in the number of discrete items that the child can combine into a single, higher-order phrase.

The proposed relationship between memory and language is supported by findings suggesting that language-delayed children have a more limited memory span.
than non-delayed children. In their study, Menyuk and Looney (1976) found that only specific language impaired (SLI) children had difficulty repeating sentences longer than three words. In tasks measuring memory for location of items, Raine, Hulme, Chadderton, and Bailey (1991) found that SLI children over a wide age range (4 to 15 years) were deficient in matching probe cards to their corresponding face-down cards, while Wyke and Asso (1979) found that 7- and 8-year-old children with SLI were weak in reproducing the locations of targets in an array after an 8-second delay. In a further task, older children with SLI were found to be almost four times slower than their peers in the sequential scanning of digits in memory (Sininger, Klatzky & Kirchner, 1989).

Kushnir and Blake (1996), found that language-delayed children aged 3 to 5 years, had significantly lower memory spans on both word span and a missing-object recall task compared to non-delayed children matched on age, sex, and nonverbal IQ. Gathercole and Baddeley (1990) add that this selective deficit in auditory memory (word span) persists in older SLI children of elementary age and exceeds their vocabulary. Thus, Gathercole and Baddeley (1990) argue that the memory deficits of language-delayed children cannot be explained by vocabulary deficits but instead are due to deficits in memory capacity.

Direct tests of the proposal that language complexity is constrained by memory span in typical children are rare. However, Case and Kurland (1980) gave kindergarten children a word span test and a sentence imitation task and found that the children were not able to repeat correctly those sentences containing a number of phrases exceeding their word span. Memory demands of linguistic phrasal units matched children’s word spans. Daneman and Case (1981) taught children between the ages of 2 and 6 years
nonsense words that varied in syntactic complexity and that labelled actions differing in numbers of semantic features. Production and comprehension of these nonsense terms was better predicted by word span than by age. Furthermore, on both the production and comprehension tests, mastery of each additional level of complexity seemed to require an additional unit in terms of the mean word span for the group.

Apart from these few studies, research investigating the relationship between memory span and language production in young children is limited. Thus, the purpose of the current study was to test the proposed relationship between working memory span and the complexity of spontaneous language production in five-year-old children.

Models of Working Memory

As in previous research, working memory is defined here as a limited capacity processing resource which functions as a flexible workspace for the storage of incoming information while the same or other information is being simultaneously manipulated (Just & Carpenter, 1992; Swanson & Berninger, 1994; Turner & Engle, 1989). Within the framework of Daneman’s (1990) model of verbal abilities, working memory may affect three interactive processes: planning, storage, and executing. Speakers must plan what to say and temporarily store the plans until ready to execute them as words, phrases, and sentences. Moreover, at any instant, individuals may be planning what to say next while concurrently executing what was planned moments earlier (Clark & Clark, 1977; Ford & Holmes, 1978; Power, 1985, 1986). Hence, speaking involves a highly complex and skilful coordination of processing and storage requirements.
Working memory is thought to play an executive role in this complex interaction by providing resources to lower-order language processes such as syntactic complexity, and by providing a temporary storage space to juggle the multiple language demands inherent in higher-order language processes such as structural complexity. Several concerns regarding this relationship between working memory and oral language, however, have not been resolved.

Issues requiring investigation include whether the working memory system that underlies language production is best conceptualised as a generalized processing resource or a domain-specific resource. This concerns whether the information processed in the working memory system is general or whether the system is specific to language demands of oral language production. A second and related issue requiring investigation concerns whether age or individual differences in the relationship between the working memory executive and language is mediated by other cognitive systems.

Engle, Cantor, and Carullo (1992) provide four explanations of the working memory system. The first explanation, the general processing hypothesis, assumes that the cognitive processes underlying the working memory system are generalized to other areas of language production. In this view, individual differences in working memory occur because of increases in the efficiency of general cognitive operations. The notion of a common executive system is found in developmental theories and in information processing models (Baddeley, 1986; Cantor, Engle & Hamilton, 1991; Swanson, 1992; Turner & Engle, 1989). According to Pascual-Leone (1970) and Case (1974, 1985), a central processing resource is responsible for normal cognitive development across a wide variety of memory-related tasks. Pascual-Leone (1970) labels this resource "mental
power” or “M-Space” and defines it as the maximum number of schemes mentally activated at a given time. He assumes that M-Space increases with age as a result of changes in the brain that are determined by biological or epigenetic factors. He argues that keeping schemes active requires mental energy, and the amount of energy (i.e., mental power) increases developmentally. Thus, the number of schemes that a person can keep active increases developmentally. More recently, Case (1985) proposed a theory in which the intellectual change observed as a child matures is a direct consequence of the child’s ability to process more information in a given period of time. According to Case (1974, 1985), mental operations all require energy from a fixed pool of total resources, or mental space. Any space not allocated to the operations can then be used for maintaining the products of this mental processing and for representing schemes or knowledge structures retrieved from long-term memory. Hence, Case (1974, 1985) posits an “executive processing space” which is responsible for attention to novel or multiple dimensions of a task, as well as inhibition of simple strategy selection that can interfere with efforts to solve the task. Empirical support for a common executive is found in studies reporting significant, positive correlations between measures of working memory and executive function (Babcock & Salthouse, 1990; Fisk & Warr, 1996), developmental strategy use (Case, 1985) and prefrontal mediation (Pennington, 1994).

A number of information processing researchers also utilize the idea of a global resource to explain the control of memory. Baddeley and Hitch (1974), for example, argue that the central executive of working memory is a flexible work space with limited capacity that is used for processing incoming information and storing the products of that processing. Two slave systems, the phonological loop (which stores and rehearses
speech-based information) and the visual-spatial sketchpad (which manipulates visual images) are under the control of the central executive. Baddeley’s working memory model is considered a unitary memory system with multiple stores, under the control of this executive.

A second model of working memory asserts that the working memory system is defined by the kind of task-specific information processed (Daneman & Carpenter, 1980, 1983; Daneman, 1987; Daneman & Tardiff, 1987). In this task-specific view, processing and storage functions compete for the limited capacity in working memory. Limited resources exist which must be shared among the processing and storage demands of the task to which the working memory system is being applied. Moreover, individuals differ in the ability to coordinate the processing and storage functions. In particular, individuals with inefficient processes have a functionally smaller temporary storage capacity, because they must allocate more of the available resources to the processes themselves. Daneman and Carpenter (1980) argue that a functionally smaller storage capacity would lead to deficits in comprehension, particularly in the processes that integrate successfully encountered words, phrases, and sentences into a coherent representation.

Working memory processes are tailored to manipulate linguistic or symbolic information only, and are dependent upon the cognitive requirements of a task. Research in support of a task-specific working memory system is provided from studies of verbal fluency which show that whereas speaking span is related to individual differences in verbal fluency on speech and reading tasks, reading span is only significantly related to individual differences in verbal fluency on the reading task.
A third explanation of the working memory system assumes that working memory is synonymous with the total amount of activation available on a knowledge net (Just & Carpenter, 1992; Turner & Engle, 1986, 1989). In this general capacity model, developmental constraints in working memory capacity reflect limitations in access to long-term memory. This view sees individual and age-related differences in working memory as reflecting differing activation limits, independent of task demands (Cantor & Engle; 1993, Conway & Engle, 1996). Working memory is not about memory per se; it is about individual differences in executive attention.

Applied to oral language production, a general capacity view holds that young children have smaller working memory capacities and therefore have limited access to long-term memory. From this perspective, limitations in working memory capacity reflect constraints on storage and/or processing functions. Due to the constraints in working memory capacity, an executive is necessary for the monitoring of information and the allocation of a limited pool of resources in lower-order systems. Thus, for proficient children, the executive resource pool (activation of information in long-term memory) is larger and is not deleted to the same extent as the pool of resources available to children who have smaller working memory capacities. That is, the cognitive demanding process or oral description strains working memory resources, consuming more available working memory capacity. Thus, when working memory demands are high, children with relatively smaller working memory capacities will differ from that of children who have more available access to resources in long-term memory.

A fourth, alternate model of working memory is the strategic allocation hypothesis. In this model, the relationship between working memory scores and higher-
level cognitive tasks are attributed to how subjects allocate their working memory resources during strategic cognitive tasks. That is, high-span children score high in the working memory tasks because they allocate their resources across tasks to maximize their span scores. These children may be more likely to use intelligent strategies causing their scores to be higher. In other words, the high-span children may just be more planful, and not have access to more working memory resources, per se.

**Syntactic Analysis and Working Memory**

Syntactic organization allows us to build nonsequential grammatical structures out of a sequence of words. Even though an utterance must have a linear sequential structure, the underlying concepts are not linearly related to each other, nor are the grammatical relations among the words strictly between adjacent words. Syntactic organization allows a sequence of words to coalesce to form higher order constituents (phrases and clauses) that can bear a variety of grammatical relations to each other. The syntactic organization provides part of the temporary structure to organize the words until the underlying concepts are understood. The coalescence occurs in working memory, where the cumulating transient structure is held.

Syntactic processes help structure information so it can be held in working memory until the succeeding parts of the sentence are processed and while other nonsyntactic processes are executed. In order to produce an utterance which has coherent semantic organization and appropriate syntactic structure, a speaker must plan at least part of the utterance in advance. Using clauses of different syntactic types, Ford and Holmes (1978) demonstrated that decisions must be made about syntax during sentence
production. Hence, speaking involves a highly complex and skilful coordination of processing and storage requirements.

These syntactic computations can, however, compete with the storage functions of working memory. Syntactic structures may tax working memory in a way that illuminates the trade-off between syntactic processing and working memory storage in individuals with varying working memory capacities. To demonstrate this, Larkin and Burns (1977) extensively studied center-embedded clauses such as: “The salesman that the doctor met departed.” They found that subjects who listened to sentences with a single center-embedded clause made errors in paraphrasing them approximately 15% of the time. Errors rose to 58% if the sentence contained a double center-embedding such as: “The salesman that the doctor that the nurse despised met departed”. Just, Carpenter and Woolley (1982) found that the difficulty is most severe for subjects with low working memory spans, and that such subjects are particularly susceptible to interference from a concurrent memory load. The high-span subjects had relatively little difficulty with the center-embedded sentences. The medium- and low-span subjects, in contrast, took longer and showed noticeable elevations in reading times in the area that introduced the most complex syntactic computations. Hence, this study demonstrates that comprehension ability is closely related to the ability to perform syntactic computations, and it links this ability to storage and processing resources in working memory.

The current research was undertaken to investigate the relationship among working memory and oral language abilities among 5-year-old children. Working memory scores were analysed in relation to syntactic and structural complexity of children’s oral language on both expository and narrative tasks. I hypothesize that
children's progress in producing complex verbal output is constrained by a limited programming or memory span. Further, I hypothesize that memory span will predict both expository and generative language complexity beyond the variation attributable to age, but that the greater linguistic knowledge of older five-year-olds alters the operation of a memory constraint.
CHAPTER 3
METHODOLOGY

Research Design

This study employed a correlational research design. This design was chosen to examine associations among measures of verbal ability, oral language, short term memory, working memory, and inhibitory control. Correlations among the variables were examined using the Statistical Analysis System (SAS) to determine if, where, and to what degree, relationships among the variables existed.

Participants were grouped based on age and then investigated to determine if groups differed on the dependent variables of working memory and oral language skills. Children were administered verbal and visual working memory tasks. Oral language was elicited from the children by asking them to create a story from a wordless picture book and by explaining the rules of their favourite game. The language produced was examined in regards to children’s mean length of utterance (MLU), bound morphemes, cohesion as well as phrasal complexity, and compared to children’s working memory, short-term memory and IQ scores. Children were also asked two questions as they created their stories from the wordless picture book. Both questions required that the child take the perspective of characters other than the protagonist.
Participants

Fifty Kindergarten children (27 males, 23 females) from urban areas of British Columbia’s Lower Mainland participated in the study. All participants were part of a larger, longitudinal study of working memory and writing relations among young children. The subjects ranged in age from 60 to 74 months (mean = 67.4 months). They were divided for statistical analysis into three groups based on age. The younger group ranged in age from 60 to 64 months (n = 17). The middle group ranged in age from 65 to 69 months (n = 17) while the older group consisted of children aged 70 to 74 months (n = 16). All participants spoke English as their primary language and came from middle or upper class backgrounds.

Measures

Participants were administered measures of working memory, short-term memory, inhibitory control, and oral language production. All administered measures were selected according to the following criteria: (1) the measure has established psychometric properties; (2) the measure has established reliability and validity based on previous research; (3) the measure is age appropriate for the participants.

Verbal Ability

Verbal ability was assessed with the Vocabulary subtest of the Stanford-Binet Intelligence Scale – Fourth Edition (SB:FE). On the first part of this subtest, children were required to label the most important detail of a picture. On the second part of the subtest, children were requested to provide definitions for words orally presented.
According to the technical manual of the SB:FE, the internal consistency (KR20) of this subtest is .82 and the test-retest reliability coefficient for children five years of age is .75.

**Inhibitory Control**

The purpose of this task was to assess children’s ability to exhibit inhibitory control when providing their answers. In a similar manner to that of Gerstadt, Hong, and Diamond (1994), sixteen trials were administered to each child in which eight “day” cards and eight “night” cards were presented in a predetermined order. For all children the cards were presented in the same order: night (n), day (d), d, n, d, n, d, n, d, n, d, n, d, n, d. The experimenter began this task by showing the subject the black card with the moon and stars and gave the child the instructions, “When you see this card, I want you to say ‘day’”. The white card with the sun was then shown and the child was instructed: “When you see this card, I want you to say ‘night’”. The two initial practice trials were then administered. Subjects who hesitated were given the prompt “What do you say for this one?” Participants were required to respond to both practice trials correctly before continuing with the exercise to ensure understanding of the instructions. These practice trials were included in the data collection as participants who caught on quickly displayed boredom if continued practice was used. The dependent measure for this task was the children’s ability to inhibit their expected response to the card presented and reply with the opposite, yet correct, word (range = 6 to 16).
Short-Term Memory

The Memory for Sentences subtest from the Stanford-Binet Intelligence Scale: Fourth Edition was administered to assess children's short term memory and recall of orally presented sentences. The task was explained to the child by stating that the experimenter would say a sentence aloud and the child would then repeat the sentence back. The sentences were grouped into sets of two and became increasingly longer as the task went on. The task was finished when the child failed to accurately repeat both sentences in a set. The dependent measure in this task was the child's ability to accurately repeat previously heard sentences (range = 12 to 29). According to the technical manual of the SB:FE, the internal consistency (KR20) of this subtest is .87 and the test-retest reliability coefficient for children five years of age is .78.

Working Memory

Four standardized WM subtests adapted by Hoskyn (2003) from the Swanson Cognitive Processing Test (Swanson, 1995, 1996) were administered. The internal consistencies of each subtest are reported by Hoskyn (2003) to range from .78 to .89.

Table 1 provides an overview of each working memory task along with the corresponding long-term memory resource drawn on. Tasks were designed to tap resources from episodic and semantic memory. In accordance with Swanson (1992), two criteria for distinguishing between episodic and semantic memory were employed. First was the nature of the stored material. Semantic memory focuses on categories or classifications, whereas episodic memory focuses on isolated events. The second criteria was the nature of the reference. Episodic memory focuses on the sequences of events or
actions, whereas semantic memory focuses on the organization of events. For example, a semantic task in this study, the visual matrix task, required children to remember the organization of a series of dots within a matrix, whereas an episodic task, such as the story retell task, required children to remember the sequence of episodes presented in a paragraph.

Table 1: Working memory tasks and what they are assumed to measure

<table>
<thead>
<tr>
<th>Task</th>
<th>Ability measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhyming</td>
<td>Auditory recall of acoustically similar words</td>
</tr>
<tr>
<td>Story retelling</td>
<td>Auditory sequential recall of prose</td>
</tr>
<tr>
<td>Visual matrix</td>
<td>Spatial organization recall of dot patterns</td>
</tr>
<tr>
<td>Spatial organization</td>
<td>Planned spatial ordered recall of meaningless shapes</td>
</tr>
</tbody>
</table>

Rhyming

The purpose of this task was to assess the child’s recall of phonetically similar words. The child listened to sets of words that rhyme (e.g., “lip-slip-clip”). Each successive word in the set was presented every two seconds. Nine words, ranging from two to four monosyllabic words were employed. Before recalling the words, the child was asked whether a particular word was included in the set. For instance, after being presented with the words “lip-slip-clip”, the child was asked if “ship” or “lip” was included in the word set. The child was then requested to recall the previously presented words (lip-slip-clip) in order. Testing was stopped when the process question was failed. The dependent measure was the number of sets recalled correctly (range = 0-9).
Visual Matrix

This task assessed the child’s ability to remember a visual sequence within a matrix. The child was presented with a series of dots in a matrix and given five seconds to study the matrix. The matrix was removed and the child was asked the process question, “Are there any dots in the first column?” To ensure understanding of the word “column,” the experimenter pointed to the first column on a blank matrix (a grid with no dots). After answering the process question, the child was asked to draw the dots in the correct boxes on the blank matrix. The matrices ranged in difficulty from 4 squares and 2 dots to 45 squares and 12 dots. The dependent measure was the number of matrices recalled correctly (range = 0-11).

Story Retelling

The purpose of this task was to assess the participant’s ability to remember a series of episodes presented in a paragraph. The experimenter read a paragraph, asked a process question, and then asked the participant to recall all the events that occurred. The paragraph was a 12-sentence story and each sentence included 2 idea units and 8 to 11 words. The experimenter presented the child with a giraffe puppet named Spotty who tells of his birthday party. The dependent measure was the number of sentences recalled correctly in order (range 0-11). For a sentence to be recalled correctly, 2 idea units must be expressed in the correct order.
Spatial Organization

This task was used to determine the child’s ability to remember the spatial organization of cards with pictures of various shapes. The cards were ordered in a top-down fashion (see Figure 3 of Swanson, 1993). The presentation of this task included five steps: (1) a description of each strategy was provided; (2) the experimenter presented the sequenced cards in their correct order and allowed the child 30 seconds to study the layout; (3) the experimenter gathered up the cards, shuffled them, then asked a process question; (4) the child was asked to select a strategy that he/she would use to remember the cards; and (5) the child was directed to reproduce each series of cards in the order in which they were given. For the process question, prior to the child placing the cards in the correct rows and order, the experimenter took the first card (row 1) and last card (row 8) and asked, “Which card came first?” The dependent measure was the number of rows recalled correctly (range = 0-8).

Oral Language Assessment

Mean Length of Utterance

The MLU measure provides an index of syntactic complexity in the child’s speech. MLU was analysed on both the morpheme and word level. Two measures of MLU were attained. Firstly, MLU was computed by dividing the total number of morphemes in a child’s speech sample by the total number of utterances. A separate computation dividing total number of words by the total number of utterances was also used.
Bound Morphemes

A morpheme is a minimal meaningful unit of language. An analysis of bound morphemes was conducted to investigate the grammatical complexity of children’s utterances. Contracted, conjugated, inflected, and pluralized words were analysed.

Structural Analysis

The hierarchical structure of each verbal response was determined using measures of cohesion and phrasal complexity. Measures of cohesion described the level of structural organization and consistency. Scores ranged from 0 to 2 (0 = no cohesion; 1 = majority of responses cohesive; 2 = clearly cohesive). Phrasal complexity was measured in the domains of complexity of sentence structure. Scores ranged from 0 to 4 (0 = no sentence structure; 1 = NP-VP; 2 = NP-VP-PP; 3 = at least one NP-VP-NP-VP; 4 = consistently correct usage of NP-VP-NP-VP). Interrater reliability, using a percentage agreement statistic and performed on a sample of 10% of the transcripts was .88.

Children’s oral language skills were investigated on these fronts using two language measures, a narrative and an expository task. In the narrative task, children were asked to narrate the wordless picture book Goodnight Gorilla by Peggy Rathmann. The story concerns a gorilla who, by taking the zookeeper’s keys, unlocks the animals’ cages. They follow the zookeeper back to his home where his wife, surprised, escorts them back to their cages. However, the monkey, who is still in possession of the keys, unlocks himself once more and returns to the zookeeper’s home. Several questions were asked by the experimenter throughout the story and upon its completion. These questions served two purposes: to ensure the child’s comprehension of the story and to assess the child’s
ability to take the perspective of various characters within the story. Children’s responses to two main questions were coded and analysed: (1) “Whose eyes do you think those are?” and (2) “Where will the man look for his keys when he wakes up in the morning?” Children’s utterances were transcribed and coded for MLU, bound morphemes, cohesion, and phrasal complexity.

The expository task assessed the children’s oral language production while describing a favourite game. Children were asked to describe to the experimenter a game that they enjoyed playing, either at home or at school. Utterances were transcribed and coded for MLU, bound morphemes, cohesion and phrasal complexity.

Procedures

All experimenters were trained prior to their assistance on this project by the project co-ordinator of this study. Training consisted of explanation and thorough demonstration of each task, allowable prompts, and correct scoring procedures. Experimenters were provided with the equipment to carry out these tasks and once experimenters were reliable in their administration, they were assigned to specific students at various schools throughout the Lower Mainland area of British Columbia, Canada.

Experimenters contacted the schools in which their participants were enrolled and explained the nature of the study as well as the child’s previous involvement with the study. Suitable times were arranged through the principal and kindergarten teacher. Parents were then contacted to explain that testing would take place once more and to confirm that their child would be in attendance at school on previously discussed dates.
On the day of testing the experimenter arrived at the participant’s school, checked-in at the main office, and met with the kindergarten teacher to negotiate a quiet space in which testing could take place. The participant was then introduced to the experimenter by the teacher and both the participant and experimenter went to the designated testing area. After some introductions and “small talk” to put the participant at ease, testing began. Upon completion of the tasks children were rewarded with small tokens of appreciation such as stickers or toys.
CHAPTER 4
RESULTS

In this chapter, results of the correlational and general linear modelling analyses that describe the relations among working memory and oral language production of young children in Kindergarten are reported. First, the performance of three age groups of children are compared on measures of working memory, short term memory, IQ, language production, and inhibitory control. Second, the associations among these variables are reported for the entire sample. The chapter concludes with the reporting of results of general linear modelling procedures to examine the relative contribution of working memory and other memory and cognitive variables to the explanation of oral language production.

Sample Description

The data from this study consisted of 17 variables for each of the 50 participants and were derived from the four working memory tasks, one short-term memory task, one inhibitory task, a verbal IQ measure and five oral language production measures. The means and standard deviations of the three age groups for each measure are shown in Table 2. A MANOVA performed on all the variables together was significant, $F(2, 47) = 142.38$, $p < .01$, however, it is noteworthy that follow-up univariate results show that these differences were entirely attributable to group variability in age. No significant group differences were found on the remaining variables. As group differences in age did
not mediate performance differences of children on any of the cognitive, memory, or language variables, participants were grouped together and analysed as a whole for the remainder of the investigation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>60-64 months (n = 17)</th>
<th>65-69 months (n = 17)</th>
<th>70-74 months (n = 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>62.29 (1.40)</td>
<td>66.82 (1.63)</td>
<td>72.69 (2.21)</td>
</tr>
<tr>
<td>IQ</td>
<td>103.29 (14.91)</td>
<td>102.88 (11.81)</td>
<td>98.07 (11.04)</td>
</tr>
<tr>
<td>STM score</td>
<td>16.06 (2.54)</td>
<td>18.73 (3.37)</td>
<td>18.56 (4.52)</td>
</tr>
<tr>
<td>Inhibitory control</td>
<td>13.53 (4.00)</td>
<td>14.33 (2.13)</td>
<td>14.19 (2.32)</td>
</tr>
</tbody>
</table>

Working Memory Measures

| Story retelling               | 6.47 (2.32)           | 5.08 (4.07)           | 8.53 (2.10)           |
| Visual matrix                 | 19.06 (23.46)         | 38.33 (34.38)         | 50.73 (39.11)         |
| Rhyming                       | 5.41 (16.85)          | 12.53 (19.44)         | 6.73 (10.80)          |
| Spatial organization          | 4.71 (3.92)           | 5.73 (4.88)           | 8.64 (7.40)           |

Verbal Measures

Narrative task

| MLU – words                   | 4.73 (1.38)           | 4.88 (0.89)           | 4.63 (1.00)           |
| MLU – morphemes               | 5.57 (1.54)           | 5.72 (0.83)           | 5.57 (1.18)           |
| Bound morphemes               | 23.44 (9.92)          | 24.63 (8.14)          | 24.69 (8.90)          |
| Cohesion                      | 1.69 (0.48)           | 1.56 (0.63)           | 1.75 (0.45)           |
| Phrasal complexity            | 2.69 (0.60)           | 2.94 (0.93)           | 2.81 (0.83)           |
| Question #1                   | 0.18 (0.39)           | 0.18 (0.39)           | 0.38 (0.50)           |
| Question #2                   | 0 (0)                 | 0.18 (0.39)           | 0.06 (0.25)           |

Expository task

| MLU – words                   | 7.01 (4.31)           | 7.20 (4.03)           | 7.67 (2.12)           |
| MLU – morphemes               | 7.56 (4.68)           | 7.83 (4.50)           | 8.24 (2.23)           |
| Bound morphemes               | 3.17 (3.26)           | 5.71 (6.85)           | 4.75 (4.45)           |
| Cohesion                      | 1.59 (0.51)           | 1.41 (0.71)           | 1.63 (0.50)           |
| Phrasal complexity            | 2.71 (0.77)           | 2.71 (0.77)           | 3.06 (0.68)           |
Correlational Analysis

Table 3 shows the correlations between age, the verbal IQ, STM, inhibitory, and working memory tasks, and all oral language production measures for the entire sample. To facilitate interpretation of the correlations, only significant values are highlighted.

Working Memory and Oral Language Production

By way of a brief reminder, in the narrative task children were asked to create a story from the wordless picture book Goodnight Gorilla. Findings show that correlations between visual working memory (visual matrix and spatial organization tasks) and measures of oral language production on this narrative task were significant; however, correlations between verbal working memory and measures of oral language production on the narrative task were not significant. Visual matrix correlated negatively with three oral language measures, MLU [analysed in both words (r = -.33, p < .05) and morphemes (r = -.35, p < .05)] as well as bound morpheme (r = -.28, p < .05). A negative correlation (r = -.33, p < .05) was obtained between the spatial organization task and measure of bound morphemes. Story retelling (r = .39, p < .05) and spatial organization (r = .34, p < .05) significantly correlated with oral language production measures of cohesion. Children’s phrasal complexity on this narrative task was also found to correlate with IQ (r = .32, p < .05). Interestingly, scores on the two questions which participants were asked: (1) “Whose eyes do you think those are?” and (2) “Where will the man look for his keys when he wakes up in the morning?” did not significantly correlate with either of the visual working memory tasks.
On the expository task, in which children were asked to describe to the investigator their favourite game, story retelling significantly correlated with oral language production measures of cohesion ($r = .31$, $p < .05$) and phrasal complexity ($r = .45$, $p < .05$). However, rhyming words, a second measure of verbal working memory, did not correlate significantly with any oral language production measure.

Notably, visual working memory as estimated by the Spatial Organization task, formed a significant association with bound morphemes on both the narrative and the expository task. This finding suggests that the working memory system that underlies children’s use of bound morphemes in oral language production across narrative and expository tasks is related to a visual working memory system.

**Short Term Memory, Inhibitory Control, and Oral Language Production**

Table 3 shows that significant correlations were obtained between measures of language production (i.e., cohesion, phrasal complexity) and verbal working memory and MLU, cohesion and visual working memory; however, there were no significant correlations between measures of language production and short term memory.

The day-night Stroop task, an inhibitory task, correlated negatively with MLU (words and morphemes) on the expository task. Mean length of utterance measured in words showed a correlation of ($r = .27$, $p > .05$) while MLU measured in morphemes correlated at a value of $r = .26$, $p > .05$. 
Table 3: Correlations between working memory and verbal measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age</th>
<th>IQSS</th>
<th>STM</th>
<th>Inhib. control</th>
<th>Story retell</th>
<th>Visual matrix</th>
<th>Rhyming</th>
<th>Spatial organiz.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Narrative Task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>MLU - words</td>
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<td>0.17</td>
<td>-0.16</td>
<td>-0.05</td>
<td>-0.21</td>
<td><strong>-0.33</strong>*</td>
<td>-0.02</td>
<td>-0.21</td>
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<tr>
<td></td>
<td>(0.42)</td>
<td>(0.24)</td>
<td>(0.25)</td>
<td>(0.76)</td>
<td>(0.14)</td>
<td>(0.02)</td>
<td>(0.90)</td>
<td>(0.14)</td>
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<tr>
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<td><strong>-0.35</strong>*</td>
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<tr>
<td></td>
<td>(0.56)</td>
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<td>(0.38)</td>
<td>(0.68)</td>
<td>(0.17)</td>
<td>(0.01)</td>
<td>(0.83)</td>
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<tr>
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<td>0.08</td>
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<td><strong>0.34</strong>*</td>
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<td>0.04</td>
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<td>(0.51)</td>
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<td>Cohesion</td>
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<td>0.02</td>
<td>0.00</td>
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<td>(0.89)</td>
<td>(1.00)</td>
<td>(0.03)</td>
<td>(0.43)</td>
<td>(0.19)</td>
<td>(0.11)</td>
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<tr>
<td>Phrasal complexity</td>
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<td>0.14</td>
<td>-0.08</td>
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<td>(0.18)</td>
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<td>(0.61)</td>
<td>(0.01)</td>
<td>(0.29)</td>
<td>(0.94)</td>
<td>(0.17)</td>
</tr>
</tbody>
</table>

Note: * p #< .05

**General Linear Modelling**

Examination of the correlation matrix in Table 3 shows that bound morphemes, a measure of syntactic complexity, was associated with both measures of visual working memory on the narrative task. The oral language measures of cohesion correlated with
both verbal and visual working memory measures on the narrative task. Verbal ability also correlated with bound morphemes on the narrative task. All remaining oral language measures (on either the narrative or expository task) were associated with a single measure of either verbal working memory or visual working memory.

To tease out the relative contribution of visual working memory and verbal ability to the prediction of bound morphemes on the narrative task, the data was submitted for analysis according to two general linear models, where the variables are entered simultaneously to the prediction of the dependent measure. Prior to submission of the variables, z-scores on the visual matrix and the spatial organization subtests were summed to provide a composite visual working memory score. A type III sums of squares was used to estimate the amount of variance attributable to each working memory measure, after the variance in the dependent measure explained by verbal ability is taken into account.

To determine the contribution of visual working memory and verbal working memory to oral language measures of cohesion, the data was submitted for analysis according to a second general linear model. To estimate the amount of variance attributable to each working memory measure, a type III sums of squares was employed.

As reported in Table 4, results show that visual working memory contributed unique variance to the prediction of bound morphemes after the variance attributable to verbal ability had been taken into account. On the other hand, once the variance due to visual working memory was removed from the model, the variance accounted for by verbal ability was reduced to non-significant. Together, these results support the idea that
visual working memory plays an important role in the prediction of children's use of bound morphemes on this narrative task.

Table 5 shows that visual working memory contributed unique variance to the prediction of cohesion after the variance attributable to verbal working memory had been taken into account. These results provide evidence that the visual working memory plays a significant role in the oral language measure of cohesiveness on this narrative task.

<table>
<thead>
<tr>
<th>Table 4: General Linear Model of Bound Morphemes (Narrative Task)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Verbal ability</td>
</tr>
<tr>
<td>Visual working memory</td>
</tr>
<tr>
<td>Total R^2 = .18, F (2, 46) = 4.61, p &lt; .01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5: General Linear Model of Cohesion (Narrative Task)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Verbal working memory</td>
</tr>
<tr>
<td>Visual working memory</td>
</tr>
<tr>
<td>Total R^2 = .21, F (2, 46) = 4.09, p &lt; .01</td>
</tr>
</tbody>
</table>

In summary, the results of the analyses in this chapter suggest that both verbal and visual working memory play a role in explaining children's performance on oral language tasks; however, this role varies according to the domain (i.e., verbal or visual) of the working memory measure and the characteristics of the oral language production task. Visual working memory is associated with the length of children's utterances, cohesiveness, and the frequency of bound morphemes on the narrative task; verbal
working memory is associated with the cohesion and phrasal complexity of oral language production on the expository task.
CHAPTER 5
DISCUSSION

The purpose of this study was to examine the relationship between working memory and oral language production among Kindergarten children. Two main issues were investigated. First, the study sought to explain if young children’s oral language production results from individual differences in short-term memory capacity or whether an executive memory system plays a role. Second, this investigation aimed to determine if information processed in the working memory (WM) system is general or specific to language demands of oral language production. In relation to these main concerns, five specific research questions were addressed. In this chapter, the key findings related to working memory and oral language production in expository and narrative tasks are explored within the context of literature related to these concepts. Additionally, limitations, practical implications, and future directions are discussed.

The five research questions addressed in this study are:

1. Does age variation in WM capacity predict developmental variation in children’s ability to perform complex language tasks?

2. Is the magnitude of the associations found between WM and language production on complex tasks greater than the associations between STM and language production?
Does WM capacity correlate more significantly with higher-order or lower-order language processes?

Can evidence be found for a domain-general or a domain-specific model of WM?

Do children with larger WM capacities reflect deeper understanding and cognitive processing of story content?

The findings emanating from each research question are discussed below.

Working Memory and Oral Language Production

Previous research has documented the need for further examination of the nature of individual differences in working memory capacity and how these are associated with variations in the expressive language abilities of young children. Presently, the bulk of the field of research concerning working memory and language focuses on written language or language-delayed children. Little attention is paid to working memory and oral language within a normal sample and the corresponding developmental impact on academic performance. Moreover, research on children’s development of executive function and subsequent language production is important for the identification of learning difficulties early on in a child’s school career.

The present study investigated the effects of age variation in young children’s oral language production by separating the Kindergarten sample into three age groups (60-64 months; 65-69 months; 70-74 months). It was hypothesized that age variation in working memory capacity could be expected to predict developmental variation in performance on
complex language tasks. However, no significant main effects were noted when age was compared with working memory or language measures. As the age groups spanned a single year, this lack of age effects may have resulted because only a short developmental period had been sampled. Perhaps as children mature and begin to use more complex language in their daily interactions, a more consistent trend may appear. However, a larger sample with children from a wider age range is required to test this hypothesis. Since age did not factor significantly into the prediction of oral language development for this age range of children, age groups were combined to add power to analyses aimed at investigating the relations between working memory and oral language production.

**Relations Between Working Memory, Short Term Memory and Oral Language**

Results of correlational analyses performed on the total sample offer adequate evidence to support the idea that even among very young children, executive function is associated with children’s oral language production. Correlations found between working memory and language production on complex language tasks ranged from weak to moderate but were all significant. In contrast, correlations between short-term memory and language production were not significant. Thus, the findings in this study are consistent with those reached by other researchers who have noted that working memory and short term memory reflect independent operations (Baddeley, 1986; Swanson & Berninger, 1996).
Relations Between Working Memory and Higher/Lower Order Language Processes

It was hypothesized that working memory would be more highly correlated with oral language measures tapping high-order language processes (e.g., structural complexity) than lower-order language processes (e.g., syntactic complexity) on both narrative and expository tasks. Results of correlational analyses and general linear modelling show that a visual working memory system underlies both higher-order language process (cohesiveness) and lower-order process (phrasal complexity) during children’s oral storytelling; however, on the expository task, both verbal and visual working memory were associated with higher and lower-order language processes. Hence, working memory appears to be associated with both higher-order and lower-order language processes on oral language production tasks.

Domain Specificity of the Working Memory System

Significant main effects were noted when examining the relations between visual and verbal working memory and performance on measures of cohesion and phrasal complexity on both the narrative and expository tasks. Three important findings emerged from the analyses.

First, children who performed well on visual working memory measures produced oral narratives that were longer and more complex when telling a story with the assistance of a picture book. This finding is interesting, because educators often assume that providing children with picture prompts such as on a wordless picture book provides the children with a visual mental model that reduces working memory load. The findings
of this study, however, suggest that telling a story from a picture book also makes
demands on children's visual working memory resources; and that these relations are
independent from children's general verbal ability or their verbal working memory
capacity.

Second, the only measure of language that correlated significantly with both
verbal and visual working memory on both the expository and narrative tasks was bound
morphemes. The finding that children's use of bound morphemes on oral production
tasks is associated with both verbal and visual working memory suggests that children's
development of complex forms of language such as bound morphemes may parallel
development of general working memory capacity. Moreover, the finding that this
relationship was not mediated by children's vocabulary development suggests that
working memory – bound morpheme relations are not a function of children's access to
morphological codes stored in long term memory. Children with smaller working
memory capacities, either due to age or individual variation, may have less storage in
working memory available to coordinate information in a way that permits the use of
bound morphemes in their oral language. Importantly, the vocabulary measure used in
this study was not a direct measure of children's understanding of bound morphemes,
therefore, further research is necessary to confirm or reject this hypothesis.

Third, at first glance, narrative oral language production appears to be associated
primarily with a visual working memory system and expository oral language production
appears to be associated primarily with a domain general working memory system (i.e.,
both visual and verbal working memory). The idea that the working memory system is
domain specific and varies according to task specific requirements (Daneman & Tardiff,
1987) is somewhat supported in this study. However, an alternative explanation is that working memory has a stronger association with different aspects of oral language production. For example, children’s use of bound morphemes on both narrative and expository tasks is associated with both verbal and visual working memory. Taken together, these findings highlight the idea that development of oral language involves more than one trajectory and working memory has a unique relationship with each linguistic path.

**Cognitive Processing of Story Content**

It was expected that the oral language elicited from children with large working memory capacities would reflect deeper understanding and cognitive processing than the oral language production of children with smaller working memory capacities. This hypothesis was tested by asking the participants two questions requiring perspective taking of the characters within the story *Goodnight Gorilla*. Results did not support the prediction: there was no significant relationships among variables. However, when transcribing the data collected, it became apparent that this finding should be viewed cautiously. In several situations, various experimenters were not consistent in having the child respond to the two questions and accepted an “I don’t know” response. Furthermore, one experimenter did not administer the questions with integrity. Instead of asking the single question, “Where will the man look for his keys in the morning?” she included “Where were the keys last?” Hence, the children may have responded appropriately to the second question when it was their response to the first question that was required.
Summary

In conclusion, results of this study confirm that individual variation in young children’s oral language production is best explained by differences in an executive working memory system rather than by a short-term memory capacity. Although age did not predict developmental variation in children’s performance on complex language tasks, specific language processes (such as MLU and bound morphemes) were associated with a working memory system. These findings are consistent with previous research that suggests that short-term memory and working memory are separate constructs with differing roles in language production (Baddeley, 1986). Furthermore, results indicate that the working memory system that underlies general oral language production is complex and best conceptualised as a multidimensional system, in which working memory operates as a domain-specific resource for narrative and expository language tasks.

Limitations

There were a number of limitations of this study. First, the participants in this study were not chosen randomly. Participants were recruited based on their ongoing participation in a developmental study examining working memory and language. Since the participants were already part of a sample involved in working memory research, this sample may be viewed as one of convenience and results may be skewed based on their familiarity with the participatory process.

Second, this study employed a correlational design which is often used for studying problems in education. A drawback to this design is that although it allows for
the inquiry into the presence of a relationship between two variables, causality cannot be determined. This form of analysis is limited in regards to the depth of the information that is produced pertaining to the correlations between the variables. Additional research is needed to obtain more in-depth understanding of the relationships among the constructs examined in this study.

Third, the sample size in this study was relatively small. A small sample size may have resulted in a Type II error; the acceptance of the null hypothesis when it is actually false.

Fourth, because this sample was chosen from a particular population of children who all resided in the Lower Mainland of British Columbia, the results of this study cannot be generalized to other areas of Canada. Further differences in socio-economic status were not examined to determine if variations in this variable resulted in significant differences in performance on measures of verbal or cognitive ability.

Fifth, data collected from the expository and narrative interviews with some subjects was at times limited. Future testing should encourage children to produce an appropriate amount of language within both categories for clearer, more noteworthy analysis.

Sixth, mean length of utterance (MLU), an index promoted by Brown (1973), has been criticized for its lack of explicitness, necessitating continual ad hoc decisions (Crystal, 1974). Furthermore, past the early stages of language development, the rules may not be reflective of the child's advancing syntactic system. Hence, MLU should not be relied on as a sole adequate measure of children's language level. Other additional
measures of verbal ability should be used in future research to replicate and confirm the findings of this study.

Finally, the aforementioned concerns regarding experimenter procedures limited the amount and content of children’s utterances when asked the two perspective-taking questions within the narrative task making any analysis of children’s responses problematical.

**Practical Implications**

Results from this study indicate that a relationship exists between working memory and oral language production abilities among Kindergarten children. Previous research has shown that understanding and producing oral language depends on memory at every stage: from recognizing phonemes and words, grammatical knowledge, word meaning and world knowledge. Any difficulties experienced within these language domains will affect children’s academic success. Acknowledgement of this information would be helpful for teachers as language skills figure prominently within Kindergarten and elementary classrooms. Information regarding a child’s working memory capacity could assist teachers in designing instruction in oral language that considers the working memory load of the task in context of children’s working memory development.

**Future Directions**

Findings in this study indicate that oral language production is mediated by variation in children’s working memory capacity. Ongoing research is necessary to investigate several unresolved issues. Future studies are needed to replicate findings of
this study and to provide converging evidence. However, it is also necessary to explore the relations of working memory and other executive systems on later oral language tasks. Longitudinal investigations among a sample group would provide information regarding working memory and oral language growth patterns. Moreover, more studies are needed to determine appropriate teaching methods that will minimize the working memory load experienced by children with small working memory capacities as they learn and practice their oral language abilities.
REFERENCE LIST


