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PREDICTING THE LANGUAGE ABILITIES OF CHILDREN

(SPINE TITLE: PREDICTING THE LANGUAGE ABILITIES OF CHILDREN)

(Thesis format: Monograph)

by

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Graduate Program in Health and Rehabilitation Science

A thesis submitted in fulfillment of the requirements for the degree of Master of Science

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CERTIFICATE OF EXAMINATION

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The thesis by

Sarah Elyse Cloutier

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Abstract

The ability to learn language is influenced both by children's biological abilities and the environment in which they find themselves. Rather than low test scores alone, it may be that children who exhibit disproportionately low language abilities relative to what would be predicted from their biological abilities and expectations based on their environmental situations may be considered to exhibit a specific language impairment. The present study explores this hypothesis by taking measures aimed at estimating 45 children's biological potential through direct measures of parental abilities and environmental situations and examining the ability of these measures to predict children's language abilities. Predictors were based on parental measures of nonword repetition, nonverbal intelligence, working memory, sentence recall, grammaticality judgment, reading, and family environment. The findings of this study show a myriad of variables affect language development from both biological and environmental factors, implying that learning language involves the interplay between children's innate makeup and their environmental conditions.

Keywords: Language development, Specific Language Impairment, nonverbal Intelligence, verbal working memory, phonological short-term memory, sentence recall, grammaticality judgment, Test of Word Reading Efficiency, Family Environment Scale

Dedication

This thesis is in his loving memory of my late grandfather, Thomas P. Russo. My grandpa will forever be my best friend, greatest devotee, and one of the most important figures I will have in my lifetime. His unconditional love and support, and daily reminder about working and studying hard to succeed carried me through this journey.

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Thank you to my mom, dad, Lizzy and extended family for supporting me each step of the way - I am grateful to have such loving support. Thank you for believing in me and being positive role models. I couldn't have succeeded without you!

Thanks to all of my friends for making this experience so memorable. To those who I shared an office with, I will never forget the hilarious moments we shared. I'm so glad I met such a wonderful group of people!

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Table of Contents

List of Tables

List of Appendices

CHAPTER 1

General Introduction

The human ability to learn language is a mini-miracle influenced both by children's biological abilities and the environment in which they find themselves. Specific language impairment (SLI), the failure to acquire language despite typical hearing, behavioural, emotional and cognitive development, has a significant impact on children's social and academic development, as well as family functioning. In accordance with current thinking regarding early intervention (Spaulding, Plante, & Vance, 2008), speech-language pathologists invest considerably in the process of identifying children with SLI as early as possible. Children are typically identified with SLI if they fall below an arbitrarily derived cutoff relative to a large normative sample usually equivalent to one standard deviation (Tomblin et al., 1997) below the normative mean (e.g., Spaulding et al., 2008; Tomblin et al., 1997). This method identifies children whose linguistic abilities are at the tail end of the distribution scale, but potentially not specifically those who have a *fundamental* developmental language impairment. Presumably, SLI should refer solely to the latter. It may be that children who are identified with SLI according to current methods are simply less able, or have not been given the opportunity to fully acquire language. If SLI exists, those affected should exhibit significant disproportionate impairments in their language development relative to their other biological abilities and expectations based on their environmental situations including recreational activities, and organization in the home. This thesis adopts an individual differences approach to identify children with SLI based on disproportionate linguistic abilities relative to measures of biological abilities, and familial and environmental factors. This research endeavour has implications for identifying children with a specific impairment in language learning.

When considering the multiple determinants of language abilities, both biological (hereafter, bio-psycho-social) and environmental factors address the facilitators and barriers to children's language development. Immerging theories such as the bio-ecological theory by Bronfenbrenner (2005) and the *International Classification of Functioning, Disability and Health* presented by the World Health Organization (World Health Organization, 2007) also provide useful frameworks for recognizing the complex interrelationships between biological, individual and contextual factors that influence child functioning (Harrison & McLeod, 2010). The following section will discuss general language development, followed by a parallel discussion of language impairments in the context of bio-psycho-social and environmental factors.

General Language Development

The ability to acquire language is a unique human achievement (Chomsky, 1981). Language acquisition begins in early infancy when babies respond *to* and *with* nonverbal gestures of communication such as smiling, and continues throughout the first years of life as the words, and grammatical and syntactical rules of language are mastered (Magnuson & Duncan, 2006; O'Neill, Pearce, & Pick, 2004). Considerable variation exists between children with regards to the onset and rate of language development. At least some of this variation arises due to the interplay of various bio-psycho-social factors as will be discussed below.

Mental Functions and Language Development

The extent to which domain-general cognitive functions may influence the emergence and growth of language is an ongoing area of interest investigated by a number of researchers (Rose, Feldman, & Jankowski, 2009). Such processes include memory (Baddeley, 2003), processing speed (Rose et al., 2009), attention (Cowan, Nugent, Elliot, Ponomarev, & Saults, 1999), executive functioning (Schroeder & Kelley, 2009), and social cognition (Harrison & McLeod, 2010).

Memory. Memory, the ability to store, retain, and recall information, is typically divided into short-term and long-term memory. Short-term memory (STM) refers to the capacity-limited ability to recall information for a brief period of time (Baddeley, 2003; Gathercole & Baddeley, 1989, 1993). More recently, the concept of short-term memory has been subsumed by working memory, the temporary storage and necessary processing of information held in the current focus of attention (Baddeley & Hitch, 1974). By contrast, long-term memory (LTM) can store large quantities of information of unknown capacity for potentially unlimited duration (Ericsson & Kintsch, 1995). While, LTM may have an effect on language learning, individual differences in an unlimited capacity have not proved to be a flourishing line of research and will not be discussed further.

Short-Term Memory. Short-term memory is divided into two separate, domain-specific stores that work together as a part of the working memory system to carryout complex cognitive tasks. Phonological short-term memory (also known as the phonological loop) consists of two separable components. The phonological store is responsible for retaining phonological representations, and a subvocal rehearsal process serving to preserve decaying representations and convert nonauditory inputs into a phonological form appropriate for the phonological store (Baddeley, 1986). A parallel visual storage system termed the visuospatial sketchpad (or visuospatial short-term memory), integrates spatial, visual and possibly kinesthetic information into one unified representation (Baddeley, 2003). Support for the distinctiveness of phonological and visuospatial STM comes partly from evidence that these systems can be damaged in isolation (Jarrold, Baddeley, Hewes, Leeke, & Phillips, 2004). The sketchpad plays a role in maintaining visuospatial representations in everyday activities such as reading; however, its influence on language development is minimal (Baddeley, 2003) and it will not be further discussed.

Phonological Short-Term Memory. Research demonstrates that until the age of eight, children's abilities to retain phonological material directly influences important facets of language development such as vocabulary acquisition (Adams & Gathercole, 1995; Gathercole & Baddeley, 1989, 1990a; Gathercole, Willis, Eroslie, & Baddeley, 1992; Gathercole, Willis, & Baddeley, 1991), language comprehension (Crain, Shankweiler, Macaruso, & Barshalom, 1990; Gathercole & Baddeley, 1990, 1993; Just & Carpenter, 1992; Shankweiler & Crain, 1986), and syntactic processing and reading comprehension (Gathercole & Baddeley, 1990b; Marton & Schwartz, 2003). Baddeley, Gathercole, and Papagno (1998) proposed that the primary function of phonological STM is to support the long-term learning of the phonological structures of language. According to this view, new phonological information is stored and rehearsed in STM prior to entering LTM, which contributes to children's lexicon growth (Jarrold, Thorn, & Stephens, 2009; Rose et al., 2009). A large number of studies have shown that vocabulary levels correlate with phonological STM among typically developing children, even when general intelligence is taken into account (see Baddeley et al., 1998).

Working Memory. The majority of working memory (WM) research has been conducted using Baddeley's original framework (Baddeley & Hitch, 1974) to examine individual differences in higher cognitive abilities (Baylis, Jarrold, Gunn, & Baddeley, 2003; Miyake, 2001). Individual differences in the limited WM capacity is associated with learning abilities during childhood (Alloway, Gathercole, Kirkwood, & Elliott, 2009). Baddeley's WM model is composed of three separate components that are highly interactive (Bayliss, Jarrold, Baddeley, Gunn, & Leigh, 2005; Gathercole, 1999). In addition to the two STM stores discussed above, the domain-general central executive is responsible for temporary activation of LTM (Baddeley, 1998), shifting between tasks (Baddeley 1986), and attention and inhibition (Baddeley, Emslie, Kolodny, & Duncan, 1998b). Recently, Baddeley (2000, 2003) introduced a fourth component; the episodic buffer functions as a temporary storage device to integrate material from the verbal and visuospatial domains into a coherent mental representation. The fourth component has recently been identified to process and retain language material; however, the buffer has not been the focus of many research studies as yet (Montgomery, Magimairaj, & Finney, 2010).

Working memory has been found to be strongly associated with language learning (Archibald & Gathercole, 2006a; Bishop, North, & Donlan, 1996; Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990a; Just & Carpenter, 1992; Marton & Schwartz, 2003) and general fluid intelligence (Ackerman, Beirer, & Boyle, 2002; Conway, Cowan, Bunting, Therriault, & Minkoff, 2002; Engle, Tuholski, Laughlin, &

Conway, 1999). Working memory is important for the processing of language because developing syntactic structures involves "relating linguistic units across a number of intervening word and syllables in a lengthy time span" (Martin & Schwartz, 2003, pg. 1139).

Processing Speed. The speed at which children and adults carry out cognitive processes (hereafter, processing speed) has been considered a central limiting factor for a variety of cognitive functions (Kail, 1991). Kail and Ferrer (2007) stated that greater processing speeds have been associated with a general increase in intellectual functioning, including increased working memory, inductive reasoning, and accuracy in solving problems. A meta-analysis of cross-sectional studies indicated that a ceiling of 79% of age-related variance in cognitive abilities could be explained by age-related variance in processing speed (Verhaeghen & Salthouse, 1997). Recently, researchers have studied the relationships between short-term memory and processing speed on working memory performance (Bayliss et al., 2003, 2005; Magimairaj, Montgomery, Marinellie, & McCarthy, 2009). Both Bayliss et al. (2005) and Magimairaj et al. (2009) reported findings showing that children's storage and processing speed contribute to developmental changes in working memory. In 1996, Fry and Hale administered a battery of four processing speed and WM tasks to a large sample of children, adolescents and young adults. The results revealed that 71% of the age-related improvement in WM capacity was determined by developmental changes in processing speed, and that there was a direct relationship between processing speed and WM capacity even when age-related differences were controlled.

Researchers have studied how processing speed affects language development (e.g.

Cowan et al., 1998; Gathercole & Baddeley, 1993; Kail & Park, 1994; Leonard et al., 2007). It has been suggested that processing speed limitations may affect the child's ability to access language input and properly use it (Leonard et al., 2007). For example, processing speed influences language development by allowing mental operations to be performed more rapidly, and thus increasing the amount of material held in working memory (Leonard et al., 2007). Kail (1992) and Kail and Park's (1994) research showed that as processing speed increases, words are refreshed more frequently in the articulatory loop, which yields more accurate recall of words.

Attention. Attention is viewed as a limited-capacity system (Lavie, 2005) encompassing the ability to engage, maintain, disengage, and shift focus (Mirsky, 1996; Posner & Petersen, 1990; Posner & Raichle, 1994). Attention is an important part of any cognitive task including working memory (Bunting & Cowan, 2005; Cowan et al., 1999) and language processing (Connor, Albert, Helm-Estabrooks, & Obler, 2000). Although there are many facets of attention (e.g., controlled, selective, joint), sustained attention - the ability to continuously attend to input so that information in the input can be processed (Leclercq, 2002) – may underlie higher aspects of attention and cognitive capacity in general (Sarter, Givens, & Bruno, 2001). Children must sustain attention to speech input and attend to only relevant information in order to perceive and correctly interpret incoming linguistic information (Montgomery, 2005). Rose and colleagues (Rose, Murphy, Schickedantz, & Tucci, 2001) conducted a study on visual sustained attention in typically developing 7- and 8-year old children. The children completed a 14-minute continuous performance task in which they were instructed to push a button in response to a small square appearing on a computer screen. The researchers reported that the children had the best response time and highest accuracy when the stimuli were presented at the faster rates. Rose et al. (2009) suggested that children with better attention are more likely to acquire language at a faster rate because they would be able to "follow others' gazes, engage in bouts of joint attention, and track the referents of others' communications" (pg. 136). The greater attention skills may lead to greater receptive and productive vocabularies (Rose et al., 2009).

Executive Functioning. The first five years of life play a critical role in the development of executive functions (Garon, Bryson, & Smith, 2008). Prefrontal/Executive functions (hereafter, executive functions) are domain-general problem solving tools critical in the production of adaptive and efficient responses to novel or different situations, and important in planning, decision making, reasoning, skill learning or troubleshooting (e.g., Baddeley, 1996; Miyake et al., 2000). Executive functions are also important for the regulation of emotions (Schroeder & Kelley, 2009). To date, links between executive functions and children's language development have not been investigated explicitly; however, executive functions are considered to be closely linked to working memory (Miyake et al., 2000), and as such may be expected to play an important role in supporting language development. Researchers do know that children with sound executive functioning skills are better able to exert self-control (Perner & Lang, 1999), think flexibly, and plan activities while changing modes of processing information (Carlson & Moses, 2001).

Social Cognition. Social cognition is a term that embraces many domains such as emotional perception, social problem solving, and self-cognition (Cohen et al., 1998). One aspect of social cognition important to this thesis is social skills - prerequisites to establishing interpersonal relationships and developing language competency (Marton, Abramoff & Rosenzweig, 2005). Sociable children tend to have more positive social relations and be more popular with friends - characteristics that are likely to enhance language development (Harrison & McLeod, 2010). Several theories about social cognition and language development have been proposed. Locke (1997) claims that social cognition underpins language acquisition. Farmer (2000) stated that social cognition and language development are related because social cognition provides for successful communication. Children with high levels of language development have been shown to have high levels of sociocognitive abilities (Jenkins & Astington, 1996).

Contextual Factors and Language Development

Language learning involves the interplay between children's innate makeup and their environmental conditions. Characteristics of the family environment have been found to be associated with children's early language development. Such factors to be discussed here include parent linguistic inputs and conversation (e.g. Hart & Risley, 1995; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; Landry, Miler-Loncar, Smith, & Swank, 1997), socioeconomic status (e.g. Hoff, 2003), parental education (e.g. Roberts, Jurgen, & Burchinal, 2005), and parental well-being (Prior et al., 2008). The identification of environmental factors responsible for substantial effects on language may prevent early language delays persisting into language impairments (Spinath, Price, Dale, & Plomin, 2004). The influence of environmental factors on language development is important to the aim of this thesis, and will be considered in detail.

Parental Linguistic Input. Correlational studies (Haden, Reese, & Fivush, 1996; vanKleeck, Gillam, Hamilton, & McGrath, 1997) and intervention studies (Lonigan & Whitehurst, 1998; Whitehurst et al., 1994a, 1994b) have shown that the quality of parental linguistic input is correlated with children's syntactic growth and developmental level (e.g. Barnes, Gutfreund, Satterly, & Wells, 1983; Dollaghan et al., 1999; Pan, Rowe, Singer, & Snow, 2005). Parents who talk more (Hart & Risley, 1995; Hoff-Ginsberg, 1991), parents who talk about objects and events in the immediate environment (Harris, 1992), and parents who engage in joint attention with their children as they label objects (Tomasello & Farrar, 1986) have children whose language development is likely to be more advanced. Huttenlocher et al. (2002) performed a multiple-regression analysis that established a positive relationship between the proportion of complex sentences produced by the mother and the child's underlying mastery of these forms. In a study of more than 500 mothers and their children, the National Institute of Child Health and Human Development, Early Child Care Research Network, (2000) reported that significant linguistic input from the mothers directed to the children was the strongest single predictor of the children's language and pre-academic skills at entry to kindergarten.

Parental Conversation. According to the ICF- Child and Youth version, conversations are defined as "starting, sustaining and ending an interchange of thoughts and ideas, carried out by means of spoken [...] forms of language" (WHO, 2007, pg. 147). Parents influence their children's linguistic development by setting an example, and providing opportunities such as inviting the child to take part in conversations and describing daily activities. These events are likely to expand children's concept formation and linguistic capacity (Westerlund & Lagerberg, 2008). There are positive correlations between maternal speech and children's language development if the mother engages the child in conversations by asking questions that elicit verbal replies, and responds to the child's speech in a contingent manner (Barnes et al., 1983; Hoff-Ginsberg, 1986; Snow, Perlmann, & Nathan, 1987; Tomasello & Farrar, 1986).

Socioeconomic Status. A number of factors have been found to influence the quality of parent's language directed at children, including social class (Hoff, 2003). Studies have linked socioeconomic status (SES) and children's verbal abilities (e.g. Bornstein & Haynes, 1998; Hoff, 2003; Huttenlocher et al., 2002; Locke, Ginsborg, & Peers, 2002; Pungello, Iruka, Dotterer, Mills-Koonce & Reznick, 2009). Research findings consistently show that children who are reared in low-SES homes exhibit lags on specific measures of vocabulary and syntax as compared to children of more advantage (Chaney, 1994; Dollaghan et al., 1999; Hart & Risley, 1995; Huttenlocher et al., 2002) and perform significantly worse on linguistic measures than the general population (e.g. Girbau & Schwartz, 2008; Hart & Risley, 1995; Klee, 1992; Locke et al., 2002; Robertson, 1998). Mothers from higher SES generally speak with longer utterances, richer vocabulary, and produce more complex sentences than mothers from lower SES (Hoff, 2003). Parents with low income have been found to use a greater amount of prohibitions, discouragements and directives than middle- or upper-middle-class parents, and less frequently ask the child questions for the purpose of engaging him or her in conversations (Farran & Haskins, 1980; Hart & Risley, 1995; Hoff-Ginsberg, 1991; Pan et al., 2005).

Parental Education. A core factor often applied in the definition of SES is parental education. As for early language development, the most influential SES component is education (Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997; Hart & Risley, 1992; Linver, Brooks-Gunn, & Kohen, 2002; Mistry, Biesanz, Taylor, Burchinal, & Cox, 2004; Tamis-LeMonda, Bornstein, & Baumwell, 2001), particularly maternal education (e.g. Dollaghan et al., 1999; Huttenlocher et al., 1991, 1994; Keller, Bost, Lock, & Marcenko, 2005; Roberts et al., 2005; Westerlund & Lagerberg, 2008). Maternal education has been found to be linearly related to spontaneous language production of children, including mean length of utterance (MLU) - a measure of syntactic development, independent of the amount the child talks, number of different words and total number of words (Dollaghan et al., 1999; Pan et al., 2005). For example, children whose mothers who were not college graduates had MLU that were significantly below average relative to a normal distribution scale (Dollaghan et al., 1999).

There is evidence that parental education is associated with variations in the quality of language that children hear (e.g., Hart & Risley, 1995). Parents with lower levels of education tend to have smaller vocabularies and use less specific language with their children. As a result, their children may not be as prepared to enter the school curriculum, and may be at greater risk for academic failure (Gottfried, 1984; Heath, 1989; Pan et al., 2005; Westerlund & Lagerberg, 2008). Pratt and colleagues (Pratt, Botting, & Conti-Ramsden, 2006) suggested that maternal educational levels could influence parenting styles and therefore, their children's language development. This statement is in agreement with Hammer and colleagues (Hammer, Tomblin, Zhang, & Weiss, 2001) study, where parents of lower educational levels had different parenting styles, such as not reading to their children as often.

Contrary to previous results, Pan, Rowe, Spier, and Tamis-Lemonda, (2004), Stokes and Klee's (2009), and Westerlund and Lagerberg's (2008) findings demonstrated no significant differences in the vocabulary development of children with mothers with higher or lower levels of education. Particularly, Pan et al. (2004) used MacArthurs Communicative Development Inventory – Short Form and concluded that maternal language and literacy skills were better predictors of children's language development than maternal education over the first 3 years of life. Results from Westerlund and Lagerberg's (2008) may be explained by the relatively equal social conditions in Sweden.

Parental well-being. Parental, particularly maternal, well-being referring to the physical, mental, and social aspects that make up a 'good life' (WHO, 2007) is an important element in any child's development (Head & Abbeduto, 2007). Maternal mental health - the ability to identify and understand social experiences, communicate feelings effectively, and constructively manage strong emotions, impacts children's language development in the home environment (Prior et al., 2008; Radke-Yarrow, Martinez, Mayfield, & Ronsaville, 1998; Stein et al., 2008). Studies have shown that maternal psychological distress or depression negatively affects children's language development (Prior et al., 2008; Radke-Yarrow et al., 1998; Stein et al., 2008). One potential reason is that the mothers talk less to their children, which may cause the children to have a generally slower growth in vocabulary production and limit their potential language development (Breznitz & Sherman, 1987; Pan et al., 2005). As well, Mistry et al. (2004) noted that perception of financial resource availability was related to maternal depression and less positive mother-child interactions, which in turn affect children's language development. In addition, findings from Stein et al. (2008) suggest that mothers who are depressed and live in compromising environments are less likely to provide their children with the quality of care giving important to facilitate language development at a rate that reflects the norm.

Language Impairments

Although most children acquire linguistic abilities with relative ease, there is a significant proportion of children who experience difficulties with learning language. Evidence suggests that those who have difficulties acquiring language show life-long problems in social behaviour (Law, Rush, Schoon, & Parsons, 2009; Nelson, Benner, Stern, & Stage, 2006), learning, and academia (Young et al., 2002). Identifying and providing support for children at risk for language impairments (LI) in their early childhood years is critical since it can reduce the severity of language difficulties (Gibbard, Coglan, & MacDonald, 2004; Schwarz & Nippold, 2002). Children with language learning difficulties are a notoriously heterogeneous lot. There is ongoing interest in understanding the influence of cognitive and environmental factors on language learning in an effort to understand the underlying cause or causes of developmental language differences. The following section will parallel section 1.1 and consider the associations between developmental language impairments and cognitive and environmental factors.

Mental Functions and Developmental Language Impairment

Memory. The memory skills of children with language impairment have received considerable attention in recent years. Research has focused on both short-term and working memory across verbal and visuospatial domains.

Short-Term Memory. Many children with language impairment show marked limitations in STM capacity. Evidence suggests that the STM deficit involves the verbal modality primarily (Archibald & Gathercole, 2006b, 2007). The evidence pertaining to visuospatial STM tasks is mixed with some researchers reporting deficits (Bavin, Wilson, Maruff, & Sleeman, 2005; Hoffman & Gillam, 2004), and others not (Archibald & Gathercole, 2006c, 2007).

Phonological Short-term Memory. Gathercole and Baddeley (1990a) first proposed the hypothesis that children with LI primarily have a phonological storage deficit, and that the language impairment was a secondary deficit. Although this suggestion has been hotly debated (Gathercole, 2006; Oetting, Rice, & Swank, 1995; Rice, Cleave, & Oetting, 2000), children with LI have been found to exhibit deficits in phonological STM relative to age-matched peers in an impressively large number of studies (e.g., Archibald & Gathercole 2006a, 2006b; Ellis Weismer et al., 2000; Gathercole & Baddeley 1990b; Montgomery, 2004; Montgomery & Evans, 2009) suggesting that this area may be a core deficit in language impairments (Baddeley et al., 1998).

Working Memory. There is a growing body of research providing evidence that children with LI exhibit difficulties with WM relative to same-age peers (Alloway et al., 2009; Archibald & Gathercole, 2006a, 2006b, 2007; Bavin, Wilson, Maruff, & Sleeman, 2005; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Gathercole & Baddeley, 1990a; Marton & Schwartz, 2003; Montgomery, 1995, 2000a, 2000b; Montgomery & Evans, 2009). More specifically, children with LI exhibit marked deficits involving the storage and processing of phonological information (e.g., Alloway & Archibald, 2008; Archibald & Gathercole, 2006b; Ellis Weismer, Evans, & Hesketh, 1999; Marton & Schwartz, 2003; Montgomery, 2000a). Contradictory results concerning the processing and storage of visuospatial information affecting children with LI exists with some reports of preserved visuospatial STM in SLI groups (e.g., Alloway & Archibald, 2008; Archibald & Gathercole, 2006b; Bavin et al., 2005; Riccio, Cash, & Cohen, 2007) and other reports of impaired functioning (e.g., Bavin et al., 2005; Hoffman & Gillam, 2004).

Archibald and Gathercole (2007a) examined processing across domains, coupled with either phonological or visuospatial storage to examine processing, storage, and WM performance in groups of typically-developing and language-impaired children. The results showed that the LI group was slower at both phonological and visuospatial processing than the age-matched group, and the LI group was less accurate on the tasks pairing phonological STM with either verbal or visuospatial processing. These results are consistent with previous research suggesting a domain-general impairment (e.g., Kail, 1994; Miller, Kail, Leonard, & Tomblin, 2001). Interestingly, phonological storage deficits alone are not sufficient to cause a persistent impairment (Gathercole, Tiffany, Briscoe, Thorn, & the ALSPAC team, 2005).

Processing Speed. Relative to age matched peers, many children with LI show significant limitations in processing speed (Im-Bolter, Johnson, & Pascual-Leone, 2006;

Leonard et al., 2007; Miller et al., 2001) in both linguistic and nonlinguistic tasks (Miller et al., 2001). It has been suggested that a generalized slowing of processing speed results in the vulnerable decay and/or interference of incoming information, which hinders language processing and learning abilities (Montgomery et al., 2010). A related hypothesis is that children with LI have a reduced information processing capacity (Bishop, 1992; Kail, 1994). Miller el al.'s (2001) research findings showed that children with LI had a generalized cognitive slowing between 14 and 21% relative to children with normal language development.

Attention. Children with LI have difficulties sustaining attention (Finneran, Francis, & Leonard, 2009; Montgomery, 2008; Montgomery, Evans, & Gillam, 2009; Spaulding et al., 2008). Spaulding et al. (2008) conducted a study in which the children were required to monitor a series of auditory (linguistic and nonlinguistic) or visual stimuli and press a response button when they saw a predetermined target. Compared to the age-matched control group, the children with LI performed less accurately, suggesting that they may have difficulties with sustained attention for auditory information. Finneran et al. (2009) conducted a study with 4- to 6-year-old children with LI and their typically developing peers on a visual sustained attention task. The children with LI were significantly less accurate but not significantly slower than their peers.

Executive Functioning. Researchers (e.g., Miyake et al., 2000) have expressed that executive functions are closely related to working memory and language development. In terms of LI, those who are affected display domain-general, executive function deficits including the ability to inhibit prepotent responses (Im-Bolder et al., 2006) and update contents of working memory for both verbal and visuo-spatial tasks

(Im-Bolder et al., 2006). However, children with LI perform similarly to unimpaired children in their ability to shift mental sets (Kiernan, Snow, Swisher, & Vance, 1997); thus, both general and domain-specific executive functions may impede the mental abilities of children with LI (Im-Bolder et al., 2006).

Executive functions impact decision making, (e.g., Baddeley, 1996, Miyake et al., 2000) and the regulation of emotions (Schroeder & Kelley, 2009). Relatedly, children with LI have been found to be less proficient at communicating their intentions, feelings, and problem-solving strategies (Marshall, Hightower, Fritton, Russel, & Meller, 1996; McCabe & Meller, 2004).

Social Cognition. Children with LI may have difficulties with social competence (Farmer, 2000), particularly in social pragmatics (Marton et al., 2005), and therefore, may be at risk for social problems and poor self-esteem (Jerome, Fujiki, Brinton, & James, 2002). They exhibit difficulties with initiating social interactions (Craig & Washington, 1993), successfully participating in ongoing interactions (Hadley & Rice, 1991), negotiating with others and resolving conflicts (Brinton, Fujiki, & McKee, 1998). Children with LI employ nonverbal coping strategies, including physically aggressive behaviour, and conversely passive/withdrawn reactions to avoid negotiating (Marton et al., 2005). Children with LI are less preferred playmates and are often subject to peer rejection (Fujiki, Brinton, Hart, & Fitgerald, 1999), which may be a reason why they display more negative self-perceptions (Jerome et al., 2002). In the classroom setting, Brinton Fujiki, Spencer, and Robinson (1997) found that children with LI talked less, were addressed less frequently and collaborated less than typically developing children. They also produced more inappropriate questions, comments, and remarks that demonstrate their inability to recognize the perspective of other individuals (Marton et al., 2005).

Contextual Factors and Developmental Language Impairment

Empirical findings of language impairments indicate that it is multiply determined, predicted not only by biological factors, but the children's environment (Bishop, 2001). It is vital to establish the mediating effect of the family environment on language impairments because it is dynamic, significant, and worthy of better understanding in order to identify the pathognomonic features (McCarty, Zimmerman, Digiuseppe, & Christakis, 2005). Nevertheless, the influential factors significantly co-vary, making it difficult to specify the extent to which each factor is independently associated with performance on developmental measures.

Parental Linguistic Input As described above, children's language accomplishments are influenced by the linguistic input to which they are exposed, particularly during early childhood (e.g. Hart & Risely, 1995; Huttenlocher et al., 1991, 2002; Laundry et al., 1997; Mashburn, Justice, Downer, & Pianta, 2009). The linguistic-environment of language-impaired children might differ from children with typical language development (TLD) (Tombin, 1989), particularly due to the way the mother speaks to the child. The parents of children with LI use fewer total words, expansions, models, verbal routines, intelligible utterances, and grammatically complete sentences compared to mothers of typically developing children (Nelson, Welsh, Camarata, Butkovsky & Camarata, 1995; Schodorf & Edwards, 1983). In these cases, parents may use fewer recasts than do parents of children with TLD (Conti-Ramsden, 1990; Conti-

Ramsden & Hutcheson, 1995; Paul & Elwood, 1991). Recasts are adult responses to child utterances that repeat some of the child's words and correct the morphologic or syntactic form of the child's sentence while maintaining the central meaning of the child's production (Proctor-Williams, Fey & Loeb, 2001). Conti-Ramsden and Hutcheson (1995) found that in cases of children with LI, parental recasts were preceded by a child's responsive utterance and less often by a child's interactive utterance. Conti-Ramsden and Hutcheson, (1995) proposed that the children's parents may reduce the amount of recasts involving verbs in their daily speech to better communicate with their children; but, the lack of parental input of verbs may exacerbate the well-documented problem with verb learning exhibited by children with LI (Rice & Bode, 1993; Rice, Buhr, & Nemeth, 1990; Windfuhr, Faragher, & Conti-Ramsden, 2002).

Parental Conversation. It is possible that parents of children with LI become less responsive to their children's utterances as they develop and begin to produce longer, more complex and grammatically accurate sentences (Proctor-Williams et al., 2001). This process would yield fewer recasts by the parents during conversations and less opportunities for the child to develop better language skills (Proctor-Williams et al., 2001). Parents of children with LI discipline their children more often than conversing (Hammer et al., 2001), and are quicker to shout at, or threaten, than to reason (Stanton-Chapman, Chapman, Bainbridge, & Scott, 2002). This may be so because the children have greater difficulty understanding directions or rationales as to why a task needs to be done in a certain manner (Stanton-Chapman et al., 2002). Hammer et al. (2001) found that parents of children with LI read, tell stories, and discuss daily activities and feelings significantly less than parents of typically developing children. A possible explanation for the findings is that LI aggregates in families (Tallal, Ross, & Curtiss, 1989; Tomblin, 1989), and it may be that the parents of the children with LI have learning deficits themselves and thus, avoid conversational activities with their children (Hammer et al., 2001).

Socioeconomic Status. Many questions remain concerning the ways in which SES may be associated with language impairments. Low SES has been found to be a risk for language impairments (e.g., Hart & Risley, 1995), although contrary results have been reported (e.g., Choudhury & Benasich 2003; Pratt et al., 2006). Pratt et al. (2006) conducted a study that questioned the concerns of a group of mothers whose children had a LI by means of psychometric tests. The mothers of those with LI were no more likely than those in the general population to have language difficulties, but the SES of the family did relate to the difficulties experienced by their children.

Parental Education. Studies have shown that the children of parents with low educational levels are at an increased risk for language impairments. These studies included only the mother's education (Campbell et al., 2003; Hammer et al, 2001; Pratt et al., 2006; Yliherva, Olsen, Maki-Torkko, Koiranen & Jarvelin, 2001), only father's education (Tomblin, Hardy, & Hein, 1991), and both mother's and father's education (Tallal et al., 1989; Tomblin, 1996; Tomblin et al., 1997). Law et al. (2009) conducted a population-based study with participants from 5 to 34 years of age with language impairments to examine factors associated with long-term outcomes. The results revealed that children whose mothers did not complete high school were twice as likely to have LI as those with TLD. By contrast, Yliherva et al. (2001) conducted a study among low-birthweight 8-year-old children in northern Finland and found that the mother's education was not associated with poor linguistic ability. Also Pratt et al.'s (2006) research showed that mothers of children with LI did not have an over-representation of low education levels.

Parental well-being. There is limited information in the literature reflecting the relationship between parental well-being and its effects on their children with LI. LaParo, Justics, Skibbe, and Pianta (2003) conducted a study comparing children whose language impairment either had or had not resolved at 4.5 years. Results showed that the children whose language impairment did not resolve by 4.5 years had mothers with greater depressive symptomatology and less maternal sensitivity (supportive presence, hostility and intrusiveness). The importance of mother-child relationships for language growth in children with language impairments warrants further investigation.

Measures of Language Influences

The present thesis focuses on the parents's mental functions as one determiner of a child's bio-psycho-social abilities and the child's home environment as one aspect of the environment because both mental functions and the home environment play important roles in the language development of young children as reviewed in sections 1.1 and 1.2 (see also, Pratt et al., 2006; Vachha & Adams, 2009). Undoubtedly, both mental abilities and characteristics of the home environment are multiply determined, and available measurement methods will not yield pure measures of either factor. In such situations, it is common to take multiple measures in order to assess the related and unique contributions of each to the ability in question – language, in the present case. By assessing the patterns across a number of measures, it may be possible to better understand factors influencing language development and impairment.

A number of tests purport to measure mental abilities. In terms of language abilities, a great deal of research has focused on nonword repetition, sentence repetition, and verb tense marking tasks as potential clinical markers of language impairment (Poll, Betz, & Miller, 2010). Clinical markers are particularly important because they represent heritable traits associated with a condition, and are present even when the condition is no longer manifest (Gershon & Goldin, 1986). By employing tasks suggested to be clinical markers, it may be possible to reliably tap underlying individual differences in language abilities.

There is very strong evidence that nonword repetition tasks are important indicators of language abilities. The task involves the repetition of an auditorily presented made up word such as *woogalamic* immediately after it is heard. Relative to children with normal language development, children with persistent as well as resolved language impairments show substantial difficulty repeating nonsense words (Bishop et al., 1996; Ellis Weismer et al., 2000; Gathercole & Baddeley, 1990b; Montgomery, 1995). Nonword repetition has been found to be a culture fair screening method for language impairments (Campbell, Dollaghan, Needleman, & Janosky, 1997; Ellis Weismer et al., 2000; Washington & Craig, 2004) because nonword repetition has not been found to distinguish between White and African American children (Campbell et al., 1997), and it is not associated with maternal education levels (Alloway, Gathercole, Willis, & Adams, 2004).

There is considerable evidence that nonword repetition is strongly associated with vocabulary acquisition of both the native language (e.g., Avons, Wragg, Cupple, & Lovegrove, 1998; Gathercole & Baddeley, 1989; Gathercole, Hitch, Service, & Martin, 1997) and foreign languages (Masoura & Gathercole, 1999, 2005; Service & Kohonen, 1995), particularly during the early stages of acquiring language (Gathercole, 2006) because children learning language heavily rely on their phonological STM. The association between nonword repetition and vocabulary acquisition declines with increasing age beyond mid-childhood because the language learners use preexisting phonological knowledge to mediate the learning process (Gathercole, 2006). Regardless of age, the ability to repeat nonwords may not strictly rely on the phonological storage capacity only; other intrinsic processes such as processing novel stimuli may be involved (Gathercole, 2006).

The two most commonly employed nonword repetition tasks for children are the Children's Test of Nonword Repetition (CNRep; Gathercole, Willis, Baddeley, & Emslie, 1994) and the Nonword Repetition Test (NRT; Dollaghan & Campbell, 1998). Both tasks are independent of performance IQ for children with typical and atypical language development (Conti-Ramsden, Botting, & Faragher, 2001; Ellis Weismer et al., 2000). Also, both tasks have been employed to evaluate the influence of several linguistic factors on recall accuracy, including the similarity of the nonword to real words known as 'wordlikeness' (Gathercole, 1995; Munson, Kurtz, & Windsor, 2005), the length of the nonword (Bishop et al., 1996; Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990a), and the motoric complexity (Archibald & Gathercole, 2006a). Researchers have consistently found children with SLI to have deficits in repeating multisyllabic nonwords (e.g. Archibald & Gathercole, 2006b; Bishop et al., 1996; Botting & Conti-Ramsden, 2001; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Gathercole & Baddeley, 1990a; Montgomery, 1995), particularly with repeating three- and four-syllable nonwords (Gathercole & Baddeley, 1990a). Nonword repetition tasks (i.e., CNRep, NRT) differ in terms of their design characteristics; the CNRep test has 40 items ranging from two to five syllables, and the items contain English words and affixes such as *pen* and *ing*. The NRT has 16 items ranging from one to four syllables, and does not contain English words.

The present study employs Dollaghan and Campbell's (1998) nonword repetition task. The task is highly dependent on phonological STM because it minimizes linguistic influences by diminishing wordlikeness. Low-wordlike nonwords reduce the opportunities for individuals to retrieve knowledge from their preexisting lexicon to fill in missing information at the time of retrieval – a process called *redintegration* (see Munson et al., 2005).

The second proposed clinical marker, sentence repetition, has been identified by multiple researchers (e.g. Conti-Ramsden et al., 2001; Stokes, Wong, Fletcher, & Leonard, 2006) and has long been part of assessment batteries for the identification of language impairments (e.g. the Clinical Evaluation of Language Fundamentals-Revised [CELF-R; Semel et al., 1989] and the Test of Language Development-Primary [TOLD-P; Newcomer & Hammill, 1997]) or general abilities (Wechsler Preschool and Primary Scale of Intellignce- Revised; Wechsler, 1989). In this task, a child is asked to recall a sentence immediately after hearing it. The ability to repeat sentences verbatim is reduced by phonological STM limitations (Conti-Ramsden et al., 2001; Hanten & Martin, 2000;

Martin, Lesch, & Bartha, 1999; Martin, Shelton, & Yaffee, 1994; Willis & Gathercole, 2001) and plausibly, information-processing abilities dependent on sentence structure (Mann, Shankweiler, & Smith, 1984; McCarthy & Warrington, 1987; Saffran & Martin, 1975), length (Willis & Gathercole, 2001), and complexity (Mann et al., 1984; McCarthy & Warrington, 1987; Saffran & Martin, 1975).

Conti-Ramsden and colleagues (Conti-Ramsden et al., 2001) completed a study comparing 11-year-old children with SLI to age-matched children on four clinical markers: nonword repetition, tense marking, third-person singular task, and sentence repetition. The results revealed that sentence repetition provided the highest accuracy in identifying SLI (also in agreement with Botting & Conti-Ramsden, 2003), followed by nonword repetition, past tense, and third person singular. The sensitivity - the accuracy of a test to identify individuals with SLI, and specificity - accuracy of a test to identify those who have typical language development, values for sentence repetition were 90% and 85% (in agreement with Archibald & Joanissee, 2009) at the 16^{th} percentile cut point. In addition, Bishop, Adams, and Norbury, (2006) completed a study with 6-year-olds that found sentence recall could differentiate those with typical language development from SLI.

The third clinical marker identified for language impairments is grammatical morphemes pertaining to tense and agreement (verb morphology). One task involves an examiner reading a sentence to a participant while omitting the target verb. The participant then verbalizes the verb that he or she believes to be correct. A point is awarded for each verb produced with correct verb marking. The linguistic task appears to be a hurdle for children with SLI throughout the primary school years (Rice & Wexler, 1996a; Rise, Wexler, & Cleave, 1995; Rice, Wexler, & Hershberger, 1998; for an in-depth review see Leonard, 1998). Rice and Wexler (1996a) proposed that a defining characteristic of language impairments is that those affected exhibit a higher than expected use of infinitival forms where finiteness is required (e.g., omission of -ed ending on a verb). Rice and Wexler (1996b) examined verb marking in a group of 5-year-old children with SLI and found that the children were likely to omit tense marking. Omission rates were about 75% for -s and -ed, compared to 50% for matched typically developing peers.

A common diagnostic task researchers use to assess limitations in receptive morphosyntax (grammatical abilities) is a grammaticality judgment task. In this task, both grammatical and agrammatical sentences are presented to the participant, and he or she judges the sentences for well-formedness. The task employed by Miller (Miller, Leonard, & Finneran, 2008) included three error types as those described above. One was the omission of a non-tense grammatical morpheme, for example, the omission of the possessive inflection *'s*, as in "Last night mother foot started to hurt and so did her knee." The second error is referred to as a *tense intrusion* – the intrusion of a present third-person singular *–s* in an inappropriate context, as in "Larry was told again not to smokes in the house" or a past tense inflection *–ed*, as in "Chris and George will learn to carved the pumpkin for Halloween." The third error referrers to a *tense omission* where the present third-person singular *–s*, and the past tense *–ed* are omitted, for example, "Joan bikes and skate in the park everyday after school", and "When he arrived at home he dump his books on his bed."

In grammaticality judgment, preschool children often judge the sentences for semantic content rather than grammaticality (deVilliers & deVilliers, 1972), whereas older children's performance may differ by construction type (Kail, 2004; Wulfect, Bates, Krupa-Kwiatkowski, & Saltzman, 2004). This task has been found to be sensitive to individual differences throughout adolescence and adulthood (Miller et al., 2008). Recently, Miller et al. (2008) used the grammaticality judgment task described above and showed that grammatical competence in adolescents is compromised for those with SLI and non-specific language impairment (NLI). Specifically the SLI and NLI groups exhibited reduced sensitivity to non-tense omissions and tense intrusions, relative to adolescents without language impairments (Miller et al., 2008).

In addition to clinical markers measuring bio-psycho-social factors, it is important to consider environmental factors because they are salient modifiers of children's language development (Vachha & Adams, 2009). Typically, characteristics of the home environment are measured using questionnaires with sound parametric properties. This is of utmost importance as the results are subject to social desirability response bias – the tendency of respondents to answer in a manner that will be viewed favorably by others. This can create false or obscured relationships between variables.

The Family Environment Scale (FES, Moos & Moos, 2002) has been employed in many studies to describe the family milieu. For the purpose of this thesis, the 90-question FES – Real form (Form R) was employed to measure the family social environment. The questionnaire is composed of 10 subscales that assess three sets of dimensions: relationships, personal growth, and system maintenance (see Table 1). The relationship and system maintenance dimensions reflect internal family functioning, and the personal growth dimension expresses the linkages between the family and the larger social context (Moos & Moos, 2002).

The FES helps clinicians, researchers, and psychologists understand the topology of family environments, identify the family's most salient aspects, and better understand how family members perceive their family to diagnose problems and promote change. The FES is used to assess and describe family social environments (e.g., Kuo, Voorhes, Harthornwaite, & Young, 2007), and contrast parent, children, and sibling perceptions of the family unit (e.g., Green, Fine, & Tollefson, 1988; Karnes & D'llio, 1988, 1989; Moos & Fuhr, 1982). In the therapeutic context, the assessment may help family members better understand their family and become more aware of how their actions and/or behaviours affect the one another (e.g., Moos & Fuhr, 1982; Peleg-Popko & Kingman, 2002).

The FES has been used as a measurement tool in nearly 2,000 published research studies. Recently, Vachha and Adams (2009) used the FES to examine the effect of the family environment on language performance in groups of children with and without myelomeningocele. They observed a relationship between intellectually and culturally enhancing activities and language performance among children with myelomeningocele.

Table 1

Description of the Family Environment Scale Subscales

RELATIONSHIPS

- Expressiveness
  - The degree to which family members directly express their feelings
- Conflict
  - The amount of expressed conflict and anger amongst the family
- Cohesion
  - How supportive, helpful, and committed family members are toward each other

PERSONAL GROWTH

- Intellectual-Cultural Orientation
  - The degree of interest in intellectual, cultural and political activities
- Active-Recreational Orientation
  - The level of participation in recreational and social activities
- Achievement Orientation
  - The amount of dedication toward activities that are achievement or competitively oriented
- Moral-Religious Emphasis
  - The value of religious and ethical issues
- Independence
  - The degree to which family members make independent decisions, are assertive and self-sufficient

SYSTEM MAINTENANCE

- Control
  - The degree of implicated rules and procedures used for family functioning
- Organization
  - The amount of structure, organization and planning of responsibilities and activities within the family

This thesis takes a holistic view of children's language abilities by means of examining the relationships between children's skills and those of their parents, as well as familial and environmental influences. For all intents and purposes, language impairments are typically not recognized from one measure alone; they are multifactorial impairments that require a series of informative measures.

Specific Language Impairment

Specific Language Impairment refers to that subset of children with language impairments whose language learning difficulties are not explained by preexisting conditions such as neurological, cognitive, or hearing impairments, and do not result from the lack of sufficient early language experiences. SLI affects approximately 7% of children (LaParo et al., 2003; Tomblin et al., 1997), with a 3:1 male to female ratio (Tomblin et al., 1997). The profiles of children with SLI are heterogeneous; many demonstrate marked receptive and/or expressive language-learning/performance difficulties. Understanding the nature of SLI is vital for reducing the negative impact (e.g. poor social, academic and overall quality of life) on those affected.

Characteristics of SLI. The identification of a clinical population of children with SLI is a challenge to clinicians and researchers alike. SLI describes a range of language difficulties in the context of normal cognitive development.

Vocabulary. Acquiring vocabulary requires adequate temporary storage of phonological representations in the mental lexicon. This process may be compromised by poor perception and extraction of phoneme sequences and poor phonological memory abilities (Bishop, 1997), as seen in children with SLI (Gathercole & Baddeley, 1990a; Montgomery, 1995b; Bishop et al., 1996; Dollaghan & Campbell, 1998). Thus, these children exhibit difficulties with vocabulary development, potentially including both receptive and expressive vocabulary skills (Nation, 2008). Children's expressive language tends to be impaired, containing phonologically incomplete words, missing inflections, incorrect word orders and missing or incorrect words (Helenius, Parviainen, Paetau, & Salmelin, 2009). In addition, children with SLI have delays in vocabulary acquisition (Leonard, 1998; Rice, 1991; Trauner, Wulfeck, Tallal, & Hesselink, 2000) and have persisting vocabulary deficits (Trauner et al., 2000) that become more marked with age (Haynes, 1992; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

Grammar. One of the hallmarks of SLI is a disproportionate deficit in grammatical development (Bishop, 2004), particularly verb tense and agreement (Rice, 2003; Pawlowska, Leonard, Camarata, Brown, & Camarata, 2008). Rice and colleagues (Rice, Wexler, Marquis, & Hershberger, 2000) have shown that children with SLI may be more delayed in their ability to learn grammar than language acquisition in general. Relative to younger typically developing children with similar mean length of utterance, as well as typically developing age-matched peers, children with SLI produce significantly fewer obligatory morphemes (Rice & Wexler, 1996a). Also, typically developing children usually master verb marking by age five, whereas children with SLI may not have reached mastery by age seven (Rice et al., 1998).

Syntax. Within the heterogeneous group of children with SLI, there are substantial portions of these children who have significant difficulties acquiring syntactic rules (e.g., Friedmann & Novogrodsky, 2004; van der Lely & Christian, 2000; van der Lely &

Fonteneau, 2006; Montgomery, 1995). The syntactic deficit includes but is not limited to impaired comprehension of object relative clauses (Friedmann & Novogrodsky, 2004, 2007), referential object questions (Friedmann & Novogrodsky, 2003), and topicalized prepositional phrases in English (van der Lely & Harris, 1990). These impaired structures are all derived by the movement of a phrase that results in a non-canonical order of the arguments in the sentence (Friedmann & Novogrodsky, 2007). One suggestion for the reason that children with SLI have difficulties in successfully learning novel syntactic rules has been attributed to their inability to use prosodic information the same way as normally developing children (Fisher, Plante, Vance, Gerken, & Glattke, 2007; Weinert, 1992).

Pragmatics. Children who experience pragmatic impairments have difficulties using language appropriately in a given context. Other aspects of pragmatic abilities extend to social or interactive abilities. To participate in a conversation, the child must understand what is being said and understand the speaker's communicative intent (Bishop, Chan, Adams, Hartley, & Weir, 2000). For the most part, children with SLI have pragmatic abilities that are within normal limits for their language abilities (e.g. Mackie & Dockrell, 2004; Norbury & Bishop, 2003), although researchers (e.g., Brinton et al., 1998) have noted that their lack of conversational abilities that negatively affects their social skills. Poor social skills are discussed in section 1.2.1.5.

Diagnostic Criteria. According to the World Health Organization's International Classification of Diseases (ICD-10; 1993) and the American Psychiatric Association's Diagnostic and Statistical Manual (DSM-IV; 2000), SLI is a term applied to children who score in the average range on measures of nonverbal intelligence, below average on language tests and who do not have psychiatric disorders (behavioural or emotional problems), neurological disorders (epilepsy, autism, etc.), inadequate environmental opportunities, loss of motor (articulation) skills, peripheral sensory (hearing abilities) or trauma to areas of the brain affecting language development from postnatal brain injury (Tallal et al., 1989).

Currently, the diagnosis of SLI is assigned largely on the basis of exclusion: the child shows no hearing loss greater than 25 dB (Montgomery & Evans, 2009; Pawlowska et al., 2008; Rice & Wexler, 1996; Weerdenburg, Verhoeven & Balkom, 2006), and no previous diagnosis of ADD/ADHD or Autism Spectrum Disorder (Pratt et al., 2006). The child typically scores at least 1.25 SD below the mean on at least two language measures (Rise & Wexler, 1996; Tomblin, Freese, & Records, 1992) and receives a standard score of greater than 85 on a nonverbal intelligence measure (Archibald & Gathercole, 2006a, 2006b, 2006c; Montgomery & Evans, 2009; Nickisch & von Kries, 2009; Pawlowska et al., 2008).

For the purpose of diagnosing SLI, Tomblin and Records (1996) conducted a study to determine a reliable cut-off score on standard language measures that both researchers and speech-language pathologists could agree upon. To diagnose SLI, Tomblin and Records (1996) established a standard deviation with the greatest specificity and sensitivity. The discrepancy cutoff that best reflected appropriate levels of sensitivity and specificity was -1.25 SD. Many researchers have employed this cut-off (e.g., Alloway & Archibald, 2008; Archibald & Gathercole, 2006b, 2006c; Bavin et al., 2005; Hammer et al., 2001; Miller et al., 2001; Montgomery, & Evans, 2009; Leonard et al., 2007), though not always (Im-Bolter et al., 2006; Nickisch & von Kries, 2009; Weismer, Evans, & Hesketh, 1999).

Problems with Diagnostic Cut Offs. The use of a single cut off score to identify children with SLI has been criticized by researchers (e.g., Spaulding et al., 2008). Plante (1998) has argued that a cut off score identifies individuals at the lower end of the distribution for language, but may not identify other patterns of language impairment. Foremost, the magnitude of discrepancy necessary for identifying SLI on norm-referenced language tests is generally 1.25 SD below the mean (Tomblin & Records, 1996). To illustrate the arbitrary nature of the cut off score, Spaulding, Plante, and Farinella (2006) reviewed published articles between August 2003-April 2004 in journals by the American Speech-Language-Hearing Association. Spaulding and colleagues (2006) found that the majority of researchers select children with SLI based on language scores set anywhere between 1 to 1.5 SD below the mean. Thus, a single cutoff score is not universally applied, which makes it difficult to carryout cross-examinations of the literature.

In addition to the arbitrary cut off score, when researchers attempt to select the purest cases of children with SLI, they want to exclude children with additional disorders such as ADHD, otitis media, or a bilingual or impoverished home environment (Bishop, 2004). This is problematic because in reality, language impairments are prevalent in children who have other developmental disorders. With such diagnostic criteria striving for the purest case of SLI, many children with language impairments will be excluded. Bishop (2004) claimed that stringent discrepancy and exclusionary criteria for SLI cannot be justified in clinical and educational contexts.

Does SLI exist? Currently, there is considerable debate as to whether SLI is an independent category of language impairments because children are diagnosed if they score in the tail end of the distribution on a standardized language measure. This raises the question of whether these children merely perform below average, or have a Specific Language Impairment. If the former is true, it is reasonable to question the existence of Specific Language Impairment. Dollaghan (2004) questioned whether the language characteristics of children with impairments are a discrete category from those with typical language development; in other words, whether, there is evidence for an SLI taxon - a different category of a phenomena rather than differences in degree. Dollaghan's (2004) study did not reveal evidence for an SLI taxon; the language skills of children aged three and four with SLI were distributed in a dimensional rather than categorical manner relative to typically developing children.

It is evident from Dollaghan's (2004) study that it is not sufficient to accurately diagnose children with SLI merely because they fall in the bottom of the distribution by attaining the arbitrary impairment criteria. The question remains as to whether there are some children whose language development is significantly more delayed than other aspects of their development or than would be predicted by their environment. To exploring this issue, this thesis will investigate the relationship between a child's language abilities, their parent's abilities, and factors about the home environment.

Research Questions

The primary purpose of this thesis is to take a holistic view including behavioural measures of parent abilities, and familial and environmental factors that influence a broad spectrum of children and their language abilities. The following specific research questions will be addressed:

1. How effective are measures of parental abilities and family environment in accounting for variability in children's language abilities?
2. Which parental abilities or environmental aspects significantly and uniquely influence children's language abilities?
3. Are there specific children whose language abilities are not well-predicted by the best predictors found in this study?

CHAPTER 2

Methods and Measures

Introduction

The following chapter describes the study design, participant recruitment processes, and the study procedures and measures. This chapter also outlines the methods of data analysis and interpretation.

The study design was selected based on previous research indicating that both environmental (La Paro et al., 2004) and biological abilities (Barry, Yasin, & Bishop, 2007) influence children's language abilities. It is well-recognized that language impairments are multifactorial and require a series of informative measures; thus, a combination of parent, familial and environmental markers may result in the best overall classification accuracy for both ruling in and ruling out a language disorder.

Participants

The participants in this study were 45 parent-child dyads including 21 mother-daughter dyads; 20 mother-son dyads; 3 father-daughter dyads, and 1 father-son dyad. The children included 24 females, and ranged in age from 6 to 9 years (all: M = 7;5, SD = 0.97, range = 6;3-9;10; females: M=7;4, SD = 0.99, range = 6;3-9;6; males: M = 7;6, SD = 0.98, range = 6;3-9;10). The mean age of the parents was 39 years; 7 months (all: SD = 5.2, range = 30;2-49;1; mothers: M = 39;7, SD = 4.8, range = 30;6-49;1; fathers: 42;6, SD = 8.5, range = 30;2-48;10).

Children. The children in the present sample were a subset of those involved in an ongoing study investigating language, memory and academic achievement in children (Language, Reading, and Mathematical Skills in Children, UWO Ethics, 16215S) conducted by Archibald and colleagues (Archibald, Cardy, Joanisse, & Ansari, 2009). The Archibald et al. study took an epidemiological approach inviting all children in Senior Kindergarten to grade 4 from 34 elementary schools in both urban and rural settings. A total of 1310 children completed screening measures from which a subset of 398 who had either scored in the average range or poorly on the screening measures were selected to complete a number of standardized tests. A group of 100 children were randomly selected from the subset of 398 to be invited to the present study in order to ensure that children with a broad range of language abilities were included. Of these, 73 parents/guardians had provided permission to be contacted for future studies, and a total of 45 were successfully recruited to the present study.

Parents. The 45 parents were recruited over a three-month time period (September-November 2010). To be eligible for this study, each participant had to be the biological parent of the child (children) involved in the larger study, and have normal to corrected vision, hearing, and manual dexterity. The University of Western Ontario Committee on the Ethics of Research for Non-Medical Research approved the present study.

Procedure

Children: Each child was seen individually in a quiet room in his or her school. The child completed a number of standardized tests including the four core subtests required for the calculation of the Composite Language Score (CLS) of the Clinical Evaluation of Language Fundamentals IV (CELF-IV; Semel, Wigg, & Secord, 2003) appropriate for the child's age. The subtests included *Recalling Sentences, Formulated Sentences, Concepts and Following Directions* for all children, and *Word Structure* (under 9 years; $n = 38$) or *Word Classes 2: Receptive and Expressive* (over 9 years; $n = 7$). Additional tests completed are not reported here. The CELF-IV is a standardized tool for the evaluation of receptive and expressive language abilities. The subtests were completed in one of three visits with the child.

Parents. Each parent completed an assessment battery consisting of eight tests in a single, 45-minute research session conducted individually in a quiet room either in their home or at the university. The battery of tests included tests of nonverbal intelligence from the Weschler Abbreviated Scale of Intelligence – third edition (WASI-III; Wechsler, 1997), verbal working memory from the Automated Working Memory Assessment (AWMA; Alloway, 2007), phonological short-term memory by Dollaghan and Campbell (1998), *Sentence Recall* by Redmond (2003), grammar by Miller et al. (2008) and reading proficiency from the *Test of Word Reading Efficiency* (TOWRE – B; Torgesen, Wagner, & Rashotte, 1999). A personal laptop computer and recording device were used to present and record stimuli. The parent participant also completed a questionnaire about their family environment by Moos and Moos (2002).

Measures

Measures Completed by the Child Participants

All of the following measures are subtests of the *CELF-IV* (Semel et al., 2003). The subtests administered were sufficient to calculate the test's Composite Language Score, which is a measure of general language ability. For ages 5-8, the CLS is based on scaled scores from the subtests Concepts and Following Directions, Word Structure, Recalling Sentences, and Formulated Sentences. For 9 years and older ages, the CLS includes the same tests previously describes but substitutes Word Classes 2 for Word Structure. One child participant did not complete the subtests Recalling Sentences and Formulated Sentences that comprise the CLS.

Formulated Sentences. In this subtest, children are asked to formulate a sentence containing a given word and pertaining to a displayed picture. For example, the student is asked to make a sentence about a picture using the word *playing* (Semel et al., 2003). The subtest evaluates the ability to formulate complete, semantically, and grammatically correct spoken sentences of increasing length and complexity using given words and contextual constraints imposed by illustrations.

Recalling Sentences. Children are asked to repeat a sentence immediately after hearing it read to them. One example of a sentence is "The coach could not find the uniforms that the team wore last year" (Semel et al., 2003). The subtest evaluates the ability repeat sentences of increasing length and complexity without changes to word meanings, inflections, derivations or morphology, or sentence structure (syntax).

Concepts and Following Directions (C&FD). In this subtest, children are asked to point to aspects of a picture following a spoken instruction. For example, "Point to the big apples, then point to the little car" (Semel et al., 2003). The subtest evaluates the ability to interpret and remember spoken directions of increasing length and complexity, and the order of mention of objects.

Word Classes 2. The subtest is used to evaluate the student's ability to understand relationships between words that share a variety of functional and conceptual relationships. Word Classes 2 includes both a receptive and expressive task. For the receptive task, the participant selects two words from a choice of four words that he or she thinks "go together" the best. For example, one set of words is "a. school, b. teacher, c. cake, d. street" (Semel et al., 2003). For the expressive task, the student explains why the two words that he or she selected go together. Continuing with the example, the student may say "teachers work in/are at school" (Semel et al., 2003). This task was completed only by those nine years of age and above.

Word Structure. The subtest evaluates the student's knowledge of grammatical rules in sentence-completion task. The student verbally completes an orally presented sentence that pertains to an illustration. For example, "This boy [point] said, "This cap is mine and that one is ______ (yours)" (Semel et al., 2003). Only those between five and eight years of age completed this task.

Measures Completed by the Parent Participants

Grammaticality Judgment. A Grammaticality Judgment task based on Miller and colleagues (Miller et al., 2008) was administered as a language-related measure. The task requires participants to initially listen to sentences such as "Joan bikes and skate_ in the park everyday" and "Father painted his daughter_ wagon red and her bike yellow", followed by indicating if he or she thought the sentence was grammatically correct. The answers were marked as right or wrong, and scored out of 24. Each sentence was only repeated once. Before beginning the task, the researcher gave the following instructions "Now you are going to hear some sentences. Some of the sentences will be correct – that is, they will sound like something a person would really say. Some sentences will be incorrect – that is, they will sound funny or wrong. If the sentence sounds correct, say 'yes'. If the sentence sounds funny or wrong, say 'no'".

Sentence Recall. The Sentence Recall task (Redmond, 2003) was administered to measure the participants' language skills. Participants were asked to immediately repeat each of 16 sentences composed of ten words (ten to 14 syllables) verbatim. For example, a sentence was "The rose bushes were planted yesterday by the girl scouts." Responses were scored in relation to the number of errors made in each sentence; a score of two meant the participant repeated the sentence perfectly, a score of one meant the participant made one to three errors, and a score of zero meant four or more errors were made. The participants could achieve a maximum score of 32. Before beginning the task, the researcher said the following instructions "Next, you're going to hear some sentences. After you hear each sentence, I want you to repeat the sentence exactly as you heard it. Just say the same thing. Are you ready?"

Phonological short-term memory. The Nonword Repetition Test (Dollaghan & Campbell, 1998) was administered to assess the participants' phonological short-term memory. The stimuli were a recording of a native English-speaking female producing each nonword according to the phonetic descriptions provided in Dollaghan and Campbell's (1998) paper. After the participant heard each nonword such as *doif*, he or she was asked to repeat each nonword verbatim. The task includes a total of 16 items, including four each of one-, two-, three-, and four- syllable nonwords. Before beginning the task, the researcher gave the following instructions "For this activity, you're going to hear some funny made-up words. When you hear each word, I want you to say exactly what you heard loudly and clearly. Listen carefully and say exactly what you hear. Are you ready?"

Verbal working memory. The Counting Recall (AWMA; Alloway, 2007) task was administered to the participants as a measure of their verbal working memory. The task places heavy demands on executive working memory because it incorporates counting and visuospatial processing. The participant is required to count four, five, six, or seven red dots on a single computer screen and say the total number aloud. A series of arrays are shown, and the participant recalls the number of dots in the same order as the arrays were presented. The test begins with a single array of dots and increases by one array until the participant makes three errors in six arrays. The maximum number of arrays in a series is seven. The participants could achieve a maximum score of 42.

Test of Word Reading Efficiency. To assess the participants reading ability, the TOWRE – B (Torgesen et al.,1999) was administered. The participants read two lists of items as fast and accurately as possible within a 45-second period. The first list of items, Sight Word Reading Efficiency (SWE), consisted of real words such as *money*, and has a maximum score of 104. The second list, Phonemic Decoding Efficiency (PDE), contained non-words such as *guddy* and has a maximum score of 63.

Nonverbal Intelligence. Nonverbal intelligence was measured by two tests: Block Design and Matrix Reasoning. Both tasks measure performance IQ, specifically perceptual organization, and are subtests of the WASI-III (Wechsler, 1997). Block Design assesses spatial perception, visual abstract processing and problem solving by using colored blocks to make specific designs. This task involves putting sets of blocks that are all red or white, or both red and white, together to match patterns on cards produced by Wechsler (1997). A total score of 69 is achievable. Matrix Reasoning assesses nonverbal abstract problem solving, inductive and spatial reasoning. The task consists of a sequence or group of designs, and the participant is required to fill in a missing design from a number of choices. The maximum score achievable is 29.

Self-report measure: Each participant completed the Family Environment Scale – Real Form (FES-R; Moos & Moos, 2002). The FES-R is a 90-item true/false self-report instrument designed to gather information about family functioning on three dimensions, including relationships (e.g., “Family members really help and support one another”), personal growth (e.g., “We often go to the movies, sports events, camping, etc.” and system maintenance (e.g., “Dishes are usually done immediately after eating”) (see section 1.3). The FES-R allows caregivers to rate their perception on each of the above scales as either ‘true most of the time’ or ‘false most of the time’.

Statistical Analysis

All of the parental measures were considered estimates of factors that may significantly and uniquely contribute to children's language abilities. A linear regression analysis using a backward method was completed initially with all of the parental measures included as possible predictors and the child's Composite Language Score from the *CELF-IV* entered as the dependent variable. The backward method was used because it starts with all of the predictors in the model; the variable that is least significant is removed and the model is refitted. The advantage of using the backwards method is that it is possible for a set of variables to have considerable predictive capability even though any subset of them does not. In all cases, more than one model was significant; thus, a second conceptually driven linear regression was completed in which parental measures were grouped according to their theoretical motivation. Results were compared across these approaches to determine the model that best described children's language. Parallel analyses were completed independently for each of the three *CELF-IV* subtests that all participants had completed: Recalling Sentences, Formulating Sentences, and Concepts and Following Directions. Analyses were complete on the subtests of the *CELF-IV* as part of the exploratory approach to identifying which parental measures are related to children's overall and specific language abilities. As well, a descriptive analysis of outliers from the best fitting model was planned.

CHAPTER 3

Results

Descriptive Statistics

Descriptive statistics for the children's raw and standard scores on the CELF-IV are provided in Table 2. Descriptive statistics for all standardized measures completed by the parents are provided in Table 3. Mean standard and scaled scores for the children participants were averaged in all cases. For the parent participants, mean scores for the grammaticality judgment and sentence recall tasks approached the maximum possible score, suggesting possible ceiling effects.

Pearson product-moment correlations amongst all parental measures are presented in Appendix A. Correlations amongst both parent and children measures are presented in Appendix B. The parental tasks (Appendix A) within the language, reading ability and nonverbal IQ measures were highly correlated ($p < .01$). Interestingly, Sentence Recall and Nonword Repetition tasks (in Appendix A) can both be considered measures of phonological STM, but the correlation between them failed to reach significance ($r = .281, p = .061$). Parental Counting Recall and Phonemic Decoding Efficiency were significantly correlated with all other measures expect for the contextual factors. As seen in Appendix A and B, the contextual factors were only significantly correlated amongst themselves; Relationships and Personal Growth were significantly correlated ($r = .429, p = .004$).

Table 2

Descriptive Statistics of the Raw and Scaled Scores on the Measures Completed by the Children Participants

Tasks	Raw Score					Scaled Score		Standard Score	
	N	Min	Max	Mean	SD	Mean	SD	Mean	SD
Composite Language Score	44	56	123					100.64	14.56
Formulated Sentences	44	16	47	33.93	7.10	11.84	2.58		
Recalling Sentences	44	11	81	51.07	13.66	9.70	2.90		
Concepts and Following Directions	45	12	52	39.60	8.91	10.78	2.84		
Word Structure	38	3	31	25.16	5.55	9.74	2.96		
Word Classes 2: Expressive	7	1	13	8.57	3.78	9.29	3.56		
Word Classes 2: Receptive	7	2	13	7.29	4.03	7.14	3.98		
Word Classes 2: Total[a]	7					8.29	3.68		

[a] Word Classes 2: Total is derived from the sum of scaled scores for Word Classes 2: Expressive and Receptive. Using the examiner's Manual, Appendix C, section b, the sum was converted to the total score

Table 3

Descriptive Statistics of All Raw Scores for the Standardized Measures Completed by the Parent Participants (N = 45)

Measures	Tasks	Maximum Score	Mean	Std. Deviation
Language	Grammaticality Judgment	24	21.84	2.26
	Sentence Recall[a]	32	30.09	2.57
Phonological Short-term Memory	Nonword Repetition	16	11.20	2.27
Verbal Working Memory	Counting Recall	42	24.62	5.54
Reading Abilities	Sight Word Reading Efficiency	104	90.00	14.13
	Phonemic Decoding Efficiency	63	46.31	11.66
Nonverbal Intelligence	Block Design	69	42.84	13.72
	Matrix Reasoning	29	21.49	3.84
Contextual Factors[b]	Relationships	27	5.55	.857
	System Maintenance	18	5.73	1.61
	Personal Growth	45	5.71	.97

[a] Sentence Recall is also a measure of phonological short-term memory
[b] One participant did not complete the contextual factors

Appendix B shows that parent's language, reading, Relationships, and Personal Growth measures were not significantly correlated with any of the children's measures. Children's Composite Language Score was significantly correlated with the parent's System Maintenance ($r = -.319, p < .05$), Counting Recall ($r = .384, p < .01$), Nonword Repetition ($r = .338, p < .05$), and Matrix Reasoning scores ($r = .341, p < .05$). Children's Formulated Sentences was significantly correlated with parent's Matrix Reasoning ($r = .320, p < .05$). Children's Recalling Sentences was significantly correlated with parent's Block Design ($r = .303, p < .05$). Children's Concepts and Following Directions was significantly correlated with parent's Nonword Repetition ($r = .306, p < .05$).

Predicting children's language abilities

The following statistics are reported for each regression: standardized regression coefficient, β, which indicates the change in standard deviation units in the outcome variable associated with a 1 SD increment in the predictor, all else being held constant; the unstandardized coefficient, *b*, which describes the relationship between the predictor and outcome variable; statistical significance, *p*; and the semipartial correlation coefficient, *sr*, which indicates the independent contribution of each individual predictor to the criterion when all else is held constant.

Children's Composite Language Score

Exploratory Model. With all parental measures entered as predictor variables in the multiple regression analysis, using a backward method, nine models were established. Five of these were significant and are shown in Table 4 (for all remaining models, $F < 5.018, p > .05$). Model 1 includes measures of language, nonverbal IQ, phonological

STM, reading abilities and contextual factors (see Table 3 for specific tasks relating to the measures). Model 1 was significant, $F(7,35) = 2.233, p = .055$, and accounted for 17% (Adjusted $R^2 = .170$) of the variance. Model 2 included measures of language, nonverbal IQ, phonological STM and contextual factors. It was significant, $F(6,36) = 2.608, p = .033$, and accounted for 19% (Adjusted $R^2 = .187$) of the variance. Model 3 was significant $F(5,37) = 3.906, p = .019$, accounted for 20% (Adjusted $R^2 = .201$) of the variance, and included the measures tapping the same constructs as model 2. Models 2 and 3 differ only in whether sentence recall was retained (Model 2) or not (Model 3). The remaining significant models, Model 4, $F(4,38) = 3.906, p = .009$, and Model 5, $F(3,39) = 5.018, p = .005$, both accounted for 22% (Adjusted $R^2 = .217$, and Adjusted $R^2 = .223$) of the variance. Both models included measures of nonverbal IQ, phonological STM and contextual factors. Model 5 differed from model 4 by not including relationships as a contextual factor.

Table 4

Regression Analysis of the Exploratory Model for Children's Composite Language Score

Model	Predictor Variable	β	b	p	sr
1	Sentence Recall	-.133	-.755	.550	-.085
	Matrix Reasoning	.298	1.131	.082	.252
	Grammaticality Judgment	.141	.909	.518	.092
	Nonword Repetition	.235	1.506	.157	.203
	Phonemic Decoding Efficiency	.097	.122	.592	.076

	Relationships	-.141	-2.441	.381	-.125
	System Maintenance	-.287	-2.627	.076	-.257
2	Sentence Recall	-.126	-.717	.566	-.081
	Matrix Reasoning	.325	1.231	.047	.287
	Grammaticality Judgment	.162	1.046	.446	.107
	Nonword Repetition	.261	1.674	.098	.237
	Relationships	-.142	-2.458	.373	-.125
	System Maintenance	-.263	-2.407	.087	-.245
3	Matrix Reasoning	.294	1.114	.053	.276
	Grammaticality Judgment	.077	.499	.608	.071
	Nonword Repetition	.259	1.658	.098	.234
	Relationships	-.131	-2.274	.402	-.117
	System Maintenance	-.258	-2.363	.089	-.241
4	Matrix Reasoning	.307	1.164	.038	.293
	Nonword Repetition	.281	1.797	.060	.264
	Relationships	-.127	-2.206	.411	-.113
	System Maintenance	-.260	-2.384	.083	-.243
5	Matrix Reasoning	.284	1.075	.049	.276
	Nonword Repetition	.252	1.614	.080	.244
	System Maintenance	-.303	-2.773	.032	-.302

All of the significant models from the exploratory analysis included nonverbal IQ (*matrix reasoning*), phonological STM (*nonword repetition*), and a contextual factor (*system maintenance*) as predictors of the children's CLS. Model 1 additionally included reading abilities, but accounted for the least variance overall (17%). The remaining models each accounted for similar amounts of variance (19-22%) and were grouped by whether they included a measure of parental language (models 2 and 3) or not (models 4 and 5). Considering the standardized β values, Model 5 included only significant factors (matrix reasoning: $p = .049$; system maintenance: $p = .032$), or factors approaching significance (nonword repetition: $p = .080$). In fact, only nonverbal IQ (*matrix reasoning*) was a significant factor in the majority of the models.

One of the problems with an exploratory analysis was that all of the measures were entered separately. By treating highly related tasks such as grammaticality judgment and sentence recall separately (both measures of language abilities), some of the power that these measures may have together to predict children's language abilities may be lost. A more conceptually driven approach that grouped measures according to their theoretical motivation was planned in order to help disambiguate the findings of the exploratory analysis.

Conceptual Model. A conceptually driven linear regression was completed with parental measures grouped according to their theoretical motivation as outlined in Table 3. For the regression analysis, each theoretical group was put into individual blocks and *force entered*, a procedure that automatically forces all dependent variables listed into the regression. The study includes six theoretical groupings (see Table 3), thus, the regression produced six outcomes. In all cases, the models were not significant [$F <$

1.844, $p > .10$]. The beta-coefficients (β) of the predictor variables were analyzed to assess the effect of variables within the equation. Only the β values with the greatest significance were entered into a second regression analysis using the same concept (sentence recall, β = -.241; grammaticality judgment, β = .245, matrix reasoning, β = .284; nonword repetition, β = .210 and system maintenance, β = -.259). The tasks with β values less than .125 were not included in the second regression (block design, counting recall, site word reading efficiency, phonemic decoding efficiency, relationships, and personal growth) because their significance value was low ($p > .400$). Table 5 presents the one model that reached significance [$F(5,37) = 2.982, p = .023$] in this second analysis, accounting for approximately 19% (Adjusted $R^2 = .191$) of the variability (all remaining models, $F < 2.982, p > .05$). This model included measures of language, nonverbal IQ, phonological STM and a contextual factor.

Table 5.

Regression Analysis of the Conceptual Model for Children's Composite Language Score

Predictor Variable	β	b	p	sr
Sentence Recall	-.103	-.587	.635	-.066
Grammaticality Judgment	.140	.904	.505	.093
Matrix Reasoning	.294	1.116	.063	.266
Nonword Repetition	.231	1.483	.131	.215
System Maintenance	-.308	-2.827	.034	-.306

The Model That Best Predicts Children's Composite Language Score: Exploratory Model 2. The results were compared across the exploratory and conceptual models to determine the model that best describeded the children's CLS. The conceptual model provided the best match to model 2 in the exploratory analysis; the only difference was that the exploratory model included relationships from the contextual factors. Taken together, these results indicated that the most inclusive model significantly predicting the children's CLS included measures of parental language, nonverbal intelligence, phonological STM, and contextual factors. Considering both exploratory and conceptual models, matrix reasoning and system maintenance accounted for significant unique variance, whereas the remaining factors, while significant to the model, did not significantly account for unique variance.

It should be noted that the models were checked to ensure that multicollinearity, the excessive correlation between predictor variables, did not have an influence (Field, 2002). When correlations between predictor variables are excessive, standard errors of the beta coefficients becomes large, making it difficult or near impossible to assess the relative importance of the predictor variables. The variance-inflation factor (VIF) indicates whether a predictor has a strong linear relationship with the other predictors (Field, 2002), and is one method used to assess multicollinearity (Field, 2002). For the model best describing the CLS, sentence recall (VIF = 2.442), matrix reasoning (VIF = 1.284), grammaticality judgment (VIF = 2.272), nonword repetition (VIF = 1.220), relationships (VIF = 1.278), and system maintenance (VIF = 1.149) showed no multicollinearity.

Cases not well predicted by Model 2. Using the model that best predicted children's CLS (exploratory analysis, Model 2), children whose language abilities were not well-predicted by the model were identified by completing an outlier analysis. Outliers were considered to be those individual scores for which the residual was no less than an arbitrarily set, 2.0 standard deviations from the mean residual (Field, 2000). The predicted and actual (raw) scores for each child's CLS based on Model 2 were inspected. Two individuals were identified as outliers. The first outlier scored -2.360 SD from the mean residual. The predicted value for the CLS for this child was 87.66, and the child's actual score was 56. The second individual scored -2.397 SD from the mean residual, and had a predicted CLS of 99.15. The child's actual CLS was 67. Interestingly, both outliers scored lower on the CLS than was predicted by the model.

Children's Formulated Sentences

Exploratory Model. Parallel analyses for the formulated sentences subtest of the *CELF-IV* were completed. With all parental measures entered as predictor variables in the multiple regression analysis, eight models were established. Four of these were significant, and shown in Table 6 (for all remaining models, $F < 2.006, p > .05$). Model 1, 2, and 3 included measures of nonverbal IQ, verbal working memory, reading abilities and contextual factors (see Table 6 for specific tasks relating to the measures). Model 1 was significant $F(7,35) = 2.346, p = .045$, and accounted for approximately 18% (Adjusted R^2 = .183) of the total variance. Model 2 was significant $F(6,36) = 2.774, p =$ .025, and accounted for approximately 20% (Adjusted R^2 = .202) of the total variance. Model 3 was significant $F(5,37) = 2.945, p = .025$, and accounted for approximately 19%

(Adjusted R^2 = .188) of the total variance. Model 4 included measures of nonverbal IQ, verbal working memory and contextual factors, was significant [$F(4,38) = 3.041, p = .029$], and explained approximately 16% (Adjusted R^2 = .163) of the total variance.

All of the significant models from the exploratory analysis included measures of nonverbal IQ (*matrix reasoning, block design*), counting recall, and a contextual factor (*personal growth*) as predictors of the children's Formulated Sentences. Model 4 only included the measures previously noted, but accounted for the least variance overall (16.3%). The remaining models each accounted for similar amounts of variance (18-20%) and can be grouped by whether they included a measure of parental reading abilities (models 2 and 3) or not (model 4). Considering the standardized β values, Model 4 included only significant factors (block design: $p = .039$; personal growth: $p = .029$), or factors approaching significance (matrix reasoning: $p = .059$; counting recall: $p = .059$). In fact, across all of the models, only block design was a significant factor in all models.

Table 6

Regression Analysis of the Exploratory Model for Children's Formulated Sentences

Model	Predictor Variable	β	b	p	sr
1	Matrix Reasoning	.358	.635	.047	.287
	Block Design	.410	.204	.044	.292
	Counting Recall	-.416	-.514	.066	-.265
	SWE	-.408	-.199	.060	-.271
	PDE	.318	.186	.195	.184

	Relationships	-.068	-.553	.690	-.056
	Personal Growth	-.289	-2.049	.144	-.208
2	Matrix Reasoning	.352	.624	.048	.283
	Block Design	.412	.204	.041	.292
	Counting Recall	-.424	-.524	.057	-.271
	Site Word Reading Efficiency	-.409	-.199	.057	-.271
	Phonemic Decoding Efficiency	.303	.177	.206	.178
	Personal Growth	-.324	-2.301	.064	-.263
3	Matrix Reasoning	.371	.659	.038	.300
	Block Design	.434	.216	.032	.309
	Counting Recall	-.354	-.436	.102	-.233
	Site Word Reading Efficiency	-.222	-108	.148	-.205
	Personal Growth	-.365	-2.592	.037	-.301
4	Matrix Reasoning	.338	.600	.059	.275
	Block Design	.423	.210	.039	.302
	Counting Recall	-.410	-.507	.059	-.275
	Personal Growth	-.387	-2.745	.029	-.320

Conceptual Model. A conceptually driven linear regression was completed in which parental measures were grouped according to their theoretical motivation as outlined in Table 3. When all measures were included, none of the resulting six models were significant [$F < 2.293$, $p > .10$]. The β values of the predictor variables were analyzed to assess the effect of variables within the equation. Only the β values with the greatest significance were entered into a second regression analysis using the same concept (matrix reasoning, β = .358; block design, β = .416; counting recall, β = -.414; site word reading efficiency, β = -.414; phonemic decoding efficiency, β =.299; and personal growth, β = -.299). The remaining tasks (sentence recall, β = .023; grammaticality judgment, β = .021; nonword repetition, β = -.016; relationships, β = -.073; and system maintenance, β = .043) were not entered into the second regression because their significant value was low ($p > .400$). Table 7 presents the one model that reached significance [$F(6,36) = 2.774$, $p = .025$], and accounted for approximately 20% (Adjusted R^2 = .202) of the total variance (all remaining models, $F < 2.427$, $p > .05$), This model included measures of nonverbal IQ, verbal working memory, reading abilities and a contextual factor.

Table 7

Regression Analysis of the Conceptual Model for Children's Formulated Sentences

Predictor Variable	β	b	p	sr
Matrix Reasoning	.352	.624	.048	.283
Block Design	.412	.204	.041	.292
Counting Recall	-.424	-.524	.057	-.271
Site Word Reading Efficiency	-.409	-.199	.057	-.271
Phonemic Decoding Efficiency	.303	.177	.206	.178
Personal Growth	-.324	-2.301	.064	-.263

The Model That Best Predicts Children's Formulated Sentences: Exploratory Model 2. The results were compared across the exploratory and conceptual models to determine the model that best described children's Formulated Sentence scores. The conceptual model is identical to model 2 in the exploratory analysis. These results indicated that the most inclusive model significantly predicting the children's Formulated Sentences included measures of parental nonverbal intelligence, verbal working memory, reading abilities, and contextual factors.. Matrix reasoning (sr^2 = 8.0%, $p < .05$; VIF = 1.546) and block design (sr^2 = 8.5%, $p < .05$; VIF = 1.982) accounted for significant unique variance, and the unique variance explained by counting recall (sr^2 = 7.3%, p = .057; VIF = 2.456) and site word reading efficiency (sr^2 = 7.3%, p = .057; VIF = 2.273) approached significance. The remaining factors (phonemic decoding efficiency [sr^2 = 3.2%, $p > .05$; VIF = 2.906] and personal growth [sr^2 = 7.0%, $p > .05$; VIF = 1.520]), while significant to the model, did not significantly account for unique variance. Also, the predictor variables did not show multicollinearity.

Cases not well predicted by Model 2. Using the model that best predicted children's Formulated Sentences (exploratory analysis, Model 2), children whose language abilities were not well-predicted by the model were identified by completing an outlier analysis. Two individuals (different from those previously identified) were identified as outliers for this particular subtest. The first outlier scored -2.102 SD from the mean residual. The predicted value for the task for this child was 39.08, and the child's actual score was 26. The second individual scored -2.023 SD from the mean residual, and had a predicted score of 28.59. The child's actual score was 16. Again, both outliers scored lower on Formulated Sentences than was predicted by the model.

Children's Recalling Sentences

Exploratory Model. The parallel multiple regression analysis for the Recalling Sentence subtests returned 10 models, three of which were significant (see Table 8; for all remaining models, $F < 2.331, p > .05$). Model 1, which included measures of nonverbal IQ, phonological STM, verbal working memory and a contextual factor, was significant [$F(4,38) = 2.642, p = .048$], and accounted for approximately 14% (Adjusted $R^2 = .135$) of the total variance. Measures of nonverbal IQ, phonological STM, and a contextual factor were included in Model 2. The model explained approximately 12% (Adjusted $R^2 = .117$) of the total variance, and was significant [$F(3,39) = 2.858, p =$ .049]. Model 3 included measures of nonverbal IQ and a contextual factor, was significant $F(2,40) = 3.742$, $p = .032$, and accounted for approximately 12% (Adjusted $R^2 = .115$) of the total variance.

Table 8

Regression Analysis of the Exploratory Model for Children's Recalling Sentences

Model	Predictor Variable	β	b	p	sr
1	Block Design	.463	.454	.024	.299
	Nonword Repetition	.253	1.494	.141	.253
	Counting Recall	-.295	-.719	.186	.194
	Personal Growth	-.394	-5.518	.031	-.184
2	Block Design	.304	.298	.063	.299
	Nonword Repetition	.161	.951	.306	.253
	Personal Growth	-.264	-3.698	.084	-.184
3	Block Design	.362	.354	.020	.299
	Personal Growth	-.268	-3.754	.080	-.184

All of the significant models from the exploratory analysis included nonverbal IQ (*block design*), and a contextual factor (*personal growth*) as predictors of the children's Recalling Sentences, and each accounted for similar amounts of variance (11-14%). Considering the standardized β values, Model 3 included only significant factors (block design: $p = .020$), or factors approaching significance (personal growth: $p = .080$). In fact, across all of the models, only block design was a significant factor in the majority of the models.

Conceptual Model. For the conceptually driven regression analysis, none of the models were significant [$F < 1.116$, $p > .30$] when all measures were included. The β values with the greatest significance were entered into a second regression analysis (matrix reasoning, β =.182; block design, β = .464; nonword repetition, β = .302; counting recall, β = -.284; and personal growth, β = -.352). The remaining tests (sentence recall, β = -.118; grammaticality judgment, β = .005; site word reading efficiency, β = -.102; phonemic decoding efficiency, β = -.071; relationships, β = -.071; and system maintenance, β = -.081) were not included in the second regression because their significance was low ($p > .400$). Table 9 presents the one model that reached significance [$F(5,37) = 2.164$, $p = .079$], and accounted for approximately 12% (Adjusted $R^2 = .122$) of the total variance (all remaining models, $F < 2.073$, $p > .10$). This model included measures of nonverbal IQ, nonword repetition, verbal working memory, and a contextual factor.

Table 9

Regression Analysis of the Conceptual Model for Children's Recalling Sentences

Predictor Variable	β	b	p	sr
Matrix Reasoning	.115	.402	.523	.093
Block Design	.436	.427	.038	.311
Nonword Repetition	.261	1.545	.132	-.223
Counting Recall	-.349	-.848	.148	-.214
Personal Growth	-.404	-5.649	.030	-.327

The Model That Best Predicts Children's Recalling Sentences: Exploratory Model 1. The results were compared across the exploratory and conceptual models to determine the model that best described children's Recalling Sentences. The conceptual model provides the best matched to model 1 in the exploratory analysis; the only difference was that the conceptual model included matrix reasoning and model 1 does not. Taken together, these results indicated that the most inclusive model significantly predicting the children's Recalling Sentences included measures of parental nonverbal intelligence, phonological STM, verbal working memory and contextual factors. Considering both exploratory and conceptual models, block design and personal growth account for significant unique variance. Whereas the remaining factors, while significant to the model, did not significantly account for unique variance. Between all of the predictor variables, block design (VIF = 1.882), nonword repetition (VIF = 1.368), counting recall (VIF = 2.335) and personal growth (VIF = 1.512), there was no multicollinearity.

Cases not well predicted by Model 1. Using the model that best predicted children's Recalling Sentences (exploratory analysis, Model 1), children whose language abilities were not well-predicted by the model were identified by completing an outlier analysis. The one individual identified as an outlier was also identified as an outlier on the CLS. The individual scored -2.236 SD from the mean residual. The predicted value for the task for this child was 39.56, and the child's actual score was 11. The outlier scored lower on Recalling Sentences than was predicted by the model.

Children's Concepts and Following Directions

Exploratory Model. The parallel multiple regression analysis for the concepts and following directions subtest returned 11 models. Five of those were significant, (see Table 10; for all remaining models, $F < 1.960, p > .05$). Model 1 and 2 included measures of nonverbal IQ, language, phonological STM and a contextual factor. Model 1 explained approximately 14% (Adjusted $R^2 = .137$) of the total variance, and was significant [$F(5,38) = 2.370, p = .058$]. Model 2 explained approximately 15% (Adjusted $R^2 = .152$) of the total variance, and was significant [$F(4,39) = 2.920, p = .033$]. Model 3 was significant [$F(3,40) = 3.165, p = .035$], and accounted for approximately 13% (Adjusted $R^2 = .131$) of the total variance. The model included measures of nonverbal IQ, language and phonological STM. Model 4 was significant, $F(2,41) = 3.322, p = .046$, and accounted for approximately 10% (Adjusted $R^2 = .097$) of the total variance. It included measures of language and phonological STM. Model 5 included the measure of phonological STM, was significant [$F(1,42) = 4.668, p = .036$], and accounted for approximately 8% (Adjusted $R^2 = .079$) of the total variance. All of the significant models from the exploratory analysis included phonological STM (*nonword repetition*) as a predictor of the children's concepts and following directions. Across all of the models, only nonword repetition was a significant factor. Model 5 included only nonword repetition ($p = .036$), and accounted for the least variance overall (8%). The remaining models each account for similar amounts of variance (10-15%).

Table 10

Regression Analysis of the Exploratory Model for Children's Concepts and Following Directions

Model	Predictor Variable	β	b	p	sr
1	Matrix Reasoning	.204	.463	.217	.178
	Grammaticality Judgment	-.276	-1.067	.083	-.252
	Block Design	.103	.065	.552	.085
	Nonword Repetition	.313	1.200	.053	.283
	System Maintenance	-.188	-1.030	.196	-.187
2	Matrix Reasoning	.245	.555	.103	.234
	Grammaticality Judgment	-.260	-1.004	.095	-.241
	Nonword Repetition	.334	1.280	.033	.310
	System Maintenance	-.197	-1.080	.169	-.197
3	Matrix Reasoning	.239	.542	.115	.229
	Grammaticality Judgment	-.256	-.989	.103	-.237
	Nonword Repetition	.349	1.335	.028	.324
4	Grammaticality Judgment	-.211	-.814	.178	-.199
	Nonword Repetition	.388	1.485	.016	.365
5	Nonword Repetition	.316	1.211	.036	.316

Conceptual Model. For the conceptually driven regression analysis, none of the models were significant [$F < 1.955$, $p > .10$] when all measures were included. The β values with the greatest significance were entered into a second regression analysis using the same concept (grammaticality judgment, β = -.328; matrix reasoning, β = .222; nonword repetition, β = .356; and system maintenance, β =-.163). The remaining tests (sentence recall, β = .064; block design, β = .124; counting recall, β = -.056; site word reading efficiency, β = .109; phonemic decoding efficiency, β = -.090; relationships, β = -.077; and personal growth, β = .006) were not included in the second regression because their significance value was low ($p > .400$). Table 11 presents the one model that reached significance [$F(4,39) = 2.920$, $p = .033$], and accounted for approximately 15% (Adjusted $R^2 = .152$) of the total variance (all remaining models, $F < 3.165$, $p > .030$). This model included measures of language, nonverbal IQ, phonological STM, and a contextual factor.

The Model That Best Predicts Children's Concepts and Following Directions: Exploratory Model 2. The results were compared across the exploratory and conceptual models to determine the model that best described children's concepts and following directions. The conceptual model is identical to model 2 in the exploratory analysis. These results indicated that the most inclusive model significantly predicting the children's concepts and following directions included measures of parental nonverbal intelligence, language, phonological STM, and contextual factors. Nonword Repetition ($sr^2 = 9.6\%$, $p < .05$; VIF = 1.165) accounted for significant unique variance, whereas the remaining factors (grammaticality judgment [$sr^2 = 5.8\%$, $p > .05$; VIF = 1.169], matrix reasoning [$sr^2 = 5.5\%$, $p > .05$; VIF = 1.092], and system maintenance [$sr^2 = 3.9\%$, $p >$

.05; VIF = 1.006]), while significant to the model, did not significantly account for unique variance. Between the predictor variables, there was no multicollinearity.

Table 11

Regression Analysis of the Conceptual Model for Children's Concepts and Following Directions

Predictor Variable	β	b	p	sr
Grammaticality Judgment	-.260	-1.004	.095	-.241
Matrix Reasoning	.245	.555	.103	.234
Nonword Repetition	.334	1.280	.033	.310
System Maintenance	-.197	-1.080	.169	-.197

Cases not well predicted by Model 2. Using the model that best predicts children's concepts and following directions (exploratory analysis, Model 2), children whose language abilities were not well-predicted by the model were identified by completing an outlier analysis. One individual, who was not previously identified, was identified as an outlier for this particular subtest. The individual scored -3.35 SD from the mean residual. The predicted value for the task for this child was 39.14, and the child's actual score was 12. The outlier scored lower on concepts and following directions than was predicted by the model.

Outliers

It is expected that in a typical sample, 95% of cases have standardized residuals within two standard deviations of the mean (Field, 2000). For this study, four cases (9%) were outside of these limits. In addition, 99% of cases should lie within 3 standard deviations above or below the mean (Field, 2000). For this study, one case was outside of the limit. This study sample is consistent with what would be expected for a fairly accurate model.

A total of nine child participants scored 1 SD below the standardized mean (below 86). Of these, five were categorized as outliers on one or more of the subtests, or the CLS, and scored between -2.02 and -3.35 SD from the mean residual. One participant was an outlier on both the CLS and recalling sentences subtest, which is not surprising since the CLS is derived from the subtest scores. As well, the CLS was not available for the outlier who scored -3.35 SD from the mean residual on concepts and following directions because the participant did not complete all of the subtests (*Recalling Sentences* and *Formulated Sentences)*. If the participant completed the subtests, he or she may have also been an outlier on the CLS since both the CLS and concepts and following directions are predicted by equivalent measures.

CHAPTER 4

Discussion

The aim of this thesis was to consider the behavioural-psychosocial and environmental factors that influence language development. These factors were estimated by measuring of parental abilities and the family environment. Behavioural measures included tests of oral and written language, nonverbal intelligence, and short-term and working memory. The family environment was measured using a questionnaire tapping the constructs of the current family as they perceive it, in a larger social context. Across analyses, parental nonverbal intelligence significantly and uniquely predicted children's language abilities. Measures of parent language, short-term memory, and the contextual factors of relationships and system maintenance additionally comprised the best model predicting children's composite language scores in exploratory and conceptual analyses. Models fitted to the children's individual language subtests revealed largely similar results for understanding concepts and following directions but some variation for formulating and repeating sentences. Measures of written language processing (reading) and phonological short-term memory were retained in the model for formulating or repeating sentences, respectively, with the remaining factors of nonverbal intelligence, verbal working memory, and the contextual factor of personal growth common to the predictive models for both tasks. A second goal of this thesis was to examine evidence indicating that some children had difficulties learning language according to what would be predicted by the models identified in the present study. An outlier analysis revealed that five individuals performed below predicted levels on one or more language subtests, or the composite measure.

Perhaps not surprisingly, the results of the present study indicate that children's overall language abilities are influenced by multiple factors. Measures of parental nonverbal intelligence, language, short-term memory, and family environment together accounted for 19% of the variability in children's language abilities in this study. It may be that more direct measures of child abilities would result in a model accounting for more variance (see study limitations below). The retained factors reflect both bio-psycho-social and contextual factors related to biological and environmental influences. The findings are in agreement with the International Classification of Functioning, Disability and Health – Child and Youth conceptual framework of child functioning (WHO, 2007) highlighting the importance of both bio-pscyho-social and contextual factors in understanding functioning. As well, the present findings are in agreement with many previous studies reporting the influence of general ability (Dupuy, 1974; Huttenlocher, 1991), short-term memory (Adams & Gathercole, 1995; Gathercole et al., 1992), working memory (Archibald & Gathercole, 2006a; Marton & Schwartz, 2003), and contextual factors (Hoff, 2003; Prior et al., 2008) on language development.

The first two research questions proposed were targeted at addressing which parental abilities or environmental aspects significantly and uniquely influenced children's language abilities, and how effective the measures were in accounting for variability in children's language abilities. As previously mentioned, nonverbal intelligence was the only measure that significantly predicted unique variance in all of the exploratory and conceptual models. These results largely support previous literature stating that parental nonverbal IQ influences children's language. For example, individuals with high nonverbal IQ have greater linguistic abilities (Barry et al., 2007). It is not surprising that parent's overall general ability was strongly related to language learning in a cross-sectional sample of children. What was unexpected in the present study was that it was the only measure to account for a significant amount of unique variance in children's language abilities. From a theoretical and practical viewpoint, it is unlikely that parental nonverbal IQ is the only unique predictor of language acquisition because language is a complex learned behaviour. As well, studies have demonstrated the influence of a number of factors on language development (e.g., Barry et al., 2007). One reason that parental nonverbal intelligence played such an important role in the results of the present study may have been related to the measure employed. The block design and matrix reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1997) are psychometrically sound, well-studied measures of nonverbal IQ in adults. In contrast, several of the remaining tasks employed in the present study were not specifically designed for adults, and may not have captured sufficient variability across participants. For example, results of the parent's grammaticality judgment and sentence recall tasks reflected ceiling effects (see study limitations below). As a result, the predictive value of these other measures may have been underestimated in the present study.

In addition to nonverbal intelligence, complementary results from exploratory and conceptual analyses identified additional associations between parental factors and children's language abilities as a whole. Phonological short-term memory as measured by nonword repetition was retained in the models predicting the children's overall language score, ability to recall sentences, and accuracy in following directions, but not the model predicting the ability to formulate sentences. A relationship between phonological short-term memory and language is well documented. Nonword repetition has been shown to predict overall vocabulary knowledge better than general nonverbal IQ (Gathercole et al., 1992), and be related to measures of sentence recall (Alloway & Gathercole, 2005; Glanzer, Dorman, & Kaplan, 1981). Corroborating evidence of the relationship between phonological short-term memory and sentence recall comes from findings that individuals with impairments of phonological short-term memory are typically poor at recalling sentences (e.g., Alloway & Gathercole, 2005; Hanten & Martin, 2000; Martin et al., 1994; McCarthy & Warrington, 1987; Willis & Gathercole, 2001). In addition, it has been argued that phonological short-term memory assists with the preservation of the structure of a sentence such as word order and inflectional markers (Baddeley et al., 1998; Caramazza, Basili, Koller, & Derndt, 1981), which may explain why phonological short-term memory was found to be related to the ability to follow directions in the present study. The lack of a relationship between phonological short-term memory and formulating sentences in the present study was somewhat unexpected. However, Gathercole (2006) has suggested that phonological short-term memory may not be critical to the formulation of spoken language due to the greater demands on conceptual planning rather than retention in generating spontaneous utterances.

Interestingly, verbal working memory was a factor retained in the model predicting the ability to formulate and recall sentences. Both of these subtests place heavy demands on expressing language, which in turn relies on working memory - the ability to process information from multiple sources over brief periods of time (Marchman &

Fernald, 2008). Additional evidence of the association between language and verbal working memory comes from studies linking verbal working memory to vocabulary development (Gathercole & Baddeley, 1993), and the comprehension and expression of complex language (Marchman & Fernald, 2008). It may be that verbal working memory was not retained in the model for the composite language score because some of the tasks included in the composite do not place high demands on working memory. For example, the word structure task is a grammatical task and the word classes task involves judging word relations.

In addition to nonverbal IQ, verbal working memory, and contextual factors, reading abilities was related to children's ability to formulate sentences. Formulating sentences was the most demanding language expression task administered in the present study, and reading is a language-related task (e.g., Garlock, Walley, & Metsala, 2001; Griffiths & Snowling, 2002). Possibly, the reading measure best captured the participant's individual differences in language abilities because the task itself had no effective cap. Contrary to the reading measure, the sentence recall task that was used to assess language abilities had a maximum score of 32, which may have introduced a ceiling effect (see below). As a result, the reading test may have acted as a better indicator of language abilities, which in turn was most strongly related to the most demanding language task, formulating sentences. Alternatively, reading ability may not have been retained in the models predicting the remaining language subtests or composite because other reading-related tasks accounted for common variance. For example, phonological short-term memory is strongly related to pseudoword reading (Hensen &

Bowey, 1994), which is the phonemic decoding efficiency task in the present study, and was retained in all remaining models.

The last behavioural-psychosocial factor included in the study was language ability. The two language measures completed by the parents, sentence recall and grammaticality judgment, were retained in the models predicting the children's overall language score, and accuracy in following directions. The finding that these parental measures were most predictive of children's language skills, and their ability to execute oral commands of increasing length and linguistic complexity is in agreement with many previous studies reporting associations between language abilities and both sentence recall (Alloway & Gathercole, 2005b) and grammaticality judgment (e.g. Leonard et al., 2007; Poll et al., 2010). What was unexpected in the present study was that neither sentence recall nor grammaticality judgment accounted for significant unique variance in children's ability to recall sentences. Possibly, the parent's performance on the phonological short-term and verbal working memory tasks together overlapped with performance on these language measures. For example, sentence recall has been argued to be a measure of phonological short-term memory (e.g. Alloway & Gathercole, 2005, 2005b; Conti-Ramsden et al., 2001; Glanzer et al., 1981; Hanten & Martin, 2000; Martin et al., 1999; Swanson, 1994) and highly sensitive to language ability (Archibald & Joanisse, 2009).

Language acquisition takes place in an interactive environment, and at least in the early years, those most involved in communication are the parents. Along with the behavioural measures of parental abilities, contextual factors as measured by the Family Environment Scale (FES; Moos & Moos, 2002) comprised the best predictive models of children's language abilities in the present study. Understanding the dynamic interaction between environmental contributors and children's language development continues to be a challenge, although the family influences have become increasingly recognized as salient factors (Vachha & Adams, 2009) and worthy of better understanding (Friedman, Holmbeck, Jandasek, Zukerman, & Abad, 2004; Girouard et al., 1998; Holmbeck et al., 2002; McCarty, Zimmerman, Digiuseppe, & Christakis, 2005; McKernon et al., 2001). Several contextual factors from the FES were related to children's language abilities overall in the present study. One factor was the *relationships* construct, which showed a negative relationship with children's language development. According to Moos and Moos (2002), relationship-oriented families are support- and conflict-oriented. Family members help and support one another but fight frequently (Moos & Moos, 2002). It may be that greater conflict in the home has a negative impact on children's language abilities, or alternatively, that having a child in the home with low language skills increases conflict in the home. System maintenance was a second construct negatively related to children's language abilities. System maintenance-oriented families are described by Moos and Moos (2002) as being generally disorganized; for example, activities are not carefully planned out and people often change their minds. One interpretation of the present findings is that children's language abilities are reduced when there is less organization in the home while another is that the presence of a child with low language skills in the home contributes to greater disorganization. One example of this may be the occurrence of consistent family dinners in more organized homes. Such families may devote more time to speaking with one another, giving the children consistent opportunities to converse and further develop their language skills. Without organized activities in the home environment, children may not have enriched opportunities to acquire language. A third factor, personal growth, was included in the models predicting children's ability to recall and formulate sentences. Personal growth is considered to reflect the link between the family and the larger social context (Moos & Moos, 2002). Personal growth-oriented families are generally independent-, achievement-, moral-religious- or intellectual-cultural-oriented families; for example, the family strongly encourages others to be independent, they strive to do things just a little better next time, and family members often go to the library (Moos & Moos, 2002). The finding of a negative relationship between personal growth and children's language abilities is more difficult to explain because theoretically, a positive relationship would have been expected. However, personal growth-oriented families may be highly focused on the coming and going of multiple events and focus less on activities promoting language development. Alternatively, children with low language skills may be more likely to be registered in multiple programs and events.

Evidence for Impairments in Language Learning

The third question addressed in this thesis was whether there are children whose language abilities were not well-predicted by the best predictors found in this study. To date, relatively few studies have reported the measurement of nonverbal IQ, language, literacy skills, and environmental context of parents who have children with language impairments (Pratt et al., 2006). The present study identified a total of five children with unexpectedly low language scores based on the models. Interestingly, not all children with low language scores were identified as outliers. Four children whose scores were well-predicted by the model had equally low, or lower, language scores than the identified five. Interestingly, no children were identified with unexpectedly high language scores. Comparing all nine children with low language scores in the present study to standard criteria for identifying Specific Language Impairment (SLI) of scoring at least 1 SD below the mean on a standardized language measure and within 1 SD of the mean on a standardized test of nonverbal intelligence (Archibald & Gathercole, 2006; Montgomery & Evans, 2009; Nickisch & von Kries, 2009; Pawlowska et al., 2008), eight of the children would be considered to have SLI. The remaining child had a low performance IQ and language score. Four of the children who met the SLI criteria were identified as outliers in the present model, and four were not. It would follow from this that only four were potentially *impaired* in their ability to learn language. While it is beyond the scope of this thesis, these findings raise questions about the use of arbitrary cutoff scores to identify children with SLI (see also, Dollaghan, 2004).

Study Limitations

There are several limitations to the present study. Foremost, there are no gold standard tests to specifically examine adult language abilities (Barry et al., 2007). The present study employed self-report measures and a series of individual tests to assess a population that was broad in terms of age. The chosen measures were not purely environmental or free from environmental influence. Nevertheless, both knowledge-dependent (e.g., word reading in the TOWRE-B; Torgesen et al., 1999) and processing-dependent measures (e.g., nonword repetition; Dollaghan & Campbell, 1998) were included, the latter of which is assumed to be less culturally dependent (Poll et al., 2010).

As well, the measure of contextual factors employed, Family Environment Scale, was a self-report measure (Moos & Moos, 2002). While the FES provided valuable information, self-report measures must be interpreted with caution due to possible biases in recall and reporting. Besides the test limitations, environmental factors that were not taken into consideration when collecting the data may have an influence on children's ability to learn language. No study can include measures of everything that may influence language development. As a result, there may be factors important to development that were not measured in the present study. Examples of factors not included but previously found to influence language development include socioeconomic status (Dixon, 2011; Pratt et al., 2006; Snow, Burns, & Griffin, 1998), maternal education (Dixon, 2011; Dickinson & Tabors, 2001; Hart & Risley, 1995), order of childbirth (Hoff-Ginsberg, 1998), or single parent status (Enos & Handal 1986).

As previously mentioned, multiple tasks employed in the present study were not specifically designed for adults, and may not have captured sufficient variability across participants. Participant's performance within one standard deviation above the mean on the measures of sentence recall and grammaticality judgment was beyond the maximum score achievable on the measure. Several of the participants reached ceiling; thus, the test items were not challenging enough to measure all of the participant's true abilities. This likely influenced the results and may have lead to the mistaken conclusion that the independent variable in question had an insignificant effect on the dependent variable. For future studies, the tests should include questions with a range of difficulty so that clear distinctions can be made throughout the test-score distribution to avoid ceiling effects.

Lastly, the parent participants were volunteers of children recruited across a broad but localized region. Thus, the generalizability of the findings may be limited by the nature of the volunteer sample.

Implications of findings

The present findings support the holistic framework for understanding children's language development. A myriad of variables affected language development from both parental bio-psycho-social and contextual factors, implying that learning language involves the interplay between children's biological makeup and their environmental conditions. Secondly, the models established for children's overall language score, accuracy in following directions, ability to recall, and formulate sentences have implications for identifying children with a specific impairment in language learning.

Conclusion

Learning language is a developmental process, one that is influenced by parental abilities and the family environment. Parental nonverbal intelligence significantly predicated children's language development, along with other contributing parental measures of language, phonological short-term and verbal working memory, reading ability, and contextual factors (relationships, personal growth and system maintenance). The models established using the noted measures identified children who have a specific impairment learning language, suggesting that assessment of children's language abilities and intervention for children with language impairments requires a holistic approach.

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Appendix A

Pearson Product-Moment Correlations Amongst Parental Measures

	1	2	3	4	5	6	7	8	9	10	11
1. Sentence Recall	1										
2. Matrix Reasoning	.399**	1									
3. Grammaticality Judgment	.717**	0.245	1								
4. Block Design	.456**	.479**	.326*	1							
5. Nonword Repetition	0.281	0.228	.339*	.351*	1						
6. Counting Recall	.395**	.532**	.426**	.547**	.468**	1					
7. Phonemic Decoding Efficiency	.394**	.415**	.408**	.369*	.402**	.546**	1				
8. Sight Word Reading Efficiency	0.256	.305*	.491**	0.271	0.258	.318*	.731**	1			
9. Relationships	0.059	0.227	0.160	0.297	0.249	0.121	0.226	0.237	1		
10. Personal Growth	-0.051	-0.001	-0.084	0.233	0.054	-0.292	-0.163	0.037	.429**	1	
11. System Maintenance	-0.082	0.008	-0.037	-0.105	-0.073	-0.098	0.217	0.176	.304*	.300*	1

**$p < .01$; *$p < .05$

Appendix B

Pearson Product-Moment Correlations Amongst Both Parent and Children Measures

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Children's Composite Language Score	1														
2. Children's Formulated Sentences	.571**	1													
3. Children's Recalling Sentences	.670**	.592**	1												
4. Children's Concepts and Following Directions	.708**	.578**	.695**	1											
5. Parents Sentence Recall	0.205	0.2	0.106	0.037	1										
6. Parents Grammaticality Judgment	0.227	0.008	0.035	-0.076	.717**	1									
7. Parents Nonword Repetition	.338*	0.001	0.25	.306*	0.281	.339*	1								
8. Parents Counting Recall	.384*	0.133	0.202	0.19	.395**	.426**	.468**	1							
9. Parents Sight Word Reading Efficiency	0.110	-0.142	-0.065	-0.001	0.256	.491**	0.258	.318*	1						
10. Parents Phonemic Decoding Efficiency	0.225	0.106	0.044	0.064	.394**	.408**	.402**	.546**	.731**	1					
11. Parents Block Design	0.297	0.276	.303*	0.247	.456**	.326*	.351*	.547**	0.27	.369*	1				
12. Parents Matrix Reasoning	.341*	.320*	0.203	0.254	.399*	0.245	0.228	.532**	.305*	.415**	.479**	1			
13. Relationships	-0.068	-0.069	-0.084	0.002	0.059	0.16	0.249	0.121	0.24	0.226	0.297	0.227	1		
14. System Maintenance	-0.319*	-0.078	-0.270	-0.21	-0.082	-0.037	-0.073	-0.098	0.18	0.217	-0.105	0.008	.304*	1	
15. Personal Growth	-0.178	-0.168	-0.184	0.032	-0.051	-0.084	0.054	-0.292	0.04	-0.16	0.233	-0.001	.429**	.300*	1

**$p < .01$; *$p < .05$