FACILITATING WORD-LEARNING ABILITIES IN CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

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The material presented in this thesis is the original work of the candidate except as acknowledged in the text, and has not been previously submitted, either in part or in whole, for a degree at this or any other University.

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ABSTRACT

Children with Specific Language Impairment (SLI) often present with difficulties in learning new words compared to age-matched children with typical language development. These difficulties may affect the acquisition, storage, or retrieval of new words. Word-learning deficits impact on children's vocabulary development and impede their language and literacy development. Findings from a wide range of studies investigating word-learning in children with SLI demonstrated that semantic and phonological knowledge are crucial to the word-learning process. However, intervention studies designed to improve the word-learning abilities in children with SLI are sparse. The experiments described in this thesis addressed this need to understand the effects of interventions on word-learning abilities. Further, the thesis describes the first investigation of word-learning abilities of New Zealand school-aged children with SLI. Specifically, the following three broad questions are asked:

1. What are the word-learning skills of New Zealand school-aged children with SLI compared to children with typical language development and which underlying language skills influence word-learning?
2. What are the immediate and longer term effects of phonological awareness and semantic intervention on word-learning and language skills in children with SLI?

3. What are the error patterns of children with SLI compared to children with typical language development when learning to produce new words and do these patterns change following phonological awareness and semantic intervention?

The first experiment compared the word-learning abilities of 19 school-aged children with SLI (aged 6;2 to 8;3) to age-matched children with typical language development and revealed that children with SLI presented with significant difficulties to produce and to comprehend new words. After repeated exposure, children with SLI caught up to the performances of children with typical language development in learning to comprehend new words, but not on production of new words. Correlation analyses demonstrated that there were no correlations between the word-learning skills and other language measures for children with SLI, whereas the word-learning abilities of children with typical language development were correlated to their phonological awareness, semantic, and general language skills.

In the second experiment, it was investigated whether there were also qualitative differences during word-learning between children with and without SLI additionally to the quantitative differences as revealed in the first experiment. Children's erroneous responses during the word-learning tasks were categorised into phonological, semantic, substitution or random errors. A comparison of the children's error patterns revealed that children with SLI presented with a different error pattern and made significantly more random errors than children with typical language development. However, after repeated exposure, children with SLI demonstrated a similar error pattern as children without SLI. Furthermore, it was examined whether a specific combination of phonological and semantic cues facilitated children's learning of new words or whether there were word-specific features that facilitated children's word-learning. No facilitative word-specific features could be identified. Analysis revealed that there were no significant effects of cueing on learning new words, but specific patterns could be derived for children with SLI. Children with SLI learned to comprehend more words that were presented with two semantic cues or one phonological and one semantic cue and learned to produce more words that were presented with two phonological cues.

In the third experiment, the effectiveness of a combined phonological awareness and semantic intervention to advance children's word-learning abilities was examined. Nineteen children with SLI (same participants as in experiment 1) participated in this intervention study that implemented an alternating treatment group design with random assignment of the participants. Children in group A received phonological awareness intervention followed by semantic intervention, whereas children in group B received the same interventions in the reverse order. Children's word-learning abilities were assessed at pre-test, prior to the intervention, at mid-test after intervention phase 1, and at post-test, immediately following the completion of the second intervention phase. Each intervention itself was effective in significantly improving children's fast mapping skills, however, gains in children's word-learning abilities were only found for children in group A for production of new words.

Extending the findings of the intervention effectiveness of phonological awareness and semantic intervention on word-learning as reported in experiment 3, it was investigated in experiment 4, whether the implemented intervention additionally influenced the error patterns of children with SLI. The erroneous responses of children with SLI on all word-learning probes at pre-, mid-, and post-test were categorised into the same error groups as described in the second experiment (semantic, phonological, substitution, and random errors). The error analyses revealed that children's error profiles changed during the course of intervention and treatment specific effects on children's erroneous responses were found. Post-intervention, children who received phonological awareness followed by semantic intervention displayed the same error patterns as children with typical language development, whereas children who received the same interventions in the reverse order maintained the same error pattern as displayed at pre-test.

The final experiment examined the longer-term effects of the combined phonological awareness and semantic intervention reported in experiment 3 on the language and literacy development of children with SLI. Eighteen of the 19 children with SLI, who received the intervention reported in experiment 3, were available for re-assessment 6 months after the completion of the intervention. The children (aged 7;1 to 9;2 years) were re-assessed on a range of standardised and experimental measures. Data analysis revealed that 6 months post-intervention, all children were able to maintain their gains in phonological awareness, semantic, and decoding skills as displayed immediately after the intervention. Children's general language and reading skills significantly improved following the intervention; however, children who received phonological awareness intervention followed by semantic intervention displayed significantly better reading outcomes than the children who received the same interventions in the reverse order.

This thesis revealed that a combination of phonological awareness and semantic intervention can enhance the word-learning abilities of children with SLI. The combined intervention approach was also effective in additionally improving children's general language skills and the reading of single non-words and real words, as well as connected text. The immediate and longer-term intervention effects provide evidence that advancing the semantic and phonological awareness skills is an effective intervention approach to support children with SLI in their word-learning and to furthermore promote their language and literacy development. However, the order of the implemented interventions played a significant role: Children in the current study profited most when they received phonological awareness intervention first, followed by semantic intervention.

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CHAPTER 1

LITERATURE REVIEW

1.1 Introduction

The ability to learn new words is an essential skill for vocabulary acquisition and crucial for language and literacy development (National Reading Panel, 2000; Rice, Buhr, & Nemeth, 1990). Most children learn their first words before their first birthday and continuously expand and elaborate their vocabulary over the years throughout adulthood (Biemiller & Slonim, 2001; McLaughlin, 2006). The learning of new words involves the acquisition, storage, and access of novel words. To learn a new word, the phonological form of the unfamiliar word first has to be analysed and its meaning retrieved. It then needs to be stored in long term memory to be available for retrieval from the lexicon.

Children with Specific Language Impairment (SLI) frequently have difficulty processing, storing, and retrieving new words efficiently (Ellis Weismer & Hesketh, 1998; Gray, 2004, 2005; Horohov & Oetting, 2004; Leonard, 1998; Oetting, Rice, & Swank, 1995; Rice, et al., 1990). These word-learning processes are crucial for lexical acquisition, with restrictions in these skills contributing to the vocabulary deficits often observed in children with SLI (Leonard, 1998; Nash & Donaldson, 2005; Rice, et al., 1990). Thus, it is important to understand the processes involved in word-learning and how such processes may be enhanced in children with SLI.

Researchers focussing on how children learn new words have predominantly examined the contribution of semantic and phonological skills to word-learning in British and American children (Alt & Plante, 2006; Gathercole, 1993; Gathercole, Hitch, Service, & Martin, 1997; Gray, 2005; McGregor, Friedman, Reilly, & Newman, 2002; Storkel, 2001, 2003). Findings from these studies indicated that both semantic and phonological knowledge are critical to the process of word-learning. This thesis seeks to extend this research by examining the word-learning abilities of New Zealand school-aged children and by investigating effects of intervention aimed at enhancing semantic and phonological processing abilities on word-learning abilities in children with SLI.

1.2 Defining Specific Language Impairment

Children with SLI present with spoken language difficulties in the absence of obvious cognitive or other disabilities (American Speech-Language-Hearing Association, 2008). SLI diagnosis is based on inclusionary and exclusionary criteria. The two main inclusionary criteria are 1) impaired language skills more than one standard deviation below the mean expected for their age and 2) nonverbal intelligence within normal limits (Stark & Tallal, 1981). Exclusionary criteria are no apparent cognitive, neurological, motor, sensory, or behavioural disabilities that could cause the language deficits (Leonard, 1998; Rice, Warren, & Betz, 2005). SLI is furthermore classified as a developmental language impairment as children with SLI display difficulties from the early stages of language acquisition (Paul, 2007).

The prevalence of SLI is estimated at slightly above 7% among 5-year-old children. Gender-ratio analysis revealed that more boys are affected than girls with a ratio of 4 : 3 (boys : girls) (Tomblin, et al., 1997). These estimations are based on an epidemiological study by Tomblin et al. (1997), involving over 7000 monolingual English speaking children in the United States of America. In the United Kingdom, 13% of children with communication impairments who were referred to specific support classes (language resource units) presented with SLI (Archibald & Gathercole, 2006). A screening of speech and language abilities of 6-year-old New Zealand children indicated that 15.7% needed further assessment of their spoken language development (Gillon & Schwarz, 1999). However, no specific data is available for the prevalence of SLI in New Zealand children. Findings from longitudinal follow-up studies investigating whether SLI persists over time or whether children 'outgrow' their language difficulties indicated that up to 60% of children who were identified with SLI at pre-school continued to present with language impairment 4 years later (Tomblin, Zhang, Buckwalter, & O'Brien, 2003). Results from a study following children with SLI over a 10-year period revealed that up to 64% of children with SLI were still presenting with SLI at 15 years of age (Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

Children with SLI are significantly more likely to have families with a history of language difficulties compared to children with typical language development (Choudhury & Benasich, 2003; Conti-Ramsden, Simkin, & Pickles, 2006; Lahey & Edwards, 1995; Tallal, et al., 2001). Data from family aggregation studies on SLI report that children with SLI are three times more likely to have a first-degree family member with SLI (Tallal, et al., 2001). This data suggests that there might be a hereditary genetic component involved in the aetiology of SLI. Genetic research identified a mutation on a gene (FOXP2) located on chromosome 7 that was associated with severe speech and language disorders (Lai, Fisher, Hurst, Vargha-Khadem, & Monaco, 2001). Conversely, other genetic researchers specifically investigating children with SLI could not confirm the link between the gene on chromosome 7 and this population (SLI Consortium, 2002). Instead, the researchers identified two new regions on chromosomes 16 and 19 that were linked to SLI.

Obviously, more research is necessary to understand genetic influences on SLI. However, it is plausible that no common denominator can be found as children with SLI are a heterogeneous group with a range of symptoms that vary in their manifestation.

1.2.1 Symptoms of SLI

The following section describes the symptoms reported in children with SLI. The language difficulties that children with SLI experience often affect some or all of the areas of language, including semantics, phonology, morphology, syntax, and pragmatics. The areas of language difficulties and the level of deficit vary in children with SLI (Conti-Ramsden, Crutchley, & Botting, 1997), but some common patterns have emerged in the research. This section reports the profile of children with SLI as a group in each aspect of language.

<u>Semantics, lexicon</u>

Semantics, the content of language, constitute an essential part of language and incorporate the concept, meaning, and knowledge of words. The labels or names of the stored words are referred to as the lexicon. Vocabulary is one core aspect of semantics and lexicon, incorporating both areas; To both receptively and expressively know a word, one needs to have a concept of the item and know its meaning (semantics), but also know the label of the word (lexicon). As a group, children with SLI display difficulties in various areas of semantics and lexicon, including vocabulary, learning new words, word-finding, and establishing semantic representations.

Children with SLI often present with vocabulary deficits when compared to age-matched children with typical language development (e.g., Alt, Plante, & Creusere, 2004; Conti-Ramsden, et al., 1997; Gray, 2005, 2006; Zens, Gillon, & Moran, in press). This discrepancy in vocabulary performance can already be observed in early vocabulary acquisition. A retrospective study based on parental report revealed that on average, the acquisition of first words in children with SLI is delayed by 12 months (Trauner, Wulfeck, Tallal, & Hesselink, 2000). During preschool and early school years, children with typical development still outperform children with SLI in receptive and expressive vocabulary tasks (Conti-Ramsden, et al., 1997; Gray, 2005, 2006). This difference in vocabulary skills appear to widen with age. In a long-term study, Stothard et al. (1998) followed the language development of children with SLI from age 5;6 (years;months) into adolescence and re-assessed their vocabulary skills at age 15. Findings of this study showed that children who displayed poor vocabulary at 5;6 years presented with a significant decline over time compared to children with typical language development who were able to improve or maintain their vocabulary skills. Thus, as a group, children with SLI present with persisting vocabulary deficits that may even aggravate over time. Considering the importance of vocabulary development on children’s language and literacy development, early intervention targeting the expansion of children’s lexical acquisitions becomes crucial.

Limitations in vocabulary size may be caused by difficulties in learning new words. Research findings have repeatedly demonstrated that children with SLI have difficulties in learning novel words compared to children with typical language development (Gray, 2003b, 2004, 2005; Oetting, et al., 1995; Rice, et al., 1990; Rice, Buhr, & Oetting, 1992). Children with SLI furthermore have difficulties deriving meanings and remembering words when they are not explicitly taught (Nash & Donaldson, 2005; Oetting, et al., 1995; Rice, et al., 1992; Shulman & Guberman, 2007). On the contrary, children with typical language development seem to be able to learn words in indirect and direct teaching conditions equally (Jaswal & Markman, 2001, 2003). Thus, there is a significant obstacle to learning novel words for children with SLI, as incidental learning of new words is crucial for vocabulary expansion. On average, children learn about 10 words a day until graduating from high school (Bloom, 2000), which are not all directly taught. Consequently, children with SLI who exhibit word-learning difficulties will most likely not be able to expand their vocabulary at the same rate and to the same extent as children with typical language development. Word-learning deficits in children with SLI will be more thoroughly discussed in Section 1.4: Word-learning in children with SLI.

There is evidence that children with SLI, especially school-aged children, also present with word-finding difficulties (Dockrell, Messer, George, & Wilson, 1998; German, 1987; Kail, Hale, Leonard, & Nippold, 1984). Children with word-finding deficits have difficulties in quickly and accurately retrieving a known word from the lexicon. Inaccuracies include circumlocutions, extensive use of unspecific terms (e.g., thing, stuff), and phonological or semantic substitutions of the targeted word (McGregor & Leonard, 1995). The two underlying processes implicated in causing word-finding deficits are poor storage and poor retrieval of words and their concepts or meanings (German, 2002; Messer & Dockrell, 2006; Nippold, 1992). Poor storage refers to the theory that children with word-finding deficits have poor semantic or phonological representations of specific entries and connections with other entries within the lexicon. Leonard (1998) hypothesised that word-finding difficulties arise from inefficient storage of words. That is, each lexical entry is not stored with sufficient associations and connections to other entries in the lexicon, which hinders immediate access to words and causes the delay in recall (p. 47). Commensurate with the storage hypothesis, findings from McGregor, Friedman et al. (2002) demonstrated that children displayed less robust representations (as determined from a drawing task) of words they misnamed in an earlier task. In contrast, poor retrieval may not be a result of insufficient storage, but that of inefficient access of specific entries in the lexicon. It is hypothesised, that children with difficulties accessing words may have difficulties retrieving the correct semantic item or phonological form or correctly matching the semantic item with the phonological form (Messer & Dockrell, 2006). Specifically, how words are stored and accessed in typical language development will be thoroughly discussed in section 1.3: Defining word-learning.

Children with SLI also present with difficulties in mapping enough semantic features when encountering new words (Alt & Plante, 2006; Alt, et al., 2004). This could restrict children in establishing strong semantic representations of words. Alt and colleagues (2006; 2004) demonstrated that, when learning new words, children with SLI have difficulties in assimilating semantic features to novel words compared to age-matched children with typical language development. This suggests that children with SLI are not as efficient as their age-matched peers in identifying and remembering as many distinct features of words, which weakens the representation of each word and may contribute to the reported word-finding and vocabulary deficits.

Research demonstrating poorer ‘qualitative’ vocabulary skills in children with SLI is consistent with findings that children with SLI use less diverse vocabulary in spontaneous speech. Leonard, Miller, and Gerber (1999) examined spontaneous language samples of children with and without SLI revealing that the latter group demonstrated significantly more lexical diversity. This indicates that children with

SLI use a reduced variety of words compared to children with typical language development.

In summary, research has demonstrated that children with SLI not only present with quantitative constraints in their vocabulary, i.e., reduced vocabulary, word-learning difficulties (e.g., Conti-Ramsden, et al., 1997; Gray, 2005; Hick, Joseph, Conti-Ramsden, Serratrice, & Faragher, 2002; Stothard, et al., 1998), but also qualitative restrictions like limited semantic mapping and less lexical diversity (e.g., Alt & Plante, 2006; Alt, et al., 2004; Leonard, et al., 1999). Considering the fundamental role of semantics and lexicon in oral communication, deficits in these areas have far-reaching impacts on children's language development. As children with SLI often present with semantic and lexical difficulties, it is important to specifically target these deficits during intervention. It is critical to not only expand the child's vocabulary (i.e., increase the amount of words), but also to provide the child with strategies to strengthen their ability to learn words independently and to establish strong representations of words.

Morphology, syntax

The most prominent markers of SLI are deficits in morphology and syntax. Extensive research investigated morphological and syntactic skills in children with SLI, resulting in a very thorough grammatical profile of this population (e.g., Leonard, 1998; Leonard, Bortolini, Caselli, & McGregor, 1992; Morehead & Ingram, 1973; Rice, et al., 2005). Generally, children with SLI present with delayed syntactic development which mostly follows the same order as the syntactic development of children with typical language development (Rescorla, Dahlsgaard, & Roberts, 2000).

However, children with SLI seem to make more errors and remain at each syntactical stage for longer periods than their peers (Rescorla & Roberts, 2002).

Children with SLI present with reduced mean lengths of utterances (MLU) (Morehead & Ingram, 1973). Studies comparing children with SLI and children with typical language development often include age-matched and/or language-matched children as a control group. In most cases, the language matching for these purposes was based on MLUs, and the language-matched children were often more than 12 months younger than their peers with SLI (Leonard, et al., 1992; Leonard, Deevy, et al., 2007; Leonard, et al., 2003; Morehead & Ingram, 1973).

A particular deficit displayed by children with SLI is in the acquisition of grammatical morphemes. Children with SLI have specific difficulties acquiring and correctly using bound morphemes, especially verbal morphemes (e.g., 3rd person singular '-s', verb endings -ed and -ing), and auxiliary verbs (e.g., be, have) compared to children with typical language development (Goffman & Leonard, 2000; Leonard, 1998; Leonard, Davis, & Deevy, 2007; Leonard, Deevy, et al., 2007; Leonard, et al., 2003; Paul, 2007; Rice & Oetting, 1993; Rice, Wexler, & Hershberger, 1998).

Limitations in morphosyntactic skills, as often experienced by children with SLI, pose a severe constraint in the communication skills of this population. During pre-school and early school years, deficits in this area will restrict children in efficiently interacting with and learning from their environment. For school-aged children, difficulties in morphology and syntax will additionally impact on their learning outcomes and hinder these children from successfully accessing the classroom curriculum.

Phonology

Phonology refers to the aspect of language concerning the representation, production, and sequencing of speech sounds. Children with SLI often exhibit weakness in aspects of their phonological development. They might present with speech disorders and/or with more subtle difficulties in their phonological processing (Aguilar-Mediavilla, Sanz-Torrent, & Serra-Raventos, 2002; Briscoe, Bishop, & Norbury, 2001; Goulandris, Snowling, & Walker, 2000; Kamhi, Lee, & Nelson, 1985; Leonard, 1982; Shriberg & Austin, 1998; Shriberg, Tomblin, & McSweeny, 1999; Warrick, Rubin, & Rowe-Walsh, 1993). Findings from studies investigating phonological skills in children with language impairment indicate that the phonological development of these children appears to be delayed rather than deviant (Fee, 1995; Leonard, 1982). That is, the phonological development of children with language impairment follows the same phonological processes as observed in children with typical language development. However, their acquisition rate is slower and, therefore, their patterns are more similar to the ones displayed by younger children with typical language development.

Broomfield and Dodd (2004) investigated the co-occurrence of speech impairment and expressive and receptive language difficulties in an epidemiological study. Co-occurrence rates ranged according to severity/classification of speech impairment. Generally, there were fewer co-occurrences of speech impairment and receptive language difficulties 27.8% (17.5 – 40%) than expressive language difficulties 42.23% (22.5 – 66.7%). Findings from a comorbidity study of speech delay and SLI by Shriberg et al. (1999) revealed that up to 15.2% of children with speech delay presented with SLI, whereas 7.6% of children with SLI presented with speech delay. This discrepancy in findings may be caused by the fact that Broomfield and Dodd did not specify 'language impairment' or 'language difficulties' as SLI. Thus, their sample may have included children with language impairment and low cognitive abilities. It also needs to be noted that the classification of speech disabilities in the Broomfield and Dodd study included articulation disorder, phonological delay, and consistent and inconsistent phonological disorder. Consequently, the higher co-occurrence of speech and language difficulties in the Broomfield and Dodd study may be caused by the broader inclusion criteria. In fact, when adding the comorbidity rates of children with language impairment with normal and low cognitive abilities in the Shriberg et al. study, the co-occurrence rate of children with speech delay who display language disorders increases up to 30.4%, which is similar to the findings of Broomfield and Dodd's study. Both studies utilised different classification systems for defining speech difficulties based on aetiology or symptoms. There is debate as to which classification system may be more applicable, however, this discussion is beyond the scope of this study. The results of these studies indicate however, that children with language difficulties may also present with additional speech impairment.

The phonological difficulties most commonly observed in children with SLI are difficulties in the phonological processing skills, especially poor phonological memory and phonological awareness (Dollaghan & Campbell, 1998; Ellis Weismer, Evans, & Hesketh, 1999; Kamhi, et al., 1985; Leitão, Hogben, & Fletcher, 1997; Warrick, et al., 1993). Findings from an extensive body of research reported that children with SLI often perform worse on phonological memory tasks than age-matched children with typical language development (Dollaghan & Campbell, 1998; Ellis Weismer, et al., 1999; Gray, 2006; Horohov & Oetting, 2004). Phonological memory is the ability to store phonological information in temporary memory and plays a crucial role in language acquisition, especially in word-learning and vocabulary acquisition and will be more thoroughly discussed in Section 1.4.1: Deficits in phonological processing skills in children with SLI.

Phonological awareness deficits place children with SLI at risk of written language difficulties. Phonological awareness is the awareness of the sound structures of spoken words and is critical to early reading success (Ehri, et al., 2001; Elbro & Petersen, 2004; Gillon, 2004; Hulme, et al., 2002; Muter, Hulme, Snowling, & Taylor, 1997). Even if children with SLI do not present with expressive phonological deficits (i.e., speech impairment), their phonological awareness development is often significantly delayed compared to children with typical language development (Kamhi, et al., 1985; Leitão, et al., 1997; Warrick, et al., 1993). This co-occurrence of phonological awareness deficits in children with language impairment is consistent with findings from studies investigating the relationship of phonological awareness and language skills. Cooper, Roth, Speece, and Schatschneider (2002) examined the correlation of phonological awareness development and oral language skills of children from kindergarten to grade 2 in a longitudinal study. Phonological awareness at grade 1 and 2 was predicted by language skills, indicating that oral language skills contributed significantly to phonological awareness development. A strong correlation was also reported for vocabulary and phonological awareness (McDowell, Lonigan, & Goldstein, 2007; Metsala, 1999). Metsala investigated the relationship between phonological processing skills (phonological memory and phonological awareness) and vocabulary development in a series of experiments. Children aged 3 to 6 years were assessed on a standardised receptive vocabulary test, phonological awareness tasks, e.g., phoneme blending, phoneme isolation, and onset-rime blending, and one or two phonological memory tasks (depending on the experiment). Analyses revealed that there was a positive correlation between the performances on the phonological awareness measures and vocabulary for children of all age groups and between phonological memory and vocabulary for children aged 3 to 5 years. This indicates that children who present with difficulties in oral language skills (e.g., children with SLI) are at great risk of additional phonological awareness deficits. Deficits in phonological awareness can have a far-reaching impact on the academic development of the child, especially early reading. This issue will be more thoroughly discussed in the next section.

Written language skills

Children with SLI are four times more likely to develop reading difficulties when compared to children with typical language development (Catts, Fey, Tomblin, & Zhang, 2002). Catts et al. followed 117 children with SLI from kindergarten to grade 4 to investigate their reading development over time. Reading was assessed in grades 2 and 4 and compared to the reading skills of age-matched control children (n = 268). Over 41% of children with SLI presented with reading disabilities in grade 2 and 35.9% in grade 4, compared to 8.6% and 8.2% of children with typical language development in grade 2 and 4, respectively. Furthermore, analysis revealed that the severity of language disorder predicted reading outcomes of young children with SLI, i.e., children who displayed severe language impairments were at a greater risk for reading disabilities in early school years than children with milder language difficulties. Flax et al. (2003) even reported that 68% of their assessed children with SLI presented with additional reading impairments. The high co-occurrence of literacy difficulties in children with SLI has motivated researchers to investigate whether SLI and dyslexia are distinct disorders (Bishop & Snowling, 2004; Catts, Adlof, Hogan, & Weismer, 2005; Goulandris, et al., 2000). Results revealed that both disorders were distinct, but that there was a significant overlap in children who presented with both disorders (Catts, et al., 2005) and that participants with dyslexia displayed similarly poor performances on phonological awareness measures as participants with SLI (Goulandris, et al., 2000).

One specific predictor of reading outcomes in early school years is phonological processing, especially phonological awareness skills on the phoneme level (Catts, 1993; Catts, Fey, Zhang, & Tomblin, 2001; Gillon, 2004; Hulme, et al., 2002; Muter, et al., 1997; Nation & Hulme, 1997; Parrila, Kirby, & McQuarrie, 2004; Vellutino, Fletcher, Snowling, & Scanlon, 2004; Wagner & Torgesen, 1987; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993; Wagner, Torgesen, & Rashotte, 1994; Wagner, et al., 1997). Considering that many children with SLI present with phonological processing deficits as discussed in the prior section, these findings substantiate the risk for this population of experiencing reading difficulties. Boudreau and Hedberg (1999) assessed children with SLI on a range of early literacy tasks (e.g., phonological awareness, print concepts, letter identification) and found that age-matched children with typical development outperformed the children with SLI on all measures. Similarly, findings from a follow-up study of children who displayed language impairment at 5;6 years demonstrated that children presented with reading difficulties at age 8;6 (Bishop & Adams, 1990). Findings from long-term follow-up studies of adolescents with a history of SLI revealed that as a group, the participants presented with persisting reading difficulties, which became aggravated over time, and that there was a strong correlation between reading difficulties and poor phonological memory abilities (Conti-Ramsden & Durkin, 2007; Rescorla, 2000;

Snowling, Bishop, & Stothard, 2000). Thus, children with SLI who exhibit phonological processing deficits appear to be at great risk of reading difficulties.

Reading comprehension, in contrast, appears to depend more on other language domains than phonology, namely semantics and morphosyntax (Deacon & Kirby, 2004; Muter, Hulme, Snowling, & Stevenson, 2004; Nagy, Wagner, Muse, & Tannenbaum, 2007; Nation, Clarke, Marshall, & Durand, 2004; Roth, Speece, & Cooper, 2002; Snowling, Bishop, & Leonard, 2000). In particular, vocabulary has been identified as a key contributor to reading comprehension (Biemiller, 2003; National Reading Panel, 2000). Biemiller (2003) found significant correlations (r = .81) between vocabulary and reading comprehension in primary school children from grade one to grade six. Together with word identification, vocabulary accounted for 87% of the variance in reading comprehension. However, the relationship between vocabulary and reading appears to be bidirectional. While vocabulary predicts reading comprehension (e.g., Biemiller 2003), reading ability was correlated to later vocabulary knowledge (Gathercole, Willis, Emslie, & Baddeley, 1992). This finding is not surprising, considering that reading is an important tool for learning new information, which includes learning new words (Fukkink, 2005; Swanborn & de Glopper, 1999, 2002).

As a group, children with SLI also present with difficulties in spelling and writing. Researchers investigating written language skills in children with SLI revealed that the children displayed specific difficulties with syntax (e.g., omission of words), morphology (e.g., verb endings), and orthography (e.g., spelling), and that their written texts were generally very short (Dockrell, Lindsay, Connelly, & Mackie, 2007; Mackie & Dockrell, 2004). This may pose another limitation for children with SLI as writing skills are an essential part of academic education and provide significant support to vocabulary learning (Ehri, 2005; Ehri & Rosenthal, 2007; Rosenthal & Ehri, 2008). Findings from research demonstrated high correlations for reading accuracy, reading comprehension, and spelling (Dockrell, et al., 2007; Ehri, 2000), and that vocabulary and reading skills accounted for 47% of children's text writing skills (Dockrell, et al., 2007).

In summary, children with SLI are at great risk of written language difficulties. These difficulties may affect decoding, reading comprehension, and/or writing. Researchers investigating reading and writing skills revealed that phonological processing skills are a key contributor to decoding and spelling (e.g., Gillon, 2004; Nation & Hulme, 1997) and that vocabulary is a key contributor to reading comprehension as well as writing composition (Biemiller, 2005; Dockrell, et al., 2007). Findings clearly indicate that various language domains are correlated and influence each other. Thus, limitations in one or more areas of language will most likely have far reaching effects on other domains. As discussed in earlier sections, children with SLI often present with vocabulary and phonological processing deficits, which is particularly problematic for their reading development. Given the importance of reading and writing to current and future academic achievements, this area of language needs to be carefully assessed and monitored and, if necessary, therapeutically addressed in children with SLI. With regards to a preventative framework, it is important to carefully plan intervention targets for children with SLI. Therefore, an intervention targeted at improving the child's vocabulary as well as phonological skills may not only enhance oral language skills, but additionally facilitate written language abilities.

Pragmatics

Considering the difficulties children with SLI display with content and form of language (semantics, phonology, morphology and syntax) as discussed in the prior sections, language deficits will most likely impact on social interaction. However, pragmatics, the use of language, appears to be a relative strength in children with SLI (Craig & Evans, 1993). Researchers investigating pragmatic behaviour in children with and without SLI indicated that both groups performed similarly on various pragmatic measures when the level of language was controlled for (Fey & Leonard, 1984). Moreover, in a study where the prevalence of SLI was investigated, difficulties in pragmatics were actually utilised as exclusionary criteria (Archibald & Gathercole, 2006). Nevertheless, findings from a study where teachers were asked to rate the social behaviour of children with and without SLI demonstrated that teachers perceived children with SLI to be more withdrawn than their peers with typical language development (Hart, Fujiki, Brinton, & Hart, 2004). Thus, even though pragmatic difficulties do not appear to be significant in children with SLI, effects on social behaviour have been reported.

Long term outcomes

Children who present with SLI at a younger age are at risk of demonstrating persistent language impairment throughout their life (Aram & Nation, 1980; Snowling, Adams, Bishop, & Stothard, 2001; Stothard, et al., 1998). Stothard et al. (1998) followed the language development of children with a history of language impairment, originally identified by Bishop and Edmundson (1987), to evaluate whether language performances change over time. At 4 years of age, these children were categorised into two groups according to their language and nonverbal abilities.

Children with typical nonverbal IQ were classified as the ‘SLI group’, and children with nonverbal skills below the mean were grouped as ‘general delay group’(Bishop & Edmundson, 1987). All children were reassessed at age 5;6 and 15 to investigate whether children would still display similar performances. For 44% of children from the ‘SLI group’ and 11% of the children from the ‘general delay group’, language impairment had resolved. This discrepancy between the groups indicated that IQ seems to be a significant factor in influencing the prognoses. Results from follow-up assessment at age 15 demonstrated that out of the 26 children who were classified as ‘resolved’ at age 5;6, eight children (31%) presented with language impairment, indicating that their language skills were not really resolved at age 5;6, but may have presented with a different level of severity and consequently remained undetected. Seventy percent of children who were grouped as ‘persistent SLI’ (meaning that their language skills did not change from age 4 to 5;6) still displayed impaired language at age 15, whereas only 10% improved their language skills to a satisfactory level. Interestingly, for 20% of the children from the ‘persistent SLI group’, the classification changed to general delay, i.e., low language skills and low IQ. This implies that these children’s performances on nonverbal intelligence measures were below age expectations in adolescence compared to expectations at age 5;6, which they met. These findings indicate that language deficits may also restrict children’s cognitive achievements over time. This result may be caused by several factors, like restricted access to the curriculum and learning environment due to limitations in comprehension, reading, or both. Specifically, how nonverbal intelligence in adolescence might be affected by language disorder during childhood, what causes the relative decline in performance, and whether it depends on the severity of the language disorder, is beyond the scope of this study. However, it highlights the possible impacts of persisting SLI and the need for further exploration.

A history of SLI in early years also appears to affect the later occupational career choices of the children. Snowling, Adams, Bishop and Stothard (2001) followed the same cohort investigated by Bishop and Edmundson (1987) and Stothard et al. (1998) to explore these children's academic and occupational achievements. These children had a history of language impairment and were contacted by the researchers at age 16 to 17. Questionnaires were utilised to obtain information about the adolescents' current occupational or educational position and about the examinations and achieved grades in school. Data revealed that adolescents without language impairment on average obtained higher grades than the adolescents with a history of SLI, and that the latter group was more likely to pursue vocational training courses after age 16 instead of continuing to study. The findings show that SLI embodies, in most cases, a continuous deficiency that affects children's social, academic, and occupational development.

In summary, findings from research have demonstrated that children with SLI present with a range of language difficulties that have far reaching impacts on the academic, social, and vocational life. The language difficulties of children with SLI affect one or all areas of language, including semantics, phonology, morphology, syntax, and written language skills. As the areas of language difficulties and the level of deficit vary in children with SLI, it is essential to conduct comprehensive assessments. This will thereby support the design of targeted interventions with the aim of best clinical outcomes.

1.2.2 Assessment of SLI

The heterogeneous profile of children with SLI makes it difficult to classify one certain symptom to identify these children. However, various assessments are available that facilitate the identification of these children. Considering the impacts SLI can have on an individual's social, academic and even vocational life, early identification is crucial so that adequate support can be provided.

A range of assessments is available to evaluate and monitor children's language skills. Language is mostly measured utilising broad spectrum language tests like:

- Clinical Evaluation of Language Fundamentals – Preschool, 2^{nd} Edition (CELF-P; Wiig, Secord, & Semel, 1992),
- Clinical Evaluation of Language Fundamentals – 4^{th} Edition (CELF-4; Semel, Wiig, & Secord, 2003),
- Test of Language Development – Primary, 3^{rd} Edition (TOLD: P-3; Newcomer & Hammil, 1997),
- Test of Language Development – Intermediate, 4^{th} Edition, (TOLD: I-4; Hammill & Newcomer, 2008)
- Test of Adolescent and Adult Language – 4^{th} Edition (TOAL-4; Hammill, Brown, Larsen, & Wiederholt, 2007).

These broad spectrum language tests assess a range of different language skills, e.g., receptive and expressive semantics, phonology, and grammar, and provide standard scores. It is crucial to assess all the various language domains receptively and expressively to identify children with language difficulties. For example, if only one language area is assessed and the child does not present with difficulties in that particular area, the wrong conclusion could be drawn and the child could be misdiagnosed. Furthermore, examining all language domains is essential to specifically determine with which areas the children have difficulties. This is particularly important for effective intervention planning to meet best practice standards.

SLI is a diagnosis based on the presence of language deficits in the absence of deficits in nonverbal intelligence. Consequently, to evaluate the intelligence scores of children with language deficits, it is important to utilise intelligence assessments that are not based on language. Nonverbal intelligence is mainly measured utilising standardised test like:

- Wechsler Preschool and Primary Scale Intelligence of Intelligence (WPPSI; Wechsler, 1990),
- Wechsler Intelligence Scale for Children (WISC; Wechsler, 1992),
- Kaufmann Assessment Battery for Children (KABC; Kaufman & Kaufman, 1983),
- Test of Nonverbal Intelligence - 3rd Edition (TONI-3; Brown, Sherbenou, & Johnsen, 1997).

Data on the exclusionary criteria (e.g., no apparent cognitive, neurological, motor, sensory, or behavioural disabilities) is often gathered through parental or teacher reports (e.g., case histories), additional medical records (e.g., medical reports, prior assessment reports) and tests (e.g., hearing test).

A different method that seems promising in the identification of children with SLI are non-word repetition tests (NWR-T) (e.g., Dollaghan & Campbell, 1998; Gathercole, Willis, Baddeley, & Emslie, 1994). In NWR-Ts children are asked to repeat nonwords of varying length, often from one to four syllables. Findings from research have repeatedly demonstrated that children with SLI have significant difficulties fulfilling this task, especially repeating three- and four-syllabic words (see Estes, Evans, & Else-Quest, 2007, for a meta analysis of studies utilising NWR-T).

In summary, a wide range of tests is available to thoroughly assess children's language skills. Assessment of the various language areas is crucial to identify need and to plan intervention for children with SLI. It is also important to carefully monitor progress, even if the child's language difficulties seem to be resolved. Findings from a long-term follow-up study revealed that 31% of children diagnosed with SLI at age 4;0 and who classified as 'resolved' at age 5;6 presented with impaired language at age 15 (Stothard, et al., 1998). Children with SLI are at danger for persistent language difficulties that may vary in severity throughout the years, which accordingly makes diagnosis difficult. Consequently, thorough assessment and on-going monitoring of children at risk of language impairment is crucial.

1.3 Defining word-learning

Children with SLI often present with word-learning deficits, resulting in reduced vocabulary as frequently reported for this population (e.g., Gray, 2005; Nash & Donaldson, 2005; Rice, et al., 1990). Given the importance of semantic and lexical acquisition in language development, it is important to examine models of word-learning, so that the possible processes underlying word-learning deficits in children with SLI can be understood. Word-learning is a complex process involving the interaction of a range of language domains. The following sections describe the processes involved in word-learning and present three models of word-learning that emerged from research findings:

- the *phonological processing hypothesis model,*
- the *semantic processing model*, and
- a combination of both models.

The learning of new words involves not only the acquisition of novel words, but also their storage and access. It is a process that requires several steps and the interaction of various language domains. First, the new word has to be phonologically analysed, that is, it has to be segmented from the speech and recognised as an unfamiliar word (i.e., no entry exists for this word in the lexicon). Then, the word meaning has to be derived. Additional cues support this process by providing semantic (it is yellow, you can eat it, etc.) morphosyntactic (it is a noun, singular, etc.), and phonological (it starts with /b/, has three syllables, etc.) information. During this process, the phonological form of the new word has to remain in short-term memory and will then be matched with the derived meaning for storage. When stored, ideally, this new word should have strong semantic representations (i.e., a clear concept of the word has to be in place) and a variety of associations relating to the new word to facilitate accessing the word at a later stage again. These associations are mainly of semantic nature (i.e., it’s a fruit, similar to apple), but can also be morphosyntactic and phonological. A strong phonological representation of the new word (i.e., /bənanʌ/) is crucial to successfully produce the word (Brackenbury & Pye, 2005; Gray, 2005; Leonard, 1998; McGregor, Friedman, et al., 2002). The specific mechanism of how the lexicon is organised and accessed though is still debated. Most researchers however, have agreed that semantic, syntactic, and phonological information is represented in the lexicon on two levels that are sequentially accessed for word retrieval (Caramazza, 1997; Levelt, Roelofs, & Meyer, 1999). The first level is the *lemma* level which contains the conceptual, semantic, and syntactic information of the word. The second level is the *lexeme* level, which includes the phonological representation, i.e., the phonological form of the word. To retrieve and produce a word, these two stages are successively accessed: first the semantic representation will be selected from the lemma level, and then at the lexeme level, the matching phonological representation will be selected. However, controversy exists about what processes are additionally involved at each level and to what degree these levels are dependent of each other (see Caramazza, 1997, for a comparison of various models). So, for example, the lemma level is often further separated into two parts: the conceptual level and the lemma level. Despite this debate about the specific processes involved in the lexical organisation and access of the lexicon, researchers have agreed upon the importance of the semantic (lemma) and phonological (lexeme) representations of words in the lexicon. The following section specifically examines the contribution of phonological and semantic influences on the word-learning process.

1.3.1 Theoretical models of word-learning

The linguistic and cognitive processes involved in learning new words in children with typical development have been the topic of much debate. In particular, the contribution of phonological and semantic processing in learning new words has been examined. There are two main theoretical models of word-learning which have motivated research in this domain: A *phonological processing model* and a *semantic* *processing model.* More recent studies have investigated the influences of both, phonological and semantic processing skills on the word-learning process. This section discusses all three models and how they impact on word-learning.

<u>Phonological processing hypothesis: word-learning at the lexeme level</u>

According to the *phonological processing hypothesis* (Baddeley, Lewis, & Vallar, 1984; Vallar & Baddeley, 1984), short-term storage of phonological information and its subvocal rehearsal system are essential skills required for new word learning (Gathercole & Baddeley, 1989, 1993; Gathercole, et al., 1992; Michas & Henry, 1994). Phonological processing includes skills like phonological memory, phonological awareness, and rapid naming. The researchers supporting this theory based their conclusions on findings demonstrating that vocabulary development is strongly correlated with phonological memory in preschool and school-aged children with typical language development (Gathercole & Baddeley, 1989; Gathercole, et al., 1997; Gathercole, et al., 1992; Michas & Henry, 1994). Gathercole and Baddeley (1989) examined the vocabulary and phonological memory skills of 4-year-old children and re-assessed their skills after 1 year. Receptive vocabulary was assessed using a standardised test and phonological memory was assessed utilising a non-word repetition task (NWR-T). At initial testing, the researchers found a high correlation between vocabulary scores and performance on the NWR-T and that the NWR-T scores accounted for the greatest amount of variance in vocabulary performances (27%). Similar results were found at follow-up assessment 1 year later: NWR-T scores still accounted for the greatest amount of variance in vocabulary scores (24%) and were highly correlated to outcomes on vocabulary performance. Analyses of influencing factors from age 4 on vocabulary performance at age 5 revealed that vocabulary scores at age 5 were correlated highest with vocabulary scores at age 4, followed by NWR-T scores at age 4. The findings indicated that vocabulary knowledge itself was the best predictor for later vocabulary development, but that these skills were highly related to phonological memory skills. The researchers furthermore concluded that phonological memory is the underlying factor for vocabulary development, as phonological memory performance at age 4 predicted vocabulary skills at age 5, but not vice versa.

The same cohort of children from the Gathercole and Baddeley (1989) study was re-assessed by Gathercole et al., (1992) 2 and 4 years after initial assessment, when the children were aged 6 and 8 years, to evaluate the correlations of vocabulary and phonological memory over time. With the same assessment measures implemented, findings revealed that at age 6 and 8, correlations between vocabulary and NWR-T were also significant. However, there was a significant decline in the correlation coefficient between those two measures at age 8, indicating that the relationship lost its strength. At age 8, previous performances on vocabulary scores were correlated highest to vocabulary scores. The authors suggested that during later vocabulary development older children rely less on the memory storage of the phonological form of words. Rather, they use their existing knowledge of vocabulary to learn the phonological forms of novel words. Nevertheless, a study investigating the correlation of phonological memory and vocabulary skills in 13- to 14-year-old children revealed a significant relationship between vocabulary scores and phonological memory measures in this age group (Gathercole, Service, Hitch, Adams, & Martin, 1999). These findings indicated that even though the relationship between phonological memory and vocabulary development may vary and even lose strength over time, it still remains significant throughout preschool and the early and middle school years.

To avoid bias that might be caused by using NWR-T as the only phonological memory measure, Gathercole et al. (1999) demonstrated that various phonological short-term memory measures also correlated significantly with vocabulary measures in 4-year-old children. The researchers assessed childrens' phonological memory skills using a NWR-T as in the earlier studies, a digit span task, where participants had to repeat increasing serials of digits, and a non-word matching span task, that required children to decide whether two series of three non-words were identical or not. The findings supported their conclusions from earlier studies that phonological memory plays a significant role in vocabulary development.

The studies of Gathercole and colleagues provided strong support for the *phonological processing hypothesis* demonstrating that phonological memory is significantly correlated to vocabulary knowledge in children. However, research findings on the correlation of phonological memory skills on actual word-learning are less lucid (Gathercole, et al., 1997; Gray, 2004, 2006; Michas & Henry, 1994). Michas and Henry (1994) assessed the phonological memory and word-learning skills of 5-year-olds. The ability to learn three nouns was measured over two sessions. After the words were presented to the children using picture cards, children were asked to produce (production), identify (comprehension), and define (definition) the novel words. The researchers found significant correlations between the phonological memory measures and production as well as definition of new words, but not comprehension. Gathercole et al. (1997) utilised a different method to assess word-learning in a cohort of 5-year-old children. Word-learning was examined on four tasks varying in the degree of phonological learning demand: children had to learn pairs of real words and non-words and recall definitions and names of the non-words. All items were auditory stimuli, i.e., no additionally pictures or objects were presented. The researchers argued that correlations of phonological memory and word-learning tasks would vary in strength depending on the phonological demand for each word-learning task. Thus, word-learning tasks with a high phonological demand like learning the pair of non-words and remembering non-words would correlate more strongly with phonological memory skills than tasks with lower phonological demand, like recalling definitions. As predicted, phonological memory correlated significantly with the learning of the non-word pairs and the recall of non-words. Only one of two phonological memory measures (namely NWR-T) correlated additionally with recalling definitions of non-words and no phonological memory task was related to learning the pairs of real words. Moreover, all vocabulary measures correlated significantly with all phonological memory measures. These findings are consistent with previous research revealing a strong correlation between phonological memory and vocabulary skills and indicate that phonological memory also correlates with certain word-learning tasks, but that the relationship depends on the phonological demand placed on the word-learning task.

Similarly, Gray (2006) found limited relationships between phonological memory and the learning of new words. Three- to six-year-old children were assessed on their abilities to 'fast map' eight new words in two separate sessions (four words in each session). During the fast mapping task, children were presented with objects and the target words were modelled by the researcher without any additional cueing. The ability to remember these words was assessed on the expressive and receptive level. Phonological memory was measured by a NWR-T and a digit span test. Correlation analyses revealed a significant relationship between production of the new words and the digit span test. Further multiple regression analyses demonstrated that the only significant predictor for the production of new words was performance on NWR-T and accounted for 7% of the variance. In line with the findings of Michas and Henry (1994), comprehension of new words was not correlated to any phonological memory measure. These findings are consistent with an earlier study by Gray (2004) investigating the word-learning abilities of young children over several days, where NWR-T accounted for 31% of the variance in producing new words and no predictor for comprehension of new words could be determined. However, in this study, the learning of new words was measured after several days, not just one as in the fast mapping task. This change in value (7% to 31%) and the strong correlations between vocabulary and phonological memory, as discussed earlier, may indicate that phonological memory is more strongly correlated to longer-term learning of words. Nevertheless, the findings indicate that learning to comprehend and learning to produce new words require different domains. In contrast to the comprehension of new words, which appears to be strongly correlated with age (Gray, 2006), production of new words appears to be correlated and predicted by phonological memory skills.

Expanding on the research demonstrating strong relationships between phonological memory and vocabulary, Metsala (1999) also found a strong correlation between vocabulary growth in young children and phonological processing skills. However, the researcher approached this issue from a novel perspective by examining the relationship between phonological awareness development and the children's vocabulary growth in a series of experiments. The findings revealed that children's vocabulary scores were positively correlated to all applied phonological awareness measures (e.g., phoneme blending, phoneme isolation, onset-rime blending). Derived from previous research into vocabulary development and phonological awareness, Metsala explains this relationship based on the ‘Lexical Restructuring Model’ (Metsala & Walley, 1998). According to this model, early vocabulary acquisition of children aged between 9 and 18 months is holistic in nature, which means that children learn each word as a whole unit. However, as the child’s vocabulary begins to increase rapidly at around 18 months of age, a differentiation of the lexical representations becomes crucial. As a consequence, children develop more segmental representations to distinguish between words with similar sound structures. That is, words that have similar phonological properties such as ‘hat, mat, cat, bat, sat, fat’ need to be stored in a segmented manner so that they can be easily differentiated from each other and can be successfully recognised. Metsala and Walley suggested that this lexical restructuring of words from whole units to segmental units facilitates children’s awareness that words can be broken down into different sound units. Consequently, the development of these segmentation skills (i.e., phonological awareness), highly depends on vocabulary and its growth. In line with Metsala and Walley’s lexical restructuring model, McDowell et al. (2007) demonstrated in a study involving 700 children, aged 2 to 5 years, that vocabulary accounted for unique variance in children’s phonological awareness skills. Similarly, Smith, McGregor, and Demille (2006) found that the phonological development of 2-year-olds was more closely related to vocabulary size than age.

There is controversy, however, regarding the causality of phonological development and vocabulary (Stoel-Gammon, 1998; Storkel & Morrisette, 2002). While researchers in support of the lexical restructuring model (e.g., McDowell, et al., 2007; Metsala, 1999; Metsala & Walley, 1998; Walley, Metsala, & Garlock, 2003) revealed that vocabulary influenced phonological development, other researchers demonstrated reverse relationships between vocabulary and phonological skills (e.g., Gathercole, et al., 1999; Gathercole, et al., 1992). Considering these findings, the relationship between phonology and vocabulary could be bidirectional. Thus, large vocabulary might foster the development of phonological development, whereas poor phonological skills might hinder learning new words for long term storage.

Demke, Graham, and Siakaluk (2002) investigated another aspect of phonological processing and word-learning. The researchers examined whether word-learning abilities of preschoolers, aged 4 to 5 years, were influenced by additional exposure to words with similar phonological properties. In this study, children's word learning abilities of novel object words were assessed in two different conditions. In condition 1, children were presented with a phonologically similar sounding word (*phonological neighbour*) before learning the new word, whereas in condition 2, children were exposed to the *phonological neighbour* of the new word after learning the novel object word. Analysis revealed that there were no influences on children's word-learning abilities in condition 1. However, in condition 2, the children who were exposed to phonologically similar words after learning a new word produced more new words correctly than children who were not exposed to the *phonological neighbours*. These findings suggest that phonological cues that are presented after a new word may facilitate children's word-learning abilities.

In summary, findings from research have revealed significant correlations between phonological processing skills (i.e., phonological short-term memory and phonological awareness) and vocabulary for children with typical language development. However, findings regarding the relationship of phonological processing and word-learning were less conclusive and indicated that the correlations may vary depending on the exposure to the new words. Phonological processing skills may be more strongly correlated to longer term word-learning than short term word-learning. Furthermore, research demonstrated that phonological processing was specifically correlated to the ability to learn to produce new words. Given the positive correlations in phonological processing and vocabulary and word-learning, it can be concluded that phonological processing skills play an essential part in the acquisition of words.

Semantic processing hypothesis: word-learning at the lemma level

A second model of word-learning, the '*semantic processing model'* emphasizes the strong correlation between word-learning and semantic skills. It is based upon a 'storage hypothesis' (Kail, et al., 1984) that purports that the quality of how words are stored in the lexicon influences the ability to successfully retrieve the words. Leonard (1998) proposed that words are stored in a network of associations. That is, each word is not stored individually but associated with other semantic, phonological or morphological information. For example, the word 'cats' might be stored with additional semantic (e.g., animals, pet, dog), morphosyntactic (e.g., noun, plural) and/or phonological information (e.g., starts with /k/). Most links are based on semantic associations (e.g., super-ordinates, co-ordinates, attributes like size, shape, etc.) and the more connections exist for each word, the stronger its network becomes. Leonard argues that words that are stored with multiple associations in the lexicon can be retrieved more efficiently than words with few connections.

The semantic processing hypothesis is further supported by findings from McGregor, Friedman et al., (2002) who investigated a different aspect of lexical storage. Results from this study indicated that the quality of semantic representations of single entries (i.e., the level of semantic knowledge for each word) is critical to successful word retrieval. In this study, the researchers examined the semantic representation of low frequency nouns in young children. Twenty-five children aged 4;2 to 6;6 were presented with 20 low frequency nouns and were asked to name, draw, and define these words. The latter two tasks were implemented to assess the degree of understanding of these words. Error analyses of the naming task revealed that semantic errors (26%) were most prevalent, followed by indeterminate (e.g., don't know) and phonological errors. This means, children were more likely to substitute the target word with a semantically related item than with an unspecific answer (indeterminate) or with a phonologically similar sounding word (e.g., stamp for clamp). The semantic errors were mainly taxonomic (72%) (i.e., substitutions of targeted words with co-ordinates or super-ordinates). Further semantic errors were thematic (substitution with word from the same topic, e.g., tree for axe) or descriptive errors (explanation of targeted item). The findings that labelling errors were mainly semantic substitutions support Leonard's theory about the storage of words in a network of associations. Furthermore, as children were mainly using taxonomic substitutions, lexical entries appear to be stored and maybe even accessed in a taxonomic hierarchy. Analyses of the drawings and definitions revealed that the semantically misnamed words were less accurately drawn and defined compared to words that were correctly named. Additional analyses of the drawings and definitions of semantically misnamed words demonstrated that both scores were highly correlated, indicating that words that were drawn less accurately, were also less accurately defined. Thus, children made more naming errors when the semantic representations of the according words were weaker. This implies that the strength of the semantic representation of words in the lexicon is critical for word-learning, particularly for word retrieval.

Adapting the drawing task from the McGregor, Friedman et al. (2002) study, Gray (2004) demonstrated that these semantic representations change with growing familiarity of the words. Gray examined the children's word-learning skills over several days and asked them to draw pictures of the items on the first day after minimal exposure and on the last day after repeated exposures. Analyses demonstrated that children's drawings of the new words were rated (by independent raters) significantly higher at the end of the study than at the beginning. This indicates that as children became more familiar with the new words, their semantic representations got stronger as demonstrated in the improved drawing performances.

The findings indicate that successful word retrieval depends on how the words are stored in the lexicon. Hence, if new words are stored with strong semantic representations and in a network of associations, the access and retrieval of the words should proceed accurately and efficiently.

Combined model

An extensive body of evidence supports the *phonological* and the *semantic processing model* in word-learning and suggests that both models may be feasible (Gathercole, et al., 1997; Gray, 2004, 2005; Leonard, 1998; McGregor, Friedman, et al., 2002; Michas & Henry, 1994; Nash & Donaldson, 2005). In fact, the models appear to be complementary. Both models can be applied to the word-learning process, without constraining or excluding each other's properties. Recalling that the word-learning process consists of the acquisition, storage, and retrieval of words, the two different models can be roughly distributed as follows: the acquisition of new words may mainly depend on phonological processing, the storage of the new word may mainly depend on semantic processing, and the retrieval may depend on both phonological and semantic processing. This does not imply that these mentioned processing skills are exclusively employed at each stage. However, this only depicts a simplified version of the word-learning process to illustrate how both models can be applied. Considering that there are two levels (lemma and lexeme) of how words are stored, organised, and accessed in the lexicon, the constant collaboration of both the phonological and semantic processing is fundamental and indispensable. Therefore, semantic skills are fundamental for establishing strong representation on the lemma level, whereas the phonological processing skills are fundamental for establishing strong representations at the lexeme level.

1.3.2 Assessment of word-learning skills

Researchers investigating the word-learning skills in young children have usually examined how many words a child can learn within a given time frame. However, the implemented methodologies assessing the children's word-learning abilities vary across studies. Some studies focussed on the learning of new words within one session, whereas others followed the word-learning process of children over several days. There were also variations in the teaching method; the two main utilised methods were explicit teaching, where the new words were directly presented to the children, or indirect teaching (incidental), where children were exposed to new words via storybooks or videos. Based on teaching method and learning period, there are three main methods commonly utilised to assess word-learning skills: Fast mapping (FM), Quick Incidental Learning (QUIL), and supported learning context (SLC).

The first stage of the word-learning process is referred to as fast mapping (Carey, 1978; Carey & Bartlett, 1978). Fast mapping occurs when a child is exposed to a novel word for the first time and the word-learning process is initiated by establishing first phonological, semantic, and syntactic representations of this word. Carey introduced the term fast mapping in a study assessing young children's' ability to learn a new word using incidental teaching. However, fast mapping refers now more commonly to an explicit teaching context of (one or more) new words and is often applied to examine whether children can remember new words after very limited, sometimes only a single, exposure (Alt, et al., 2004; Dollaghan, 1987; Gray, 2006).

QUIL (Oetting, et al., 1995; Rice, et al., 1990) refers to the instant ('quick') learning of novel words in a more 'naturalistic' environment. It is based on the more natural process of learning words as children are more likely to encounter new words in conversations or stories rather than being prompted to focus on the novel words. During a QUIL task, children are repeatedly presented with new words in a story or video without direct prompting, and learning occurs while listening/watching ('incidentally').

An SLC provides a child with additional support during the word-learning process. In an SLC, the new words are explicitly taught (i.e., directly presented) to the children and presented with additional cues and/or feedback (Gray, 2003b, 2004, 2005). Word-learning in an SLC includes several exposures to the new words, often over a period of several days. This methodology allows the researcher to follow the child's word-learning abilities beyond the initial fast mapping. Thus, more comprehensive analyses are possible to evaluate how children learn new words.

The stimuli used to assess word-learning in children has varied across studies. As researchers need to select unfamiliar words to examine children's learning of new words, non-words or real words with low frequency were adopted in the various studies. This makes a comparison of the various research findings difficult, as specific word features affect the rate and intensity of learning the words. For example, an important factor that requires consideration when choosing the stimuli is the phonotactic probability of the utilised items. There are two different levels of phonotactic probability: phoneme and biphone probability (Vitevitch & Luce, 2004). Phoneme probability refers to the probability for each phoneme itself to occur in a specific position of a word and biphone probability refers to the probability of the two neighbouring phonemes to occur within a word. It is important to control for the phonotactic probability of the used stimuli, as (non-) words with higher phonotactic probability are learned easier than (non-) words with low phonotactic probability (Storkel, 2003). There is also a significant difference in children's performances when learning new words depending on the word classes. Children appear to have more difficulties learning verbs than nouns/objects (Leonard, et al., 1982; Oetting, et al., 1995; Rice, et al., 1990). This appears plausible, as nouns can often be depicted or represented as concrete items (picture, object), whereas verbs mostly involve actions or a change of state, which additionally requires an agent or activity and might not be as obvious.

Another important consideration in examining word-learning skills is the selection of tasks to assess whether a new word is learned and what the criterion for 'learned' is. The tester needs to be aware that different tasks require different levels of representations. For example, for comprehension probes (i.e. picture pointing) even weak semantic representations might be sufficient to correctly identify the object, whereas for production probes (i.e., naming the object), a strong representation in the lemma and lexeme level are necessary for successful labelling.

In conclusion, word-learning assesses how many words a child can learn within a given time frame. However, there are great differences in how this is specifically assessed. A variety of factors need to be considered, as they influence word-learning outcomes. The various settings (e.g., FM, QUIL, SLC), the utilised stimuli (e.g., words, non-words), amount of stimuli (e.g., 1, 4, 8) and tests to evaluate the learning of the new words (e.g., comprehension, drawing, production) utilised in word-learning studies make comparisons between studies difficult, but also highlight the variety in assessing word-learning. For each study, these factors need to be adapted according to the participants' skills, learning context, and the objective of the research.

As the current study aims to examine the word-learning abilities of New Zealand school-aged children with SLI, it will employ an SLC in order to assess the children's word-learning abilities over several days and observe the word-learning process over time. For universal applicability, the utilised stimuli in the study will consist of low frequency words of varying lengths and CV or CC structures. Throughout their lexical development, children will encounter and learn words of varying lengths and structures. The current study additionally explores what word specific features may facilitate the learning of new words and whether intervention influences these facilitators. Children with SLI often present with difficulties in morphology, like bound morphemes which includes verb-flexion. Thus, the items in the current study will consist of nouns in order to avoid grammatical abilities influencing the word-learning outcomes. Word-learning will be assessed on several tasks (comprehension, production and recognition) in order to understand the level of representations of the learned items.

1.4 Word-learning in children with SLI

Findings from a body of research have demonstrated that children with language impairment typically perform poorly on word-learning tasks compared to children with typical language development (Gray, 2003b, 2004, 2005; Horohov & Oetting, 2004; Nash & Donaldson, 2005; Oetting, et al., 1995; Rice, et al., 1990). The process of learning new words requires children to analyse the word's phonological form, derive its meaning, and then connect its phonological form with the semantic meaning to establish a representation of the word that can be stored in the lexicon.

Rice and colleagues (1990) utilised a quick incidental learning (QUIL) task to compare the performance of children with SLI to children with typical language development. The children, aged 2;4 to 6 years, were exposed to unfamiliar words during video sessions. Comprehension of these novel words was assessed immediately after the last video session. When compared to age-matched and language-matched control children, the children with SLI learned significantly fewer new words during the QUIL task than their peers despite equal exposure. The researchers concluded from their findings that vocabulary deficits in children with language impairment are caused by limited skills in fast mapping new words.

More recent studies also support the view that children with SLI perform worse on word-learning tasks than age-matched children with typical development (Ellis Weismer & Hesketh, 1998; Gray, 2003b; Horohov & Oetting, 2004; Nash & Donaldson, 2005). Gray (2003b) investigated the word-learning abilities in 4- to 5-year old children with and without SLI utilising a word-learning paradigm that was implemented over 5 days. During this time, children were exposed to the novel words during a play session with repeated exposure to the novel words via the researcher's input to the play session. Word-learning was assessed on comprehension and production of the novel words. Findings revealed that all children scored higher on tasks that assessed understanding (comprehension) of the novel words than their ability to accurately produce (production) the novel words. The age-matched children without SLI learned significantly more words on both comprehension and production than the children with SLI. Gray concluded that despite within-group variability, children with SLI needed more exposure to new words before they can learn them (Gray, 2003b). In particular, the production of new words appears to be significantly restricted for children with SLI (Gray, 2004).

The word-learning difficulties exhibited by children with SLI have motivated researchers to further investigate the cause of these difficulties. Based on word-learning in children with typical language development, research has focused on examining the contribution of phonological processing deficits and semantic deficits to word-learning difficulties. The following sections consider the evidence of word-learning difficulties in children with SLI and discuss the involvement of both phonological and semantic processing abilities in restricting children's vocabulary growth.

1.4.1 Deficits in phonological processing skills in children with SLI

Phonological processing skills are an essential part of the word-learning process. When first learning a new word, the word has to be filtered from connected speech the child is hearing, and then the phonological structure of the word analysed and compared to words in the child's existing lexicon. The phonological form of this novel word is then stored in the lexicon, if no other entry for this word exists. During this process, the new word needs to be held in phonological short-term memory. To efficiently access the word from long-term memory, strong phonological representations are necessary for the child to retrieve and correctly produce the word.

Various researchers have demonstrated the correlations between word-learning and phonological processing skills (see Section 1.3.1). Specifically, the role of phonological short-term memory and phonological awareness, two components of phonological processing, has been examined (e.g., Gathercole & Baddeley, 1989; Metsala, 1999). Extensive research has investigated the phonological processing abilities of children with SLI, documenting that these children perform worse on phonological processing tasks than age-matched control children (Briscoe, et al., 2001; Dollaghan & Campbell, 1998; Ellis Weismer, et al., 1999; Ellis Weismer, et al., 2000; Estes, et al., 2007; Gathercole & Baddeley, 1990; Gray, 2006; Horohov & Oetting, 2004; Zens, et al., in press). There is a range of experimental tasks and standardised tests tapping into various phonological processing skills like phonological memory and phonological awareness, for children of various ages. Phonological memory is often assessed using a NWR-T and a digit span task, or the standardised Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999), whereas phonological awareness is often assessed at the phoneme, rhyme, and syllable level with standardised assessments like the Preschool and Primary Inventory of Phonological Awareness (PIPA; Dodd, Crosbie, MacIntosh, Teitzel, & Ozanne, 2000) or Queensland University Inventory of Literacy (QUIL; Dodd, Holm, Oerlemans, & McCormick, 1996) or experimental probes (e.g., Stahl & Murray, 1994). NWR-Ts appear especially promising in the identification of children with SLI. A meta analysis by Estes et al. (2007) comparing 23 studies of NWR-Ts revealed that across all studies, children with SLI performed significantly worse on NWR-Ts than children with typical language development. Thus, the researchers concluded that NWR-Ts are promising in identifying children with SLI. There is clearly an implication that children with SLI present with a significant deficit in phonological processing.

In line with prior research (Gathercole & Baddeley, 1989), Gathercole and Baddeley (1990) concluded from a series of experiments that poor phonological processing skills may be the underlying cause of language deficits, including vocabulary deficits. They found that the phonological memory skills in children with SLI were significantly lower (delay of approximately 4 years) than the phonological memory skills of language-matched children who were about 2 years younger. Consequently, Gathercole and Baddeley argued, that the language deficits are a direct consequence of limited phonological processing skills; as otherwise, there would not be this discrepancy.

The findings that children with SLI present with limited phonological processing abilities are further supported by research from Horohov and Oetting (2004). The study assessed the word-learning abilities in children, aged 5 to 7 years, with and without SLI by manipulating the input variables of the targeted words. More specifically, the researchers varied the presentation characteristics while children were exposed to novel words during a storybook reading task. The input manipulations were presentation rate (fast rate and slow rate), word type (nouns and verbs), and sentence type (complex and simple sentences). The findings revealed that children with SLI demonstrated a reduced ability to process rapidly presented sentences compared to age-matched as well as language-matched children (who were on average 18 months younger) with typical language development.

In conclusion, considering the significant role of phonological processing in word-learning, limitations in this ability as exhibited by children with SLI, will most likely result in difficulties in being able to recognise, store, and retrieve new words.

1.4.2 Deficits in semantic processing skills in children with SLI

Research focussing on word-learning also provides evidence for underlying semantic difficulties as a cause of vocabulary deficits in children with SLI (Alt & Plante, 2006; Alt, et al., 2004; Leonard, 1998; McGregor, Newman, Reilly, & Capone, 2002). Children with SLI display difficulties in efficiently storing words in a strong network of associations (Leonard, 1998). Leonard proposed that words in the lexicon are normally stored in a network of associations. A strong network facilitates successful retrieval of the word from the lexicon. Given that children with SLI frequently present with vocabulary deficits, the researcher concluded that children with SLI have difficulties in establishing a range of associations between words that are stored in the lexicon. However, Leonard argued that vocabulary deficits of children with SLI are caused rather by difficulties with efficient storage of words than their retrieval.

Restricted skills in efficiently storing words in the lexicon in children with SLI were also reported by McGregor, Newman et al., (2002), who investigated a different aspect of vocabulary acquisition in children with SLI. The researchers examined the quality of semantic representations of words in the lexicon in children with and without SLI, aged 5;0 to 7;11 years. In this study, children had to name, draw, and define low frequency nouns. Findings revealed that children with SLI made more errors in naming the nouns correctly than children with typical language development, and that for both groups naming errors were mostly semantic (e.g., ‘cherry’ for ‘strawberry’ or ‘something you chop with’ for ‘axe’) rather than phonological (e.g., ‘pitcher’ for ‘picture’) or indeterminate errors (e.g., ‘don’t know’). Furthermore, analyses of the drawing and defining tasks revealed that scores were lowest for words that were misnamed with semantic and indeterminate errors. The researchers concluded that the naming errors by children with SLI are mainly caused by limited semantic representations and that these limited representations of words in the lexicon also are likely to hinder successful word retrieval. Therefore, intervention focussing on word-learning should emphasise establishing strong semantic representations (McGregor, Newman, et al., 2002).

Limited semantic representations in children with SLI could be caused by difficulties mapping enough semantic features when encountering new words. Alt and colleagues (2006; 2004) demonstrated that children with SLI have difficulties in assimilating semantic features to novel words compared to age-matched children with typical language development. Children were presented with novel words via a computer programme and had to remember as many semantic associations as possible (out of four) for each word. The novel words were made-up objects and actions and had made-up labels to avoid influences of prior knowledge of any word on the task. The semantic features differed for objects and verbs and included colour, pattern, speed, and shape change. Analyses revealed that children with SLI not only performed worse than their age-matched peers in labelling the new words, but also in remembering semantic attributes for each word. This result indicates that children with SLI have difficulties mapping semantic information to new words, which in turn limits the strength of the semantic representations of the words.

In summary, children with SLI present with significant limitations in their abilities to establish strong semantic representations within and among new words, which places them at great risk for word-learning difficulties.

1.4.3 Evidence of phonological and semantic influences on word-learning deficits in children with SLI

Based on the considerable body of research documenting the contribution of phonological processing skills on word-learning (e.g., Gathercole, 2006) and semantic skills on word-learning (e.g., Alt, et al., 2004), researchers examined the relationship of both of these aspects on word-learning in children with SLI (Brackenbury & Pye, 2005; Gray, 2005; Nash & Donaldson, 2005).

Nash and Donaldson (2005) investigated whether word-learning difficulties in children with SLI are manifested in limited phonological or semantic learning of the novel words, and to what extent deficits in phonological and semantic skills may be related to each other in restricting the learning of new words. The word-learning abilities of 16 children with SLI, aged 5;5 to 9 years, were compared to performances of age-matched and vocabulary-matched (3;9 to 5;8 years) children with typical language development in an explicit teaching and an incidental learning context. Phonological learning of the new words was assessed utilising a naming and a word recognition task and semantic learning was evaluated through three different tasks: word definition, meaning recognition, and picture selection. The findings revealed that for phonological learning, the children with SLI performed worse than their age- and vocabulary-matched peers and for semantic learning, the children with SLI performed below their age-matched peers but equal compared to the vocabulary-matched peers. A further analysis of the correlation between phonological and semantic tasks revealed that these were not strongly correlated. Thus, the researchers concluded that children with SLI display difficulties in both the phonological as well as semantic aspects of learning new words, but that both these aspects of word-learning are not related to each other. Furthermore, findings demonstrated that all children performed better in the explicit teaching context than in the incidental learning context on two of the three semantic measures (word definition and meaning recognition). Explicit teaching of new words may facilitate child's semantic word-learning skills as it reduces the processing demand on the semantic level by directly providing children with additional cues directly. Consequently, children do not have to derive the meanings from the context and hence have more processing resources left to focus on learning more semantic features strengthening the representations of the new words. However, there was no difference between the performances on the phonological word-learning measures for both learning contexts. Thus, direct teaching of new words appears to place the same phonological learning demands on children as implicit teaching.

To specifically examine the influences of phonological and semantic processing skills on the word-learning process, Gray (2005) assessed children's word-learning abilities integrating a phonological and a semantic condition. Twenty-four children with SLI aged 4;0 to 5;11 years and age-matched children with typical language development participated in a word-learning paradigm where novel words were presented to the children with additional phonological or semantic cues. Word-learning was tested on comprehension and production of the new words. Consistent with prior research, findings revealed that children with SLI needed more exposure to receptively and expressively learn the novel words than the children in the control group. Moreover, children with SLI performed better on the comprehension test of word-learning when the words were presented with semantic cues and better on the production test where words were presented with phonological cues. This finding indicates that even though both, phonological processing and semantic processing, are crucial in the word-learning process, they both impact on word-learning skills in children with SLI in different ways. These findings are commensurate with studies demonstrating that the production of new words is correlated with phonological processing skills (Gray, 2006; Michas & Henry, 1994).

In summary, research has revealed that children with typical language development outperform children with SLI in learning new words. These difficulties demonstrated by children with SLI appear to be caused by underlying phonological and semantic deficits which impede successful word-learning.

1.4.4 Limited processing capacity and word-learning deficits

The complex process of word-learning requires children to simultaneously activate phonological, semantic, morphosyntactic, and other processing skills. For successful word-learning, these domains need to work in concert so that incoming information can be processed and stored. Findings from research have demonstrated that children with SLI present with deficits in their processing abilities, which appear to be the cause of the word-learning difficulties (Alt & Plante, 2006; Alt, et al., 2004; Estes, et al., 2007; Gathercole, et al., 1992; Gray, 2006; Horohov & Oetting, 2004; Nash & Donaldson, 2005). These 'deficits' are not limited to phonological and semantic processing mechanisms and are often explained within a model of limitations in processing capacities (Alt & Plante, 2006; Ellis Weismer, 1996; Ellis Weismer, 2008; Ellis Weismer & Hesketh, 1996). This limitation in resources will become apparent when an increased processing demand is placed on the children.

Word-learning for example, requires children to concurrently process and store information on different levels. It is plausible that increased processing demands exceed the available processing capacities in children with SLI, hindering successful word-learning.

Alt and Plante (2006) examined whether increasing processing demands while learning new words will influence the performance of children with SLI. Children in this study were presented with 12 new objects, each matched with four additional semantic features. Processing demands were varied by utilising labels for these objects with high and low phonotactic probability (words with low phonotactic probability are more difficult to learn as they place more demand on phonological decoding and encoding), and by providing additional linguistic, non-linguistic or no auditory input. The researchers found that the fast mapping abilities in children with SLI to assimilate semantic features of novel words and to learn the novel words was restricted by limited processing capacities. Children with SLI performed significantly worse in mapping semantic features when additional processing demands were implemented. On the contrary, performance of children with typical language development did not differ despite varying processing demands.

Research findings revealing that children with SLI have limited processing capacities compared to children with typical language development are consistent with previous investigations. Ellis Weismer and Hesketh (1996) demonstrated that increased processing demands limit children's word-learning abilities. The researchers examined whether faster speaking rates impede children's learning of new words. A fast speaking rate increases processing demands as the same amount of information has to be processed and stored within a shorter time frame. In line with the limited processing capacity model, children with SLI displayed significant difficulties learning new words presented in the fast speaking rate than in the slow or normal rate. Compared to age- and language-matched children with typical development, children with SLI were significantly less proficient in learning new words at a fast rate. As in the Alt and Plante study (2006), there was no difference in the word-learning performances of children with typical language development depending on varying processing demands.

Limitations in general processing capacities continue into adolescence. Ellis Weismer (2008) reported that adolescents with language impairment continue to perform more poorly on language and visuospatial processing tasks compared to peers with typical language skills.

Considering the conditions in which children normally learn new words, it becomes understandable why children with SLI present with difficulties in word-learning and consequently with limited vocabulary. As word-learning requires the simultaneous collaboration of phonological and semantic processing in particular, the limited processing capacities of children with SLI place them at great risk of failing to successfully process and store incoming information about new words. Environmental conditions in which new words are encountered can additionally diminish word-learning outcomes when the processing demand increases, placing yet another impediment on successful word-learning.

1.5 WL intervention

As a group, children with SLI present with a variety of language difficulties which vary in severity and affect different language domains of each individual. Research has predominantly focused on improving spoken language skills in children with SLI, although interventions aimed at improving written language are becoming of increasing interest (Munro, Lee, & Baker, 2008). Treatment approaches aimed at facilitating language skills in children with SLI vary greatly (Leonard, 1998; Paul, 2007). The differing approaches employ various methodologies to enhance language skills and target language domains. There are three main intervention methods (Fey, 1986):

- Child-centred (CC),
- Clinician-directed (CD), and
- Hybrid approach.

The CC approach aims to elicit responses from the child by providing an activity or 'game' that would evoke these responses. The child learns more incidentally during play and is not aware of the teaching situation. In the CD method on the other hand, the clinician provides direct instructions to the child during the session and feedback regarding the performance of the child. CD interventions are highly structured and highlight the targeted goals. The hybrid approach also targets selected specific goals, but provides the child with an activity or material that tempts the child to produce the targeted form. Thus, it is less direct than the CD model but more controlled than the CC method. Language domains are either targeted individually or via a holistic approach. There is controversy over which intervention approach is most effective, but considering the heterogeneity of children with SLI, it seems reasonable that for each individual, the planning of the intervention depends on various factors. Factors that influence the selection of intervention methods include the age or developmental level of the child, the severity of the affected language domain, the targeted goals, and whether certain intervention methods work better to target specific areas of language (e.g., CD for phonology, hybrid for morphosyntax).

As mentioned earlier, children with SLI present with a range of symptoms in varying severity. Therefore, careful considerations are necessary when choosing which areas of language will be targeted first. General considerations should include the effect of language deficits on the child's communication abilities, and what language domain will affect language development the most when facilitated. Enhancing one area of language may improve another language domain as well (Fey, Long, & Finestack, 2003; Gillon, Moran, & Page, 2007; Paul, 2007). This following section specifically focuses on intervention methods facilitating word-learning in children with SLI and examines the applicability of these interventions for school-aged children. In order to control for intervention bias between participants, a clinician-directed intervention model will be implemented in the current study.

Given previous research indicating the contribution of phonological processing and semantic processing skills on word-learning ability, it is plausible that interventions designed to facilitate skills in each of these areas will positively influence word-learning abilities. As it is impossible to teach all vocabulary to children with SLI in the way they would profit most (repeated exposure, direct teaching, reducing processing demands, etc.) it is important to facilitate their word-learning by strengthening the underlying mechanisms to support the learning of new words independently.

1.5.1 Phonological awareness intervention

Phonological awareness is an aspect of phonological processing and denotes the awareness of the sound structures of spoken words (Gillon, 2004). Facilitating phonological awareness skills in children with SLI enhances their phonological de- and encoding skills, which will support them in analysing the phonological form of new words and establishing strong phonological representations of the new words for successful retrieval. Improved phonological awareness skills will reduce the processing demand of learning new words leaving children with more processing resources to map semantic features to the new words and/or to create strong semantic representations.

Phonological awareness intervention has been successfully implemented in children with speech and/or language impairment (Gillon, 2000, 2002; Justice, Kaderavek, Bowles, & Grimm, 2005; Segers & Verhoeven, 2004; van Kleeck, Gillam, & McFadden, 1998; Warrick, et al., 1993), children with childhood apraxia of speech (Moriarty & Gillon, 2006), very young children (Gillon, 2005; Warrick, et al., 1993), children with Down Syndrome (van Bysterveldt, Gillon, & Moran, 2006) and school-aged children from low socioeconomic backgrounds (Gillon, Moran, Hamilton, et al., 2007). Most interventions targeted at enhancing phonological awareness skills at the onset-rime, syllable, and/or phoneme level with the aim to improve speech and/or to support their reading and spelling development. A meta-analysis of 52 studies by Ehri et al. (2001) revealed that phonological awareness intervention facilitates reading and spelling development. Improved reading included not only word-recognition, but also reading comprehension. Thus, enhanced phonological awareness skills affected the processing abilities of children: Improved phonological awareness skills frees the processing resources from decoding written words to be used to process and store the read information.

For school-aged children, phonological awareness intervention should focus on facilitating skills at the phoneme level (Gillon, 2004). The phonological awareness development of children progresses from the awareness that words can be broken down into parts that consist of bigger units within the word (i.e., syllables and onsetrimes) to parts that consist of smaller units (phonemes). By the junior school years, children have typically mastered tasks that tap explicit awareness of the syllable and onset-rime structure of words. Thus, it is crucial to enhance children's phonological awareness skills at the phoneme level as it is the most critical skill for early decoding abilities (Catts & Kamhi, 2005; Hulme, et al., 2002; Muter, et al., 1997; Muter, et al., 2004). Instruction at the phoneme level proved to be particularly helpful for children who have already experienced reading difficulties (Gillon, 2002) or who are at risk of developing reading difficulties (Hatcher, Hulme, & Snowling, 2004). In particular, phonological awareness intervention in phoneme segmentation and blending contributes to greater reading and spelling success (Ehri, et al., 2001; Torgesen, Morgan, & Davis, 1992). Consequently, in light of evidence-based practice, phonological awareness intervention for the children in this study needs to enhance phonological awareness skills at the phoneme level.

Explicitly linking the spoken language and its written representations appears to ease reading and spelling success. Phonological awareness intervention integrating letter-sound knowledge facilitates greater transfer of phonological awareness knowledge to enhance reading and spelling than just phonological intervention alone (Hatcher, Hulme, & Ellis, 1994; Hatcher, et al., 2004). Thus, the implemented phonological awareness intervention for the children in this study will integrate reading tasks and explicitly link the spoken and written language.

In summary, phonological awareness intervention will support children's word-learning by enhancing their abilities to analyse the phonological form and establish strong phonological representations (lexeme) of new words. As children with SLI are at great risk of reading difficulties, the phonological awareness intervention will specifically target the phoneme level and integrate letter-sound knowledge. The intervention aims to not only facilitate improvement in the children's word-learning skills, but also enhance the children's written language skills.

1.5.2 Semantic intervention

Children with SLI present with difficulties in establishing strong semantic representations of new words and storing them with sufficient semantic associations that allow successful retrieval from long term storage (Leonard, 1998; McGregor, Newman, et al., 2002). Consequently, interventions which aim to improve word-learning skills should focus on advancing the underlying semantic processes. McGregor, Friedman, et al. (2002) investigated the semantic representations of low frequency nouns in children with typical development and proposed that the semantic lexicon is organised and accessed in a mainly taxonomic hierarchy. That is, words are mostly stored within categories like co-ordinates, super-ordinates and sub-ordinates. However, words are also often stored within thematic contexts (e.g., juice-drink). This indicates that interventions targeting strategies to improve the storage of new words should facilitate the organisation of entries in a similar structure. As words are stored in a taxonomic hierarchy, it is important to highlight the levels of classes and their associations with each other and organise the semantic entries accordingly, supporting the creation of a strong network of associations on the lemma level. Additionally, emphasising thematic associations can further strengthen this network of associations. A strong network in an organised structure can facilitate the efficient retrieval of words from long-term storage.

In order to strengthen semantic representations (lemma) of words in children with SLI, intervention should focus on providing strategies to enhance the fast mapping of semantic features to new words. Alt and colleagues (2006; 2004) demonstrated that children with SLI presented with difficulties mapping semantic features to new words, compared to children with typical language development, thus establishing considerably weak representations of the novel words. Highlighting significant attributes of words should focus on functional and physical properties, as most objects are mainly mapped using these properties (McGregor, Friedman, et al., 2002). Strengthening the semantic representations of words at the lemma level will facilitate accessing and retrieving it from storage (Best, Dockrell, & Braisby, 2006).

There is support in the literature that a combination of phonological awareness intervention and semantic intervention enhances children's abilities to establish stronger representations of words in the semantic lexicon. In a feasibility study, Munro, Lee and Baker (2008) investigated whether a hybrid approach of improving phonological awareness and semantic skills in young children with SLI enhanced their performances on two different tasks measuring lexical skills. In one task, children had to identify phonological and semantic attributes of high frequency words and in the other task, children's abilities to associate words to presented high frequency words was assessed. The hybrid intervention approach targeted phonological awareness and semantic intervention based on storybook narratives and drill play. Additionally, parents were asked to consolidate the intervention contents at home on a daily basis using similar materials. Results demonstrated that enhancing children's phonological awareness and semantic skills significantly improved performance on both tasks assessing lexical skills. Following the intervention, children identified significantly more phonological and semantic attributes of the words than prior to the intervention. Furthermore, in the word association task, children were able to produce more 'correct' answers (i.e., generating semantically or phonologically related associations) and reduce 'wrong' answers (i.e., repeating words or naming unrelated words) after the intervention. As this intervention study implemented high frequency nouns for their experimental tasks, findings indicate that children were able to strengthen their semantic (lemma) and phonological representations (lexeme) of words that were already stored in their semantic lexicon. These results seem very promising that intervention focused at improving phonological awareness and semantic skills in children with SLI may also enhance their ability to establish strong representations of new words on the phonological and semantic level.

1.6 Summary and thesis aims

Children with SLI often present with word-learning difficulties. That is, compared to children with typical language development, children with SLI may have difficulties in acquiring, storing, and/or retrieving new words. Research has provided robust evidence that phonological and semantic processing skills are related to word-learning and may contribute to the word-learning difficulties experienced by children with SLI. As most words are not learned through direct teaching, it is important to strengthen the underlying mechanisms that are necessary for successful word-learning. Hence, intervention aimed at improving word-learning ability should target phonological and semantic processing skills. The phonological intervention should target children’s phonological awareness skills at the phoneme level in order to facilitate the ability to analyse the phonological form of new words. The semantic intervention should aim to support the children with SLI in establishing strong semantic representations of words and a network of associations among the words for efficient storage.

This research seeks to examine the word-learning skills of school-aged children in New Zealand who have SLI. This study aims to investigate the effectiveness of phonological awareness, semantic intervention, or a combination of both phonological and semantic intervention in facilitating word-learning abilities in children with SLI. To accomplish these aims, the following questions are addressed in this thesis:

1. What are the receptive and expressive word-learning skills of New Zealand school-aged children with SLI compared to children with typical language development?
2. Which underlying language skills influence word-learning?
3. What word-specific features and cues facilitate word-learning in children with SLI and children with typical language development?
4. What are the error patterns of children with SLI compared to children with typical language development when learning to produce new words?
5. What are the immediate effects of phonological awareness and semantic intervention on word-learning outcomes in children with SLI and does the order of the implemented interventions influence outcomes?
6. What are the longer term effects of phonological awareness and semantic intervention on language skills in children with SLI?

In Chapter 2, the word-learning, phonological awareness, semantic, vocabulary, language, and reading skills of school-aged children with SLI are examined and described. Their performances on all measures will be compared to children with typical language development. Furthermore, best subsets regression analysis will determine which (combination of) skills predict word-learning outcomes. In Chapter 3, an error analysis is conducted to examine what naming errors occurred most frequently in children with SLI compared to children with typical language development. Additionally, the utilised stimuli for the word-learning probes will be analysed to evaluate whether certain criteria (e.g., word length, phonotactic probability of words, category of the word) influence word-learning outcomes. Furthermore, the influence of teaching conditions on word-learning outcomes is evaluated. The effectiveness of semantic and phonological awareness intervention on word-learning performances is investigated in Chapter 4. In this study, children with SLI, as described in Chapter 2, are randomly assigned to one of two treatment groups. One group receives phonological awareness intervention (phase 1) followed by semantic intervention (phase 2), whereas the other group receives the same interventions in the reverse order. Word-learning is assessed following the first intervention phase and after the second intervention phase. In Chapter 5, the error patters of children with SLI at pre-, mid-, and post-test are compared in order to evaluate whether their error patterns changed from pre- to post-intervention. Moreover, it is analysed whether the teaching conditions for the new words affected word-learning outcomes at mid- and post-test. A 6-months follow-up study of the children with SLI is presented in Chapter 6. Finally, in Chapter 7, the results are summarised and conclusions from the findings with regards to the clinical and scientific implications are drawn.

CHAPTER 2

INVESTIGATING WORD-LEARNING ABILITIES IN CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

2.1 Introduction

The literature review (Chapter 1) revealed that children with Specific Language Impairment (SLI) often present with word-learning difficulties (Ellis Weismer & Hesketh, 1998; Gathercole & Baddeley, 1990; Gray, 2003b, 2004, 2005; Nash & Donaldson, 2005; Rice, et al., 1990) that may affect the acquisition, storage, or retrieval of new words.

Researchers investigating word-learning abilities in children with SLI have predominantly focussed on pre-school and young school-aged children (Alt & Plante, 2006; Alt, et al., 2004; Gray, 2003b, 2004, 2005, 2006; Rice, et al., 1990; Riches, Tomasello, & Conti-Ramsden, 2005). Gray (2005) examined the fast mapping skills in 4- and 5-year old children and demonstrated that at 4 years of age, there were no differences between the fast mapping performances of children with SLI and children with typical language development. In contrast, group differences for 5-year old children were significant for production and comprehension of novel words during fast mapping, with children with typical language development learning more words than children with SLI. Nevertheless, another study by Gray (2006) revealed that this significant difference was not evident in 6-year-old children. This suggests that differences in the fast mapping performances between children with and without SLI may vary according to age and learning environment. Participants for Gray's (2006) study were recruited from various settings including schools. Thus, it can be assumed that some of the 6-year-old children were attending school and consequently exposed to regular classroom instruction, which may have influenced their fast mapping abilities.

When word-learning was assessed after repeated exposure or over several days like in supported learning context (SLC) or in Quick Incidental Learning (QUIL) studies, research consistently revealed that children with typical language development mostly outperform their age-matched peers with SLI (Gray, 2003b, 2005; Nash & Donaldson, 2005; Oetting, et al., 1995; Rice, et al., 1992). In a word-learning study including older children, Nash and Donaldson (2005) assessed word-learning skills in children aged between 5;5 and 9 years employing a more supported word-learning context that provided children with additional cues during word-learning. Word-learning was assessed on several semantic and phonological measures after 6 and 12 exposures to the items. The findings revealed that children with typical language development learned significantly more novel words than the children with SLI.

Findings of earlier studies indicate that word-learning differences between children with and without SLI may vary depending on the assessed context (e.g., fast mapping and supported learning context). In order to understand word-learning abilities in school-aged children with SLI, word-learning should be assessed on fast mapping and supported learning contexts. It is important to examine word-learning in school-aged children to evaluate whether word-learning difficulties in children with SLI manifest over time or whether children are able to overcome their difficulties once they start attending school and receive a strong curriculum in language and literacy. The study in this chapter aimed to extend previous research by comparing word-learning abilities of school-aged children with SLI to children with typical language development in fast mapping and supported learning of new words. This comparison will assist in understanding how word-learning abilities may differ in children who have attended school for at least one year.

A review of the literature (Chapter 1) highlighted that children with SLI present with difficulties in various language domains and that their word-learning deficits may be caused by limited underlying language skills. In particular, research findings identified the importance of phonological and semantic skills on word-learning (Alt, et al., 2004; Gathercole, et al., 1997). Thus, an examination of the relationship between word-learning skills and specific language measures will provide an insight into which language skills may influence word-learning in children with SLI.

This research sought to examine the word-learning skills of school-aged children in New Zealand who have SLI. Specifically, it was hypothesised that:

- The performance of school-aged children with SLI will be inferior to that of age-matched children with typical language development in comprehending and producing new words.

This study further aimed to investigate the relationship between word-learning abilities, age, and performance on language measures. Thus, the following questions were addressed:

1. What is the relationship between oral language measures, vocabulary, phonological awareness skills, semantic abilities, and word-learning; and
2. Which of these measures predict word-learning?

2.2 Methodology

2.2.1 Participants

Following the approval of the University of Canterbury's Human Ethics Committee[1] to conduct this research, 19 children with Specific Language Impairment (SLI) aged between 6;2 and 8;3 years (mean age 85.63 months, SD 6.89 months) were selected to participate in this study. Inclusion criteria were:

1. An average score between 85 and 115 on a standardised nonverbal intelligence test,
2. A score of 1.25 standard deviations below the mean on a standardised broad spectrum language test,
3. No history of neurological, sensory, physical, or intellectual disabilities as reported in the school records, and
4. Articulation within normal limits.

These 19 participants with SLI were matched to 19 children with typical language development who participated as a comparison group. Children were matched for nonverbal IQ, gender, age, and socioeconomic status. All children were monolingual English speakers.

<u>Participants' selection process Phase 1</u>

Teachers of all primary schools in Christchurch, New Zealand (*n*=120) were asked to identify monolingual English speaking children between 6 and 8 years who are struggling to follow classroom instructions, have difficulties expressing their ideas

[1] The University of Canterbury's Human Ethics Committee approved this study given that anonymity of participants and parental permission for entry into the study were followed.

or formulating ideas using grammatically correct sentence structures or use simple vocabulary that is below the expected age level. In New Zealand, formal schooling typically starts at exactly 5 years of age for every child (i.e., children's 5th birthday or the closest school day following their 5th birthday is the child's first day of school). All children who returned a signed consent form as required by the Human Ethics approval process, (*n*=68) were screened in phase 1 on the Test of Nonverbal Intelligence - 3rd Edition (TONI-3; Brown, et al., 1997) and the Recalling Sentences subtest of the Clinical Evaluation of Language Fundamentals - 4th Edition (CELF-4; Semel, Secord, & Wiig, 2006). This subtest examines a child's ability to remember sentences provided to them verbally. Children are required to recall sentences word for word. To be eligible to participate in the study, children were required to score within normal limits on the TONI-3 and receive a standard score below seven on the subtest of the CELF-4.

<u>Participants' selection process Phase 2</u>

In phase 2, all remaining children following phase 1 screening processes (*n*=31) were assessed on the complete CELF-4 core language skills. Children with a standard score of 82 or below (1.25 SD below the mean) on the core language skills of the CELF-4 (*n*=20) were included in this study. These 20 children were then further assessed on a range of standardised and norm-referenced assessments and experimental probes. All assessment measures are discussed below. One child displayed severe articulation deficits and was subsequently excluded from the study, leaving a sample size of 19 children with SLI. The children with SLI attended grades 2 to 4 and were from a range of schools of various decile rankings. In New Zealand, schools are ranked on a decile ranking scale from 1 to 10 according to the proportion of students from low socioeconomic communities. Schools with the lowest percentage of students from low socioeconomic communities are decile ranking 10, whereas schools with the highest percentage are ranked as decile 1 (New Zealand Ministry of Education, 2008).

Comparison group

The 19 participants with SLI were matched to 19 children with typical language development (mean age 84.3 months, SD 6.69 months) who participated as a comparison group. Children from the comparison group were drawn from the same schools as the participants to control for educational environment and community influences. The children were individually matched on gender and for the majority of children on age and nonverbal IQ. It was not possible to individually match four of the children with SLI on age and nonverbal IQ with children with typical language development. Consequently, four children were included in the comparison group based on the group means for age and nonverbal IQ.

2.2.2 Assessment measures

The 38 participants were assessed on a range of standardised and norm referenced assessments as well as experimental probes. All assessments and probes were carried out by the author and were administered individually to each child in a quiet setting at the child's school during school hours.

Standardised assessments

- Test of Nonverbal Intelligence 3rd Edition (TONI-3; Brown, et al., 1997)

  This standardised test assesses cognitive abilities on a nonverbal basis. In this assessment, the participant has to find the matching puzzle pieces to complete sequences of figures. Standard scores are provided for participants aged 6 to 89;11 years. A score between 85 and 115 indicates performance within normal limits.

- Clinical Evaluation of Language Fundamentals 4th Edition (CELF-4; Semel, et al., 2006)

  The CELF-4 is a broad spectrum language test that assesses receptive and expressive language skills of participants aged 5 to 21 years. This standardised assessment consists of three subtests examining receptive and three subtests examining expressive language skills. Standard scores are obtained from the performance on each subtest. A standard score for the core language development is calculated from the standard scores of four subtests. A core language score between 85 and 115 indicates performance within normal limits.

- Peabody Picture Vocabulary Test 4th Edition (PPVT-4; Dunn & Dunn, 2006)

  This standardised assessment is designed to assess a person's receptive vocabulary skills. Participants are required to identify a picture from a choice of four. Standard scores for participants aged 2;6 to over 90 years are provided. Scores between 85 and 115 are considered to be within normal limits.

- Structured Photographic Expressive Language Test 3rd Edition (SPELT-3; Dawson, Stout, & Eyer, 2003)

  This standardised test assesses expressive use of morphology and syntax. Standard scores are provided for children aged 4 to 9;11 years. Scores between 85 and 115 are considered to be within normal limits.

- Queensland University Inventory of Literacy (QUIL; Dodd, et al., 1996)

  This standardised test assesses phonological awareness skills on a range of phonological awareness tasks at the syllable, rhyme, and phoneme level and consists of 10 subtests. Standard scores for children attending grades 1 to 7 are obtained from their performance on each subtest.

- New Zealand Articulation Test (NZAT; Moyle, 2004)

  The NZAT assesses the production of all speech sounds at a single word level. All responses were transcribed via broad transcription. Delayed imitation was utilised to obtain a response from the child, if a spontaneous response could not be elicited by the picture. Standard scores are available for children aged 5 to 7;11 years.

Norm-referenced assessments

- Neale Analysis of Reading Ability 3rd Edition (NARA-3; Neale, 1999)

  The NARA-3 assesses a child's reading accuracy and comprehension of connected text. The child is asked to read stories with gradually increasing levels of difficulty and complexity. After each story the child is asked four to eight comprehension questions about the story. Scores are given in age equivalents for children aged 6 to 12;11 years.

- Burt Word Reading Test New Zealand Revision (BURT; Gilmore, Croft, & Reid, 1981).

  The BURT assesses a child's word recognition at the single word level. The child is asked to read a list of words that are ranked by difficulty until 10 consecutive mistakes are made. Scores are given in age equivalents for children aged 5;10 to 13;3 years.

Experimental measures

Word-learning Probes

To evaluate the word-learning skills of the children, experimental word-learning probes were administered. These experimental probes were adapted from a word-learning paradigm developed by Gray (2005). The word-learning paradigm consisted of three different tasks that were implemented over a period of 5 consecutive days. Day 1 consisted of a fast mapping task. On days 2, 3, and 4 word-learning was examined in a supported learning context (SLC), and on day 5, a word-learning test was administered. A timetable of the word-learning paradigm is displayed in Appendix A. The learning context for the word-learning in this study utilised an explicit instructional approach. For example, on all 5 days, the examiner and the child were sitting at a table and the stimuli were presented and explicitly taught to the children. The word-learning process was introduced to the children on day 1 with these sentences: "I am going to teach you some new words this week. Let's see how quickly you can learn these new words." Procedure protocols for all three word-learning tasks are displayed in Appendix B.

Stimuli

The words that were utilised in the word-learning task were carefully selected and evaluated prior to the commencement of this study. First, a pool of words, which consisted of phonetically regular CV or CC structures within the words, and had an affiliation to relevant school topics (science, art, music, etc.) was generated. Then, pictures were chosen to represent these new words. These 49 pictures were then presented to 10 children aged between 6 and 8 years who were not further involved in this study. All pictures that these children could not identify (n = 32) were selected for the next step. Finally, the remaining pictures were presented to 9 adults. Only pictures that were correctly identified by all adults were chosen for inclusion. This left a sample of 27 words as word-learning items. All items were printed in colour on an A6 laminated card.

The 27 selected words for the word-learning task were separated into three sets of nine words each. The word-learning items were balanced across each set according to affiliation (science, food, art), number of syllables, and phonotactic probability. The latter was calculated for phoneme and biphone probability using a phonotactic probability calculator (Vitevitch & Luce, 2004). Phoneme probability refers to the probability for each phoneme to occur in a specific position of a word and biphone probability refers to the probability of the two neighbouring phonemes to occur within a word. There were no significant differences between the three sets on affiliation, number of syllables, phonotactic probability, and biphone probability. All word-learning probes were administered in random sequence on each day and all sets were equally balanced across the participants (e.g., 1/3 of the participants learned set 1, another 1/3 learned set 2 and another 1/3 learned set 3). Appendix C displays the sets of words utilised in the word-learning probes.

Day 1: Fast mapping

Day 1 consisted of a fast mapping task (FM) where the examiner introduced children to the nine unfamiliar words (e.g., “This is compass, this is protractor, etc”). After each word was named once to the child, a comprehension probe (e.g., “Where is compass?”) and a production probe (“What is this?”) of all nine items was administered. This process was repeated three times in succession, resulting in three receptive and expressive responses for each word on day 1. As a set consisted of nine novel words, there were 27 possible correct answers for comprehension and production each on the FM task.

Days 2 – 4: Word-learning

Days 2 to 4 are referred to as the 'word-learning days' (WL). During that period, the children were exposed to the same words as in the FM task on day 1. This time however, the words were presented in a SLC. That is, additional cues and feedback were provided, the examiner provided a number of models of the new words, and children were asked to repeat the presented word after the examiner's model. Again, after each word has been demonstrated to the child, a comprehension and production probe was administered. This entire procedure was repeated three times successively, with an additional comprehension and production probe resulting in four receptive and expressive responses for each word on days 2 to 4. Feedback on the responses was provided for each child. As a word-learning set consisted of nine novel words, there were 36 possible correct answers for comprehension and production each.

Day 5: Word-learning test

On day 5, a word-learning test (WLTest) was administered consisting of a comprehension, recognition, and production probe for each novel word. Children were first asked to name the nine novel words in the production probe. This was followed by the recognition probe where children had to identify the correct name for each item out of a choice of four orally presented names: one was the correct name and the three other ones were distracter names. These three distracter names were equally composed for each novel word: 1) was the correct name with a changed initial sound of a different sound category (e.g., fricative => stop, liquid => fricative, etc), 2) was a different word out of the same set, and 3) was one completely different novel word with a similar word structure as the target word. The pictures and all four name options were always presented in random order to all children. Finally, in the comprehension task children were asked to point to the correct picture when presented with the name. As there were nine words in each set, there was a maximum score of nine correct answers for each subtest. Appendix D displays the WLTest protocols.

Phonological Awareness Probes (PA Probes; Stahl & Murray, 1994)

These experimental tasks measure a range of phonological awareness skills at the phoneme level and were utilised to measure the participants' phonological awareness skills. The tasks include: phoneme blending, phoneme isolation, phoneme segmentation, and phoneme deletion. The phoneme blending task requires a child to blend 3 – 4 single phonemes to a word ("Guess what word I am saying: *sh-ee-p*."), in the phoneme isolation task children have to isolate the initial or final phoneme from words in CV, VC, or CC structures ("Tell me the sound that you hear at the beginning of *ship*."), in the phoneme segmentation task children need to segment CVC, CCVC, and CVCC words into all its phonemes ("Tell me all the sounds you hear in *fish*."), and the phoneme deletion task requires children to delete the initial or final phoneme of words in CV/VC as well as CC combinations ("Say *make* without *m*."). Each task was introduced as described by the authors and practice items were provided prior to testing. All responses were recorded online and scored after data collection. Scores were given for each correct answer as described.

Non-word Reading Probes (NWR Probes; Calder, 1992)

These reading probes consist of a set of 30 single syllabic non-words with typical English and phonetically regular CV, CVC, and CCVC structures. Each word is individually presented to the participants. Scores are given for correctly decoded words and phonemes. The NWR Probes were included to assess whether children were utilising decoding skills when reading unfamiliar words.

Semantic Probes

The Semantic Probes were selected by the author to assess the children's semantic skills. These experimental probes consisted of a range of semantic tasks including: word generation, word description, relational vocabulary, and word associations. The word generation task requires a child to think of 3 items that share a particular semantic feature (e.g., "name three things that are sweet", "name three things that can swim"). A catalogue of all answers was compiled following data collection and answers were divided into acceptable and unacceptable answers by a team of speech therapists including native New Zealand speakers. Answers classified as unacceptable included incorrect answers (e.g., "salt is something that is sweet"), descriptions (e.g., "you put pictures on it"), and responses where the particular semantic feature was not intrinsic to the item (e.g., "T-shirts are yellow", "decorations are made out of paper"). Scores were given for three correct answers per question.

The word description and the relational vocabulary task consist of selected items from the subtests 'Oral Vocabulary' and 'Relational Vocabulary' of the Test of Language Development 3rd Edition (TOLD-3, Newcomer & Hammil, 1997). To maintain the assessment format, but to reduce the assessment load, questions were randomly selected across a range of difficulty levels. However, items where the vocabulary was culturally not applicable to New Zealand children's vocabulary were excluded prior to the selection (e.g., penny, dime, faucet). Twenty of the 28 items from the 'Oral Vocabulary' subtest, and 15 of the 30 items from the 'Relational Vocabulary' subtest were selected for the probes. Both tasks were introduced to the participants and scored as described in the examiner's manual.

The word associations task is based on the 'Associations' task of The Word Kit (Huisingh, Barrett, Zachmann, Blagden, & Orman, 1988). The Word Kit is a training programme developed to enhance children's expressive vocabulary and semantic skills. For the word associations task, 10 out of the 50 training cards were selected across a range of difficulty levels. As in the selection of the prior tasks, items where the vocabulary was culturally not applicable to New Zealand children's vocabulary were excluded prior to the selection. Each card depicts four different pictures where three are semantically related to each other and one was not. In the word association task, children were presented with those cards, had to identify the odd one out and then had to explain why it didn't belong to the other pictures. Again, a catalogue of all explanations was compiled following data collection and answers were divided into acceptable and unacceptable explanations by the same team of speech therapists as mentioned before. Scores were given for each correctly identified picture and for each correct explanation. Practice items were provided for all four tasks.

2.2.3 Assessment order

Children were first assessed on the standardised and norm-referenced tests and the experimental probes. The order of the assessments and probes was randomised where possible. That is, in participants' selection phase 1, the assessment order of the

TONI-3 and the recalling sentences subtest of the CELF-4 was alternated, whereas in participants' selection phase 2, the remaining subtests of the CELF-4 were administered in the proposed order. The remaining tests and experimental probes of the assessment battery were administered in random order over several sessions for each child. Finally, the word-learning probes were administered on five consecutive days as described. All children were assessed on varying times during school hours to avoid time effects that might influence children's performances.

2.2.4 Reliability

For transcription and reliability purposes, all assessments were recorded on a digital voice recorder (Panasonic; RR-US050). The author administered, transcribed, and scored all assessments and assessment probes. All standardised and norm referenced tests were administered and scored according to the examiner's manual. The experimental probes were administered and scored as described in the protocols. An independent researcher checked 25% of all assessment data on three levels: administration, transcription, and scoring. Inter-rater agreement on administration and scoring of the standardised assessments was 100% and 97.6%, respectively and on administration and scoring of the norm referenced tests was 100% and 99.7%, respectively. For the PA, NWR, and Semantic Probes, inter-rater agreement on administration was always 100% and point-to-point inter-rater agreement for scoring was 99.5% (92.5% – 100%). Point-to-point inter-rater reliability for administration of the word-learning probes was 99.2% (98.5% - 99.8%) and for scoring was 100%.

Any inter-rater discrepancies regarding the transcription were resolved by consensus after repeated listening to the audio files. Prior to data entry, the author rechecked all data and any errors were corrected.

2.3 Results

Unpaired t-tests were conducted to evaluate group differences on the performances of the children with SLI and the children with typical language development. Effect sizes for all statistically significant differences were calculated by utilising the effect size index Cohen's d with the conventional values of small d = 0.2, medium d = 0.5 and large d = 0.8. An alpha level of .03 was utilised for all word-learning analyses (Sheskin, 1997) and an alpha level of .05 for all remaining statistical analyses (Portney & Watkins, 2000). Post hoc Bonferroni adjustments were utilised for multiple comparisons.

Pearson correlation analyses were conducted to evaluate the relationship between word-learning and other language measures. Best subsets regression analyses were used to determine which measure predicted word-learning. All data analyses were conducted using the computer programme SPSS 17.0. Raw scores were utilised for data evaluation of the experimental probes and the norm referenced assessments.

2.3.1 Group comparisons

Group comparison on standardised assessments

Performances of the children with SLI and the children with typical language development were compared on the standardised tests. For data analyses, age was converted into months and standard scores were utilised for the performance on the assessments.

There were no significant differences in age and nonverbal IQ between the comparison group and the children with SLI. However, children with typical language development scored significantly higher than children with SLI on the PPVT-4, the CELF-4, and the SPELT-3, with $p < .001$, and on the Non-word Reading, Syllable Identification, Phoneme Manipulation, and Spoonerisms subtests of the QUIL with $p < .006$ following the Bonferroni adjustment. There were no significant group differences on the QUIL subtests Rhyme Recognition, Phoneme Segmentation, Syllable Segmentation, Phoneme Deletion, and Non-word Spelling. Table 2.1 displays participants' performance on selected standardised assessments.

Table 2.1. Participants' performance on standardised assessments

	Comparison Group (*n*=19)		SLI Group (*n*=19)				
	Mean	SD	Mean	SD	*t*	*p*	*d*
Age	84.7	6.5	84.6	6.8	.049	.961	0
TONI-3	95	7	94	5.2	.475	.638	.16
PPVT-4	105	7.9	86	7.1	7.762	<.001**	2.48
CELF-4	97.2	6	71.7	6.3	12.527	<.001**	4.06
SPELT-3	105.8	6.8	88.8	7.5	7.336	<.001**	2.32
Q-NWS	6.5	2.6	4.8	1	2.696	.013	.84
Q-NWR	6.8	2.3	4.8	1.7	3.103	.004*	.97
Q-SID	8.7	2.8	5.4	2.8	3.722	.001*	1.15
Q-SS	8.5	3.3	6.1	3	2.361	.024	.75
Q-RR	6.4	3.1	4.7	3.2	1.650	.108	.53
Q-S	9.4	3.2	6	1.5	4.104	<.001**	1.33
Q-PD	7	3	4.9	2.2	2.494	.017	.78
Q-PS	9.1	3.6	7.3	2.4	1.817	.079	.58
Q-PM	7	3.4	4	1.3	3.596	.001*	1.14

Note. SLI, Specific Language Impairment; Age in months; TONI-3, Test Of Nonverbal Intelligence 3rd Edition standard scores; PPVT-4, Peabody Picture Vocabulary test 4th Edition standard scores; CELF-4, Clinical Evaluation of Language Fundamentals 4th Edition standard scores; SPELT-3, Structured Photographic Expressive Language Test 3rd Edition standard scores; Q, Queensland University Inventory of Literacy; NWS, Non-Word Spelling subtest; NWR, Non-Word Reading subtest; SID, Syllable Identity subtest; SS, Syllable Segmentation subtest; RR, Rhyme Recognition subtest; S, Spoonerisms subtest; PD, Phoneme Detection subtest; PS, Phoneme Segmentation subtest; PM, Phoneme Manipulation subtest; * Significant group difference at the level of $p < .006$; ** Significant group difference at the level of $p < .001$.

Group comparison on norm referenced assessments

All reading measures were norm referenced tests, providing age equivalence scores for reading performance. For data analyses, raw scores were utilised to compare group performances. Children with SLI scored significantly lower on all reading measures than the children with typical language development. Table 2.2 displays the participants' performance on these norm referenced reading assessments.

Table 2.2. Participants' performance on reading assessments

	Comparison Group (*n*=19)		SLI Group (*n*=19)				
	Mean	SD	Mean	SD	*t*	*p*	*d*
NARA-3 Acc	24.1	14.6	9.7	6.6	3.916	.001*	1.24
NARA-3 Com	9.1	4.7	3.3	2	4.918	<.001**	1.57
BURT	35.8	16.7	15.7	8.9	4.626	<.001**	1.47

Note. SLI, Specific Language Impairment; NARA-3, The Neale Analysis of Reading Ability 3rd Edition; Acc, Reading Accuracy raw scores; Com, Reading Comprehension raw scores; BURT, Burt Word Reading Test New Zealand Revision raw scores; * Significant group difference at the level of $p < .05$; ** Significant group difference at the level of $p < .001$.

Group comparison on word-learning probes

For analyses purposes, performances on all word-learning probes were separated into the three components of the word-learning paradigm: Fast mapping (FM; day 1), word-learning (WL; days 2 to 4) and word-learning test (WLTest; day 5). For FM and WL, scores were given for correct answers on comprehension and production of each new word. Recognition abilities were additionally assessed in the WLTest.

Fast Mapping

The FM task consisted of three repetitive phases where a comprehension and production probe for each word was administered in each phase. As each word-learning set consisted of nine novel words, there was a maximum of 27 possible correct answers for comprehension and production each. Analyses revealed that children with typical language development significantly outperformed the children with SLI on comprehension, $t(30.4) = 2.76$, $p = .01$, and production, $t(21.7) = 4.564$, $p < 0.001$, of the new words on the FM task.

Word-Learning

Children's word-learning abilities were assessed on days 2, 3, and 4. Over these 3 days, children were presented with the same items as in the FM task with additional cues. On each day, there were four comprehension and production trials for each word. As each word-learning set consisted of nine novel words, there was a maximum of 36 possible correct answers for comprehension and production each. For analyses purposes, these word-learning days (days 2 to 4) will be referred to as WL1, WL2, and WL3, respectively.

WL Comprehension

There was a significant group difference between the performance of the children with SLI and the children in the comparison group on WL1, $t(36) = 2.89$, $p = .006$, with the children in the comparison group scoring significantly higher than the children with SLI. However, there was no significant difference between the comparison group and the SLI group on WL2, $t(36) = 1.89$, $p = .067$, and WL3, $t(36) = 1.853$, $p = .072$.

WL Production

Analyses revealed that children with SLI scored significantly lower on all 3 word-learning days than the children with typical language development. There were significant group differences on WL1, $t(30.1) = 6.006$, $p < .001$, WL2, $t(36) = 5.166$, $p < .001$, and WL3, $t(33) = 4.807$, $p < .001$, on the production probes of the word-learning days.

Word Learning Test

The WLTest assessed the learning abilities of the new words on three different levels: comprehension, recognition, and production. Independent t-tests revealed that the children in the comparison group scored significantly higher on the production, $t(32.7) = 5.268$, $p < .001$, and the recognition probes, $t(22.1) = 2.486$, $p = .021$, of the WLTest than the children with SLI. There were no significant differences between the groups on the comprehension probe of the WLTest, $t(36) = .97$, $p = .338$, where both groups almost reached ceiling for this task (Comparison group: $M = 8.8$, $SD = .7$; SLI group: $M = 8.6$, $SD = 1$). Performance of participants on comprehension and production of new words are displayed in Figures 2.1 and 2.2, respectively.

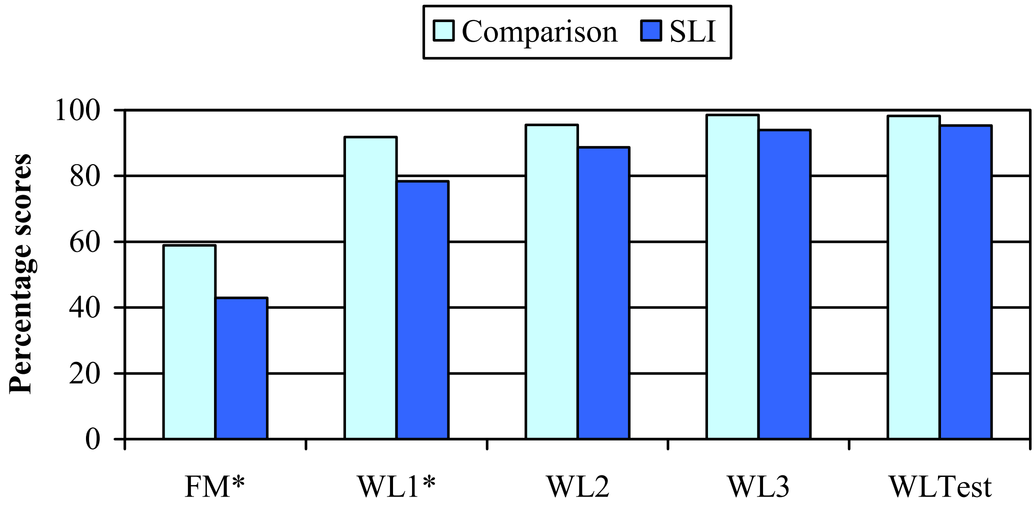

Figure 2.1. Performance of participants on comprehension of new words in percentage scores.
*** indicates significant group difference at the level of *p* < .03.**

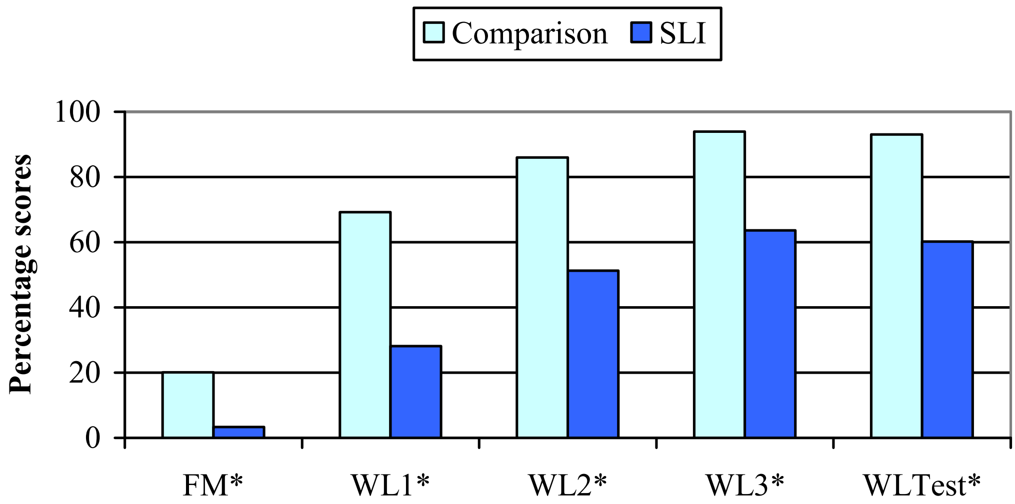

Figure 2.2. Performance of participants on production of new words in percentage scores.
*** indicates significant group difference at the level of *p* < .03.**

The results of the word-learning probes demonstrated that children with typical language development performed near ceiling on almost all comprehension tasks, and on the last 3 days of the word-learning paradigm on the production tasks. Data analysis using the Kolmogorov-Smirnov Test revealed that most of the variables for the children in the comparison group were not normally distributed. Thus, all word-learning data was re-analysed utilising the non-parametric Mann-Whitney test. The analyses using the Mann-Whitney test demonstrated the same significant group differences as reported earlier. As the t-test is generally quite robust for departures from normality (Conover, 1999) and as the significance levels were not marginal with $p < .03$ (Sheskin, 1997), the author decided to report the results from the t-tests.

Group comparison on PA, Semantic, and NWR measures

Raw scores were utilised for all data analyses of the experimental probes. There were significant group differences ($p < .05$) on all measures with the children with typical language development scoring significantly higher than the children with SLI on all experimental probes. Table 2.3 displays the participants' performance on all experimental probes in percentage scores.

Table 2.3. Participants' performance on the experimental probes.

	Comparison Group (n=19)		SLI Group (n=19)				
	Mean	SD	Mean	SD	t	p	d
PA-PB	69.1	25.1	33	30.3	4.009	<.001**	1.27
PA-PI	82.9	20	64.2	18.7	2.971	.005*	.95
PA-PS	34.4	20.4	15.4	15.9	3.195	.003*	1.02
PA-PD	61.3	25.9	27.1	23.6	4.255	<.001**	1.35
NWR-W	40.5	25.8	9.8	16.3	4.378	<.001**	1.39
NWR-P	58.5	26.1	23	20.3	4.716	<.001**	1.49
Sem-G	53.3	20.7	34.74	14	3.242	.003*	1.03
Sem-WD	43.9	23.7	17.1	11.9	4.406	<.001**	1.40
Sem-RV	39.3	15.1	17.9	11.1	4.984	<.001**	1.58
Sem-WA	77.6	14.4	61.1	13.7	3.639	.001*	1.15

Note. SLI, Specific Language Impairment; PA, Phonological Awareness Probes percentage scores; PB, Phoneme Blending subtest; PI, Phoneme Isolation subtest; PS Phoneme Segmentation subtest; PD, Phoneme Deletion subtest; NWR-W, Non-Word Reading Probes percentage scores for words correct; NWR-P, Non-Word Reading Probes percentage scores for phonemes correct; Sem, Semantic Probes percentage scores; G, Generation subtest; WD, Word Description subtest; RV, Relational Vocabulary subtest; WA, Word Association subtest; * Significant group difference at the level of $p < .05$; ** Significant group difference at the level of $p < .001$.

2.3.2 *Relationship between word-learning and language measures*

Partial correlation analyses controlling for children's age were conducted to evaluate the relationship between the performance on all word-learning tasks (FM, WL1-3, and WL test) and on the PA Probes, the Semantic Probes, the CELF-4, and the PPVT-4. For data reduction purposes, all four subtests of the PA Probes were summarised as the PA measure, and all four subtests of the Semantic Probes were summarised as the semantic measure. Furthermore, word-learning scores from WL1-3 were converted into a composite score for 'WL Production' and for 'WL Comprehension'. The composite scores were based on the criteria of having learned a new word. A word was considered 'learned' when the child was able to correctly answer three out of four trials on 2 consecutive WL days (WL1, WL2, and WL3) for comprehension and production each (Gray, 2003b).

Correlations for performances of children in the comparison group and children with SLI are presented in Tables 2.4 and 2.5, respectively. For the children in the comparison group, 10 out of the 15 correlations among the word-learning tasks were significantly correlated. Additionally, performance on the phonological awareness probes was significantly correlated with WL and WLTest for both, comprehension and production. Performances on FM Production were significantly correlated to the performances on the Semantic Probes and the CELF-4 for children in the comparison group. For children in the SLI group, only 7 out of the 15 correlations among the word-learning tasks were significantly correlated. There were no further significant correlations for the children in the SLI group.

Multiple regression analyses were conducted to further evaluate the relationship between word-learning and language measures. Best subsets regression analyses were utilised to determine which variables or combination of variables predicted FM and word-learning (WL). Performance on the PPVT-4, the CELF-4, the PA probes, the semantic probes, and age in months were entered as the predictor variables and FM and WL were the dependent variables. Only variables that reached a significance level of $p < .05$ were entered into the models. No variables predicted FM Comprehension or FM Production for children with SLI.

For the comparison group, the most parsimonious model for predicting FM Comprehension was performance on the PPVT-4 and Semantic Probes, which accounted for 37.7% of the variance, and for predicting FM Production was performance on Semantic Probes, which accounted for 55.7% of the variance. Best subsets models for WL (composite scores for learned new words) are presented in Table 2.6 for WL Comprehension and WL Production. For children with SLI, no variables predicted WL Comprehension.

Table 2.4. Partial correlations (*r*) controlling for age for children in the comparison group

Comparison group (n = 19)	1	2	3	4	5	6	7	8	9	10
1. PPVT-4	—	.531*	.580*	-.102	-.253	.017	.190	.217	.075	.113
2. CELF-4		—	.443	.218	-.055	-.007	.066	.473*	.073	.132
3. Semantic Probes			—	.077	.294	.195	.285	.712*	.457	.352
4. PA Probes				—	.318	.733*	.555*	.374	.574*	.726*
5. FM Comprehension					—	.508*	.330	.598*	.675*	.461
6. WL Comprehension						—	.891**	.276	.777**	.940**
7. WLTest Comprehension							—	.148	.586*	.904**
8. FM Production								—	.609*	.366
9. WL Production									—	.830**
10. WLTest Production										—

Note. PPVT, Peabody Picture Vocabulary test 4th Edition; CELF, Clinical Evaluation of Language Fundamentals 4th Edition standard scores; PA Probes, Phonological Awareness Probes; FM, Fast Mapping; WL, Word-learning composite score; WLTest, Word-learning Test; * for $p < .05$; ** for $p < .001$.

Table 2.5. Partial correlations (*r*) controlling for age for children in the SLI group

SLI group (n = 19)	1	2	3	4	5	6	7	8	9	10
1. PPVT-4	—	.562*	.534*	-.002	-.017	.099	.113	.271	.258	.078
2. CELF-4		—	.552*	-.027	.025	.235	.257	.094	.161	.037
3. Semantic Probes			—	.179	-.168	-.009	.135	.206	.041	-.043
4. PA Probes				—	.199	-.016	.083	.354	.204	.451
5. FM Comprehension					—	.366	.116	.346	.584*	.398
6. WL Comprehension						—	.507*	.357	.769**	.528*
7. WLTest Comprehension							—	.196	.413	.481*
8. FM Production								—	.520*	.334
9. WL Production									—	.741**
10. WLTest Production										—

Note. SLI, Specific Language Impairment; PPVT, Peabody Picture Vocabulary test 4th Edition; CELF, Clinical Evaluation of Language Fundamentals 4th Edition standard scores; PA Probes, Phonological Awareness Probes; FM, Fast Mapping; WL, Word-learning composite score; WLTest, Word-learning Test; * for $p < .05$; ** for $p < .001$.

Table 2.6. Best subsets regression analyses for WL Comprehension and WL Production

Variables	R^2	Adj R^2	*p*
Comparison group on WL Comprehension			
Model 1	**.465**	**.433**	
PA Probes			**.001**
Model 2	**.625**	**.577**	
Age (months)			**.004**
PA Probes			**.019**
Comparison group on WL Production			
Model 1	**.537**	**.510**	
FM Comprehension			**<.001**
Model 2	**.640**	**.595**	
PA Probes			**.048**
FM Comprehension			**.001**
Model 3	**.731**	**.677**	
Semantic Probes			**.040**
PA Probes			**.025**
FM Comprehension			**.007**
SLI group on WL Production			
Model 1	**.369**	**.332**	**.006**
FM Comprehension			
Model 2	**.524**	**.464**	
FM Comprehension			**.014**
FM Production			**.037**

Note. WL, Word-learning composite scores; PA, Phonological awareness; FM, Fast mapping; Adj R^2, adjusted R square value.

2.4 Discussion

In this study, the word-learning skills of children with SLI were compared to the skills of age-matched children with typical language development. Children's word-learning skills were examined over a period of 5 days utilising a fast mapping task (day 1), word-learning in a supported learning context (days 2, 3, and 4), and a word-learning test (day 5).

Consistent with prior research, the analyses in the current study demonstrated significant differences between the children with SLI and the children with typical language development on comprehension and production of novel words (Alt, et al., 2004; Gray, 2003a, 2004, 2005; Nash & Donaldson, 2005; Rice, et al., 1990; Riches, et al., 2005). Children with typical language development performed significantly better on the word-learning tasks than children with SLI. Results from this current research revealed that children with SLI performed significantly lower on comprehending new words on the initial two days of the word-learning paradigm. However, on days 3, 4, and 5 children with SLI caught up with their performance on comprehension of novel words to the performance of children with typical language development. This suggests that children with SLI require more exposure to new words than children without SLI before succeeding in a comprehension task. These 'catching-up' skills were not observed for production of new words in children with SLI. Even after 5 days of exposure to the novel words, children with SLI were not able to approach the performance levels of children without SLI. This significant deficit on production of new words has been observed by previous researchers (Gathercole, 1993; Gray, 2004) and emphasises the importance of effective interventions to facilitate the production of new words in children with SLI.

The findings further revealed that children with typical language development almost reached ceiling on learning to comprehend new words on word-learning days 1, 2, 3, and on word-learning test and on production of new words on the last 2 days of the word-learning paradigm. This suggests that the word-learning task was too easy for children with typical language development as most of them were able to receptively learn all nine new words after one day of exposure and to produce all words after 3 days.

The second part of this study examined the correlation of the word-learning tasks (FM, WL, and WLTest) and language measures (PPVT-4, CELF-4, PA Probes, and Semantic Probes) and which variables predicted performance on word-learning. Analyses revealed that for children with typical language development, WL and WLTest were significantly correlated to performance on the PA Probes, whereas FM Production was significantly correlated to performance on the Semantic Probes and the CELF-4. However, for the children with SLI, there were no significant correlations between any language measure and the word-learning tasks.

Multiple regression analyses demonstrated that for the SLI group, no variables appeared to predict FM Comprehension, FM Production, and WL Comprehension, and the best predictors for WL Production were performances on both FM tasks. In contrast, for the comparison group the word-learning tasks were predicted by a range of variables. Performance on the Semantic Probes predicted 55.7% of the variance for FM Production and combined with the PPVT-4 score predicted 37.7% of the variance for FM Comprehension. Performance on the PA Probes significantly explained 43.3% of the variance for WL Comprehension and combined with FM Comprehension scores predicted 59.5% of the variance for WL Production. Commensurate with similar research, FM Comprehension was the best predictor for performance on WL

Production for both groups (Gray, 2003b). The findings of the current study indicate that word-learning in children with typical language development is largely influenced by prior language abilities. However, different language abilities appear to influence different word-learning tasks. Thus, semantic skills appear to influence fast mapping skills, whereas phonological awareness skills appear to influence word-learning. Nevertheless, as performances of children with SLI did not display any correlation between word-learning and other language measures, it can be concluded that children with SLI cannot depend on underlying language skills when learning new words. This is not surprising considering that as a group, children with SLI performed significantly lower on almost all language assessments and therefore only have a limited pool of language abilities available to generate from.

In summary, children with SLI are a heterogeneous group varying in presentation of affected language domains and the severity of difficulties in each child. Nevertheless, as a group, they scored significantly lower on almost all assessment measures compared to children with typical language development in this study. Findings demonstrated that children with SLI present with a range of language deficits, including difficulties with word-learning, vocabulary, grammar, semantics, phonological awareness, and reading. Given that the children in this study had attended school for at least 1 year and had received a strong national curriculum in language and literacy, the performances on the various language measures demonstrated that children with SLI were not able to catch up with their peers solely based on classroom instructions. Rather, the data suggest, that these children require specific support targeting their language weaknesses.

The broad language deficits children with SLI are experiencing highlight the necessity of careful intervention planning. For school-age children, it may be more beneficial to enhance vocabulary and phonological awareness at the phoneme level as these are crucial skills for reading development. In consideration of a preventative framework, it is crucial to facilitate underlying skills for reading as reading is an essential skill for later academic success. The lower scores of children with SLI on all reading measures compared to children in the comparison group indicated that they are at risk of future academic failure. This is especially concerning as some of the older children in this study were theoretically in transition from the learning-to-read stage to the reading-to-learn stage (Catts & Kamhi, 2005; Chall, 1983).

The findings of this study indicated that children with SLI were not using underlying language skills for word-learning, most likely because of limitations in these areas. In order to understand what underlying skills or strategies children with SLI may employ during word-learning, a qualitative analysis of children's responses may be more informative. This will be addressed in the following chapter.

CHAPTER 3

NAMING ERRORS IN WORD-LEARNING OF CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

3.1 Introduction

In the previous chapter, the quantitative differences during word-learning of children with Specific Language Impairment (SLI) compared to children with typical language development were investigated. Findings revealed that the children with typical language development outperformed children with SLI when learning new words. The results furthermore demonstrated that there were no correlations between any word-learning task and the assessed language measures (i.e., semantic, phonological awareness, receptive vocabulary, and overall language measures) in children with SLI, whereas for children with typical language development, fast mapping was significantly correlated to semantic skills and word-learning and word-learning test to phonological awareness skills. Thus, as children with SLI appear to not being able to utilise underlying language skills when learning new words, an analysis of their error pattern when attempting to learn new words may provide insight into the strategies used by children with SLI.

An analysis of naming errors during a word-learning task by Nash and Donaldson (2005) revealed that children with SLI mainly presented with semantic errors (67%), followed by miscellaneous (28%) and phonological errors (5%). After repeated exposure, children with SLI demonstrated the same order of error distribution, however, the frequency of displayed errors changed to a more even spread across all three error types. In contrast, age-matched children with typical language development produced more miscellaneous (49%) errors, followed by semantic (31%) and phonological errors (20%), whereas the order of the latter two error types changed after repeated exposure to the new words. At the same time, children with typical language development demonstrated a relatively even distribution of miscellaneous, phonological, and semantic errors.

On the contrary, McGregor, Newman, et al. (2002) as well as Lahey and Edwards (1999) found that children with and without SLI present with the same error patterns during a naming task, with semantic errors as the most frequent error type followed by indeterminate and phonological errors. However, the researchers did not utilise a word-learning task, but assessed children's representations of objects that were low in frequency of occurrence in the children's age-group. These findings suggest that children generally may tend to utilise semantic knowledge when experiencing difficulties retrieving a word from long-term storage as it was assessed in the latter two studies. Nevertheless, when learning new words, children with and without SLI appear to employ different strategies as demonstrated in the error analysis by Nash and Donaldson (2005). In the current chapter, the qualitative differences between children with and without SLI were examined by specifically exploring whether children with SLI displayed the same word error pattern as children with typical language development when naming new words during word-learning.

In the second section of this study, it was investigated whether there were other factors besides group that influenced word-learning outcomes in children with SLI and typical language development. In particular, it was examined whether there were certain word-specific features, namely number of syllables, affiliation, and phoneme and biphone probability, which facilitated the acquisition of the words and whether the teaching condition influenced word-learning.

Storkel (2001, 2003) examined the influences of phonotactic probability on word-learning in young children with typical language development. Phonotactic probability refers to the probability for a phoneme to occur in a specific position of a word or the probability of sequences of phonemes to occur within a word. Findings revealed that children learned new words with high phonotactic probability, i.e., words with common phoneme sequences, more easily than words that consisted of uncommon phonemes sequences. As children with SLI often present with deficits in their phonological skills (e.g., Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990), it is important to examine whether phonotactic probability influences word-learning outcomes in children with SLI to the same degree and whether there are differences between the performances of children with and without SLI. Furthermore, the length of words may also influence word-learning in children with SLI as the children appear to present with difficulties in repeating longer non-words than short non-words (Dollaghan & Campbell, 1998). Thus, difficulties in being able to store longer words in short-term memory for instant repetition may also impact on the learning of new words. This aspect was also addressed in the current study.

Teaching condition of the novel words also appears to influence word-learning in children with SLI (Gray, 2005). Gray found that children with SLI learned to comprehend more words that were presented with semantic cues, whereas they learned to produce more words that were presented with phonological cues. Thus, word-learning may be accelerated in children with SLI by providing the according cues. The researcher concluded that a combination of phonological and semantic cues may facilitate word-learning more than the individual cues. The study in this chapter addresses this suggestion by examining whether phonological cues, semantic cues, or a combination of phonological and semantic cues influenced word-learning outcomes in children with and without SLI.

The followings questions will be addressed in this chapter:

1. Do children with SLI display the same error pattern as children with typical language development when learning new words,
2. Do the word-specific features number of syllables, affiliation, and phoneme and biphone probability influence word-learning for school-aged children with and without SLI, and
3. Does the condition in which new words are presented influence word-learning outcomes?

3.2 Method

3.2.1 Participants

The participants for this study included the same 19 children with SLI (mean age 85.63 months, SD 6.89 months) and 19 children with typical language development (mean age 84.3 months, SD 6.69 months) described in Chapter 2.

3.2.2 Procedure

Data Collection

The word-learning abilities of all children were assessed utilising the word-learning probes described in Chapter 2.

Assignment and distribution of groups

For word-learning, the children with SLI were randomly separated into three groups. Each group learned the same set. Consequently, six children were presented with set 1, six children were presented with items in set 2, and seven children were presented with the stimuli in set 3. The children in the comparison group were exposed to the same set as their individual match. During the word-learning probes, all word-learning items were administered in random sequence on each day for each child.

Word-learning Cues

During the word-learning probes, children were provided with additional cues to support the learning of the new words. Each word was presented along with two different cues. These cues were generated prior to the commencement of the study, and were based on Gray's (2005) word-learning paradigm that employed phonological and semantic cues to assist children's word-learning. The utilised cues in the present study were either two semantic cues (condition SS: super-ordinate and attribute), two phonological cues (condition PP: initial phoneme and number of syllables), or one of each (condition PS: initial phoneme and super-ordinate). The distribution of cues was systematically varied within each set. Firstly, items within each set were divided into three 3-word subsets which were largely equivalent in number of syllables. Then, each subset was assigned a different combination of cues (i.e., two phonological cues, two semantic cues, or one of each). Thus, within each set, there were three different conditions (PP, SS, and PS): one per subset. The assignment of cues was then counterbalanced within and across all sets. For example, in condition PP, 'compass' was introduced with two phonological cues, in condition SS, 'compass' was presented with two semantic cues and in condition PS, 'compass' was introduced with one phonological and one semantic cue. Appendix E displays a list of all items with the cues by set 1, 2, and 3 and their subsets.

Data Analyses

In order to describe the differences in the erroneous responses of all children, to evaluate the influencing features of the utilised word-learning stimuli on learning outcomes, and to examine the influences of word-learning conditions, analyses were carried out in three different stages. First, an error analysis was conducted to determine differences in the responses of children with SLI and children with typical language development. Then, an item analysis was conducted to evaluate whether there were differences across all word-learning items and whether there was an effect influencing whether specific words were learned. Finally, it was evaluated whether cueing influenced the word-learning outcomes, i.e., whether a certain combination of cues facilitated children's word-learning abilities.

Error analysis

For the error analysis, all responses of the children on production of the new words were coded according to error type. Error types were differentiated into phonological errors, semantic errors, substitutions, random answers, and 'don't know' answers. These error types were furthermore distinguished into subtypes of errors according to the responses of the children.

There were three kinds of phonological errors:

- children named only the initial sound of the target words (equivalent to phonological cue 1),
- children named the number of syllables of the target word (equivalent to phonological cue 2), and
- children named a word that was phonologically similar to the target word (e.g., 'compost' for 'compass').

The four semantic error types were:

- children named the superordinate of the target word (equivalent to semantic cue 1),
- children named the attribute (equivalent to semantic cue 2),
- children described the function or appearance of the target word (e.g., 'it is oval' for 'sapphire'), and
- children named a co-ordinate (e.g., 'ruler' for 'protractor').

Responses of children who substituted the target with a word from the same set were distinguished between:

- naming a wrong item with phonological errors (e.g., ‘projector’ instead of protractor for ‘amphora’) or
- naming a wrong item (e.g., ‘rhombus’ for ‘scalpel’).

Random error types were given for responses that were not semantically or phonologically related to the target. The last error type constituted of the responses when children specifically said ‘don’t know’. Table 3.1 presents the coding for the responses according to error types.

Item analysis

The responses of all children on the word-learning probes were computed for each word individually. Data evaluation was separated for children with SLI and children in the comparison group. Comprehension and production of the new words was separately scored on FM, WL, and WLTest. For FM and WLTest, each correct response was counted and percentage scores for each word were computed. Percentage scores for WL were calculated by adding the number of children who ‘learned’ a word and dividing the sum by the amount of children who were exposed to the same word. The criterion for ‘learned’ was that a child had to correctly respond to three out of four trials on 2 consecutive days.

Additional information for each word included number of syllables, affiliation, as well as phoneme and biphone probability. Affiliation for each word was coded into the following: 1 = science, 2 = arts/music, 3 = food.

Table 3.1. Coding of responses according to error type

Code	Error type	Response
0	No error	Correct response
1	Phonological errors	Initial phoneme of target (cue 1)
2	Phonological errors	Syllables of target (cue 2)
3	Phonological errors	Phonologically similar word to target
4	Semantic errors	Superordinate of target (cue 1)
5	Semantic errors	Attribute of target (cue 2)
6	Semantic errors	Description of target
7	Semantic errors	Coordinate of target
8	Substitutions	Wrong item from same set
38	Substitutions	Wrong item from same set with phonological error
9	Random	Unrelated item
10	Don’t know	‘don’t know’

Response to cues

In order to evaluate whether a certain combination of cues facilitated word-learning in children with and without SLI, responses were divided by teaching condition PP, SS, or PS. Condition PP consisted of the two phonological cues, condition SS of two semantic cues, and condition PS of one phonological and one semantic cue. Comprehension and production scores were separately computed for WL and WLTest. Scores for WL were accounted according to the 'learned' criterion. Effects of cues on FM was not analysed as the items were not presented with any cues during FM.

3.2.3 Reliability

An independent researcher checked approximately 25% of the word-learning probes for reliability purposes. Point-to-point inter-rater reliability for administration of the word-learning probes was 99.2% (98.5% - 99.8%) and for scoring was 100%.

An independent speech-language therapist checked 25% of the scoring for the item analyses, cueing effects, and for error coding. Inter-rater agreement on the item analysis was 98.9 % and point-to-point inter-rater agreement for cueing effects was 99.7% (98.8% – 100%). Point-to-point inter-rater agreement for the coding of the errors was 99.86% (99.3% – 100%). All data were rechecked prior to data entry, and any errors were corrected.

3.3 Results

All data analyses were conducted using the statistical computer programme SPSS 17.0. Data were analysed in the following order: Error analysis, item analysis, and response to cues.

3.3.1 Error analysis

An error analysis describing the error patters of children with SLI and with typical language development was conducted to evaluate the differences in the erroneous responses of all children. One child in the comparison group was identified as poor word-learner. On 8 out of all 11 word-learning tasks, he was classified as an outlier. The error analysis aimed to compare and describe the differences in errors between children with SLI and children with typical language development. As this particular child did not display the characteristic behaviour of children with typical language development during word-learning, his data was consequently removed for the error analysis. Based on the error coding as described earlier, a range of independent t-tests was conducted to evaluate group differences on FM, WL, and WLTest and percentage scores were calculated for occurrence of error types on all responses. For the error analysis, an alpha level of $p < .01$ was utilised for the data analyses on the word-learning probes following the Bonferroni adjustment.

Fast Mapping

Children with SLI made significantly more naming errors than children with typical language development on production of new words during FM, $t(20.5) = 4.643$, $p < .001$, resulting in a higher error rate overall for children with SLI.

Nevertheless, children with typical language development presented with more phonological errors, $t(35) = .76$, $p = .452$, and more 'don't know' errors, $t(35) = 1.107$, $p = .276$, than children with SLI, however, differences were not significant. Children with SLI demonstrated a higher error rate on semantic errors, $t(25.7) = 2.38$, $p = .025$, substitutions, $t(35) = 1.318$, $p < .196$, and unrelated errors, $t(20.4) = 2.935$, $p = .008$, compared to their peers without SLI. However, differences were only significant for random errors.

Both groups displayed different patterns of error type distributions. Erroneous responses of the children in the comparison group consisted mainly of 'don't know', followed by phonological errors, substitutions, random answers, and semantic errors. As in the comparison group, the most frequent error type for children with SLI was 'don't know'. However, their second most frequent error response was random answers, followed by an almost equal number of error responses of phonological errors, semantic errors, and substitutions. Figure 3.1 displays the error types for each group in percentage scores. Analysis of the subtypes for each error type revealed that there was also a different distribution of subtypes for each group as listed in Table 3.2.

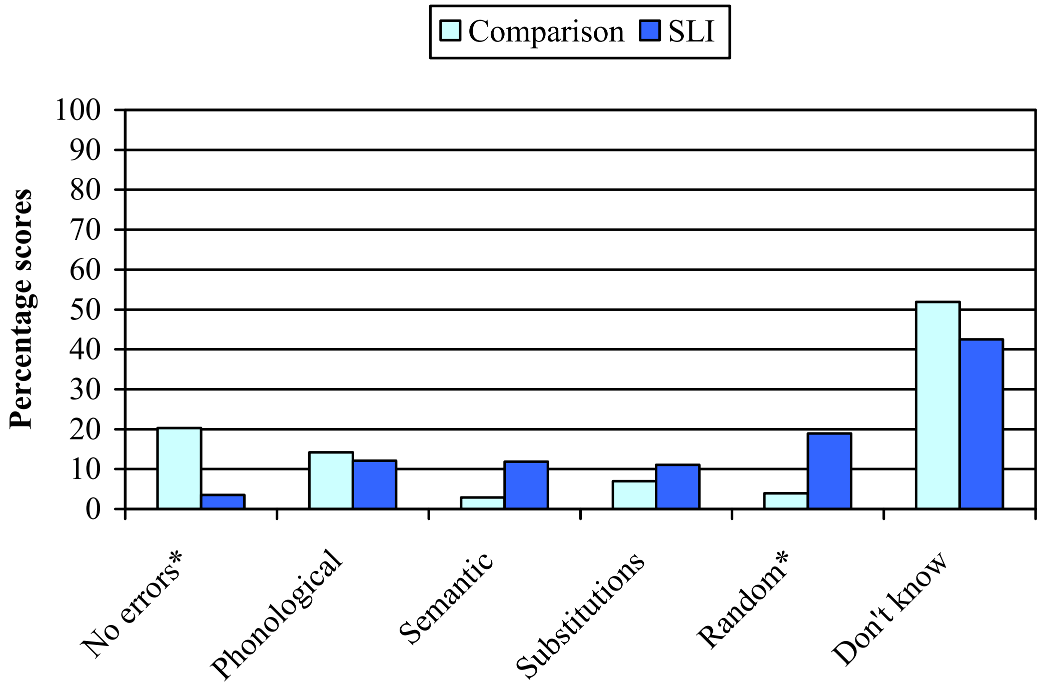

Figure 3.1. Distribution of error types of all participants on fast mapping.
*** indicates significant group difference at the level of $p < .01$.**

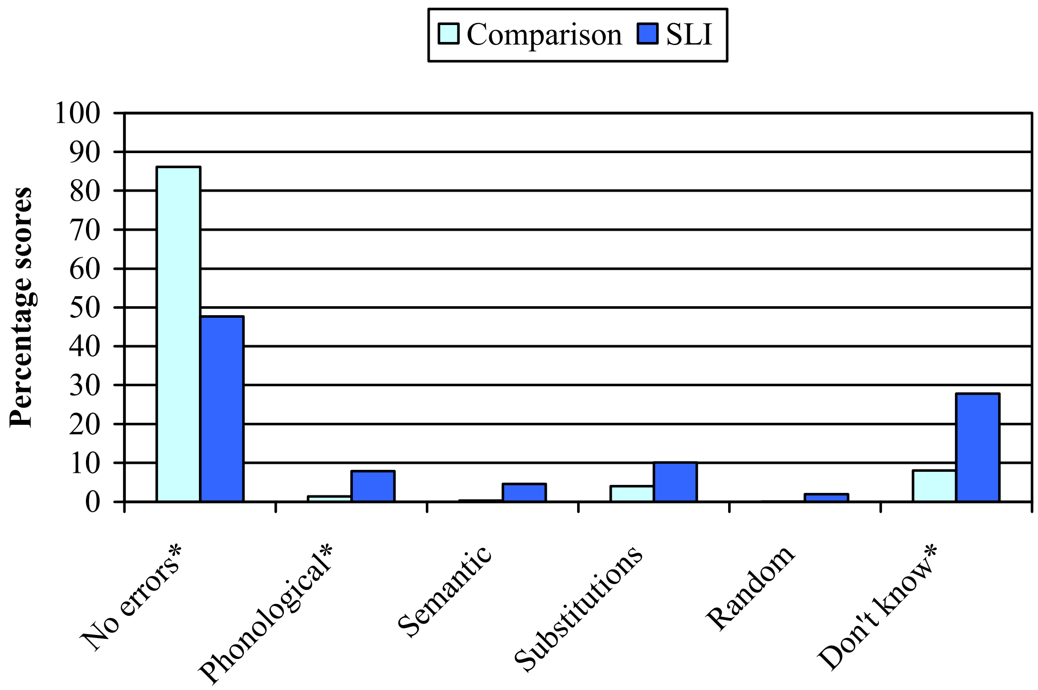

Figure 3.2. Distribution of error types of all participants on word-learning.
*** indicates significant group difference at the level of $p < .01$.**

Table 3.2. Distribution of error subtypes for both groups on fast mapping in percentage scores (PS) and raw scores (RS of max 27)

		Comparison Group		SLI Group	
Error type	**Error subtype**	**PS: Mean/SD**	**RS: Mean/SD**	**PS: Mean/SD**	**RS: Mean/SD**
No errors	**Correct response**	**20.4 / 14.7**	**5.5 / 3.9**	**3.5 / 4.9**	**.95 / 1.3**
Phonological errors	**Initial phoneme**	**2.7 / 3.9**	**.72 / 1.1**	**3.1 / 4.8**	**.84 / 1.3**
	Syllables	**-**	**-**	**-**	**-**
	Phonologically similar word	**11.5 / 7.5**	**3.1 / 2.0**	**9 / 8.9**	**2.4 / 2.4**
Semantic errors	**Superordinate**	**0.6 / 2.6**	**.17 / .71**	**4.9 / 8.5**	**1.3 / 2.3**
	Attribute	**0.8 / 3.5**	**.22 / .94**	**0.8 / 2.6**	**.21 / .71**
	Describe	**0.2 / 0.9**	**.06 / .23**	**-**	**-**
	Coordinate	**1.2 / 3.8**	**.33 / 1.0**	**6.2 / 7.3**	**1.7 / 2.0**
Substitution	**Wrong item from same set**	**2.7 / 4.9**	**.72 / 1.3**	**4.3 / 6.2**	**1.2 / 1.6**
	Wrong item from same set with phonological errors	**4.3 / 7.6**	**1.2 / 2.1**	**6.8 / 8.7**	**1.8 / 2.3**
Random	**Unrelated item**	**3.9 / 5.5**	**1.1 / 1.4**	**18.9 / 21.6**	**5.1 / 5.8**
Don’t know	**‘don’t know’**	**51.9 / 20.8**	**14 / 5.6**	**42.5 / 29.6**	**11.5 / 8.0**

Word-learning

According to the independent t-test, children with typical language development made significantly less naming errors than children with SLI during WL, $t(35) = 7.24$, $p < .001$. Consequently, children with SLI demonstrated a significantly higher error rate on all error types than children without SLI. Differences were significant for phonological errors, $t(19.5) = 3.718$, $p = .001$, and 'don't know' errors, $t(28.6) = 5.276$, $p < .001$. Even though children with SLI also produced more random errors, $t(18.3) = 2.609$, $p = .018$, substitutions, $t(35) = 2.427$, $p = .02$, and semantic errors, $t(18.3) = 2.156$, $p = .045$, between-group differences were not significant.

Unlike in FM, where both groups presented with different error patterns, on WL, both groups displayed the same order of error patterns. The most frequent error type was 'don't know' followed by substitutions, phonological errors, semantic errors, and random answers. The error types for each group are displayed in Figure 3.2 in percentage scores.

Analysis of the subtypes for each error type revealed different patterns for both groups compared to their performances on FM. The distribution of subtypes for each group is listed in Table 3.3.

Table 3.3. Distribution of error subtypes for both groups on word-learning in percentage scores (PS) and raw scores (RS of max 108)

		Comparison Group		SLI Group	
Error type	Error subtype	PS: Mean/SD	RS: Mean/SD	PS: Mean/SD	RS: Mean/SD
No errors	Correct response	86.2 / 12.8	93.1 / 13.9	47.7 / 18.8	51.5 / 20.3
Phonological errors	Initial phoneme	0.7 / 0.2	.44 / .78	1.9 / 3.3	2.0 / 3.6
	Syllables	-	-	-	-
	Phonologically similar word	1 / 1.3	1.1 / 1.4	6 / 6.8	6.5 / 7.4
Semantic errors	Superordinate	0.2 / 0.4	.22 / .42	2.5 / 6.5	2.7 / 7.0
	Attribute	-	-	0.4 / 0.9	.47 / .96
	Describe	0.1 / 0.2	.06 / .23	-	-
	Coordinate	0.1 / 0.2	.06 / .23	1.6 / 3.5	1.7 / 3.8
Substitution	Wrong item from same set	3.1 / 5.8	3.4 / 6.3	7.8 / 7.3	8.5 / 7.9
	Wrong item from same set with phonological errors	0.8 / 1.7	.89 / 1.8	2.3 / 1.9	2.5 / 2.1
Random	Unrelated item	0.1 / 0.3	.11 / .32	2 / 3.2	2.2 / 3.4
Don’t know	‘don’t know’	8 / 8	8.6 / 8.9	27.8 / 14.2	30 / 15.3

Word-learning Test

Commensurate with the findings on FM and WL, children with typical language development made significantly less naming errors than children with SLI during WLTest, $t(35) = 6.825$, $p < .001$. Children with typical language development almost reached ceiling on WLTest, which resulted in a very small number of errors. The few errors were 'don't know' (2.5%), followed by phonological errors and substitutions (both 0.6%). Error analysis of the responses of children with SLI displayed a more diverse pattern. The most frequent error was 'don't know', followed by phonological errors, semantic errors, and substitutions. No random answers were given by the children with SLI at WLTest. Between group differences were significant for 'don't know' errors, $t(21.2) = 5.033$, $p < .001$ but not for phonological errors, $t(20.1) = 2.414$, $p = .025$, substitutions, $t(35) = .877$, $p = .386$, and semantic errors, $t(18) = 1.564$, $p = .135$. The error types for each group on WLTest are displayed in Figure 3.3.

As there were not enough errors on WLTest for children in the comparison group, an analysis of subtypes was not feasible. Phonological errors for children with SLI were primarily naming phonological similar words (5.8%) and initial phonemes (1.2%). Semantic errors were naming of superordinates (1.8%) and of coordinates (1.2%).

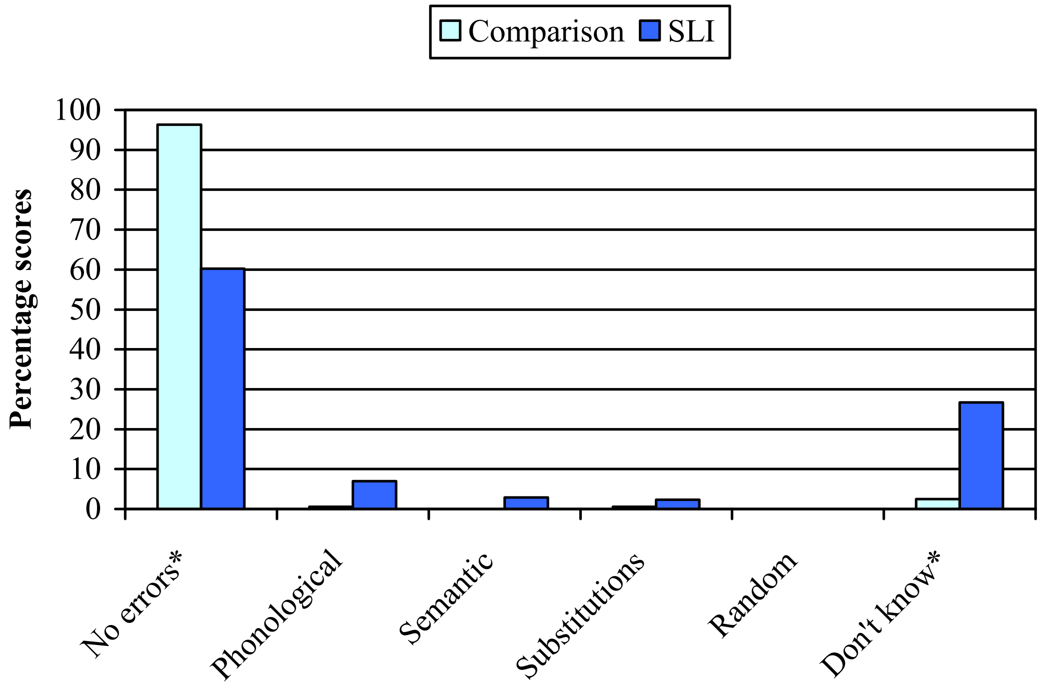

Figure 3.3. Distribution of error types of all participants on word-learning test. * indicates significant group difference at the level of $p < .01$.

3.3.2 Item analyses

In order to evaluate which words were acquired by most children and whether there were influencing features that facilitated the learning of certain words, hierarchies of all 27 words were established. All words were ranked in descending order according to the number of children who learned to produce and/or comprehend the word. Hierarchies were separately generated for comprehension and production, for each word-learning task, and for each group. Due to ceiling effects for comprehension of new words for both groups on WL and WLTest, only results for FM Comprehension were further analysed. Production of new words also reached ceiling for the comparison group on WL and WLTest. Consequently, for the comparison group, only FM Production data was integrated into the further analysis. In contrast, due to flooring effects on FM Production for children with SLI, only data of WL and WLTest Production for children with SLI was included for further evaluations.

For children in the comparison group, partial correlation analyses were computed for FM Comprehension and Production with the variables number of syllables, phonotactic probability, and biphone probability, controlling for affiliation. There were no significant correlations between FM and the three variables ($p > .05$). Partial correlation analyses were calculated for children with SLI with the same variables for WL Production, WLTest Production, and FM Comprehension. There were no significant correlations between the three WL tasks and the variables number of syllables, phonotactic probability, and biphone probability ($p > .05$).

3.3.3 Response to cues

Chi-square tests were conducted in order to examine whether a certain combination of cues facilitated children's word-learning abilities. Percentage scores of correct answers were calculated for each condition (PP = two phonological cues, SS = two semantic cues, PS = one phonological and one semantic cue). These percentage scores were then ranked for production and comprehension on WL and WLTest in two separate sets, one for children with SLI and one for children in the comparison group. For the comparison group, ranking of the word-learning conditions by percent correct scores varied for each task. There were no significant differences between the conditions as indicated by Chi-square test statistics, $\chi^2(2, N=171) = 1.08$, $p > .05$ for WL Production, $\chi^2(2, N=171) = .54$, $p > .05$ for WLTest Production, $\chi^2(2, N=171) = .70$, $p > .05$ for WL Comprehension, and $\chi^2(2, N=171) = 2.04$, $p > .05$ for WLTest Comprehension.

For children with SLI, learning to produce new words on WL and WLTest was best when the words were presented with two phonological cues. Words that were presented with two semantic cues were as easily learned as in condition PP on WL, but not on WLTest. Production on WL and WLTest was most difficult for children with SLI in condition PS, where words were introduced with one phonological and one semantic cue. However, the differences were not significant, $\chi^2(2, N=171) = 1.18$, $p > .05$ for WL Production and $\chi^2(2, N=171) = 1.51$, $p > .05$ for WLTest Production. For WL Comprehension, condition PS yielded the highest score, whereas condition PP and SS were equally ranked. Children with SLI comprehended more words in the WLTest that were presented with two semantic cues than words that were presented with conditions PP and PS. As in the prior Chi-square analyses, the differences were not significant, $\chi^2(2, N=171) = .87$, $p > .05$ for WL Comprehension and $\chi^2(2, N=171) = 4.20$, $p > .05$ for WLTest Comprehension. Table 3.2 presents the percentage scores of correct answers for both groups on each task.

Table 3.4. Percentage of correct answers for both groups by word-learning conditions

	Condition	Comparison Group (n=19) Mean / SD	SLI Group (n=19) Mean / SD
WL Production	**PP**	**78.9 / 41.1**	**49.1 / 50.4**
	SS	**84.2 / 36.8**	**49.1 / 50.4**
	PS	**86.0 / 35.0**	**40.4 / 49.5**
WLTest Production	**PP**	**92.8 / 25.8**	**66.7 / 47.6**
	SS	**94.7 / 22.5**	**57.9 / 49.8**
	PS	**91.2 / 28.5**	**56.1 / 50.1**
WL Comprehension	**PP**	**96.5 / 18.6**	**84.2 / 36.8**
	SS	**94.7 / 22.5**	**84.2 / 36.8**
	PS	**93.0 / 25.8**	**89.5 / 31.0**
WLTest Comprehension	**PP**	**96.5 / 18.6**	**93.0 / 25.8**
	SS	**100 / -**	**100 / -**
	PS	**98.2 / 13.2**	**93.0 / 25.8**

Note. WL, word-learning; Condition PP, items were presented with two phonological cues; condition SS, items were presented with two semantic cues; condition PS, items were presented with one phonological and one semantic cue.

3.4 Discussion

In this study, it was explored whether there were qualitative differences in the performances of children with and without SLI in learning new words and whether there were other factors that influenced word-learning success. First, an error analysis of the word-learning responses was carried out to compare error patterns of children with SLI and children with typical language development. This error analysis was followed by an evaluation of the influencing features of the word-learning stimuli on learning outcomes. Finally, an analysis was conducted examining the influence of specific cues on word-learning outcomes.

In the first section, the error responses of children with SLI on the word-learning probes were compared to the responses of children with typical language development. Commensurate with Nash and Donaldson's (2005) findings, results of this study revealed that children with SLI displayed a different error pattern than children with typical language development when learning new words. Children with SLI in the current study made significantly more naming errors on all three word-learning tasks (FM, WL, and WLTest); consequently their error rate was higher on all error types. However, there were differences in the distribution patterns of both groups on FM and WLTest.

Analysis of the error patterns of children in the comparison group clarified specifically how error patterns of children with SLI differ from children with typical word-learning abilities. Children in the comparison group appeared to have a much clearer concept of whether they know a word or not. This is supported by their performances on FM, where the children in the comparison group produced 20% of the words correctly and their most frequent error type was 'don't know' (52%). Thus, after limited exposure to the words, over half of the time children clearly indicated when they did not remember the new word's name. The remaining error types were mainly phonological (14%) and substitutions with another item from the word-learning set (7%). This implied that children with typical language development were able to remember phonological features of the words, i.e., approaching the correct phonological form of the new word. The occurrence of substitutions indicated that children had a representation of the lexeme, but were not able to match it to the correct lemma. Hence, children with typical language development appear to rely on their semantic and phonological skills for learning new words as indicated by their error patterns. Performances of the children in the comparison group on WL and WLTest were not feasible for in-depth analysis as most children reached ceiling on learning new words at this stage.

Children with SLI displayed various error patterns for FM, WL, and WLTest. At FM, children's most frequent error type was 'don't know' (42%), but considerably less frequent than children in the comparison group. The second most frequent error response was random answers (19%), which was one of the least frequent error types in children with typical language development (4%). This indicated that children with SLI only had limited semantic or phonological representations of the novel words and that they may not draw on their phonological or semantic skills for learning new words. This is not surprising as children with SLI often present with semantic and phonological difficulties, as discussed in Chapter 1 and demonstrated in Chapter 2. Thus, poor semantic and phonological skills prohibit the use of underlying language for word-learning. The relatively high frequency of random errors and the comparably lower frequency of 'don't know' answers suggested that children with SLI did not have a clear concept and may have been guessing some of the answers.

The error patterns of children with SLI changed after repeated exposure to the new words. On WL, the children with SLI approached the error pattern of children in the comparison group. The most frequent error types after 'don't know' were substitutions, phonological errors, semantic errors, and random answers. The substantial reduction in random errors and the shift to substitutions and phonological errors implied that children with SLI were starting to draw on phonological skills. This result could be caused by two factors. Firstly, the repeated exposure to the words strengthened the phonological representation of the new words. Secondly, words were now additionally presented with cues that may have supported learning.

Similar error patterns were observed on WLTest, indicating children with SLI needed repeated exposure to new words to demonstrate similar patterns as children with typical language development after minimal exposure. The findings of the error analysis also suggested that children with SLI particularly struggled to remember the correct lexemes of new words.

The error patterns of children in this study appear contradictory to findings by Nash & Donaldson (2005). However, a different scheme for the categorisation of the naming errors was utilised. In particular, random or unrelated answers were clearly distinguished from 'don't know' answers in the current study, compared to the 'miscellaneous errors' in the study by Nash and Donaldson, which included both error types. Thus, no conclusion can be drawn between these two studies.

In the second section of this chapter, the author aimed to determine specific features of words that may facilitate word-learning for school-aged children with and without SLI. For this purpose, hierarchies were generated to evaluate whether the number of syllables, affiliation, phoneme probability, and biphone probability influenced the learning of new words. Findings revealed that no patterns could be identified that may have facilitated word-learning. Unfortunately, only a limited amount of data was available for this analysis due to ceiling effects on several WL tasks, which restricted the analysis. For comprehension, only data on the performances on FM was included for both groups. For the same reason, only FM production data was used for the comparison group, whereas only WL and WLTest on production of children with SLI were included.

Even though word-learning stimuli and images were carefully selected, word-learning might have been influenced by underlying factors that have not been investigated in this study. For example, Alt and colleagues (2006; 2004) reported that children with SLI have difficulties mapping enough semantic features when learning new words. This aspect was not considered in the evaluation of the word-learning stimuli in the current study and was consequently not included in the item analysis. The findings of the current study revealed that there were also no effects of the phonotactic probability of the stimuli on word-learning outcomes. This is contradictory to findings that young children learn words with high phonotactic probability more rapidly than words with low phonotactic probability (Storkel, 2001, 2003). However, according to the criteria of high and low phonotactic probability as utilised by Storkel, all items of the current study consisted of common sound sequences (i.e., high phonotactic probability). Consequently, differences in the phonotactic probability of the words might not have been sufficiently large for observable effects. Results furthermore demonstrated no effects of number of syllables on word-learning. Therefore, children learned longer words (three to four syllabic words) as rapidly as short words (one to two syllabic words).

The final section of this chapter examined whether word-learning was influenced by the teaching condition for the stimuli. Specifically, whether the acquisition of new words varied when the words were presented with two phonological cues (condition PP), two semantic cues (condition SS), or one phonological and one semantic cue (condition PS) was examined. Findings of the current study partly concurred with Gray's (2005) in that phonological cues facilitated the production of new words, and semantic cues facilitated the comprehension of new words. Children with SLI learned to produce more words that were presented with two phonological cues than with condition SS or PS on WLTest, whereas WL Production of new words was highest for condition PP and SS. In contrast, children with SLI learned to comprehend more words in condition PS on WL and comprehended more words that were presented with two semantic cues on WLTest. Thus, while not statistically significant, it could be observed that phonological cues supported the production of new words best, while comprehension of new words profited most when words were presented with two semantic cues or a combination of a semantic and a phonological cue.

Data from the comparison group was less conclusive, as the ranking of the percentage scores for word-learning conditions varied for each task. As discussed earlier, children in the comparison group almost reached ceiling on comprehension and production of new words on WL and WLTest, which restricted interpretation. Nevertheless, these findings suggest that children with typical language development are able to learn new words after minimal exposure and independent of additional cues. The results of this analysis are in accordance with Gray's (2005) findings, where cueing did not influence the performance of children with typical language development.

Findings of this study are limited by several factors. Due to the counterbalancing of the three different word-learning sets across participants, each set was presented to only a limited number of participants. The limited data hindered finding significant features that may have facilitated the word-learning. Furthermore, as the children in the comparison group quickly reached ceiling in their word-learning performance, there was only restricted data available for in-depth evaluation. This needs to be carefully considered when an in-depth analysis is warranted.

Several clinical implications can be derived from this study. Firstly, children in this study learned longer words that consisted of common sound sequences as easily as shorter words. Secondly, phonological cues appear to support production of new words and semantic cues appear to support comprehension of new words in children with SLI. This result needs to be considered when word-learning strategies are selected to support word-learning in children with SLI. Thirdly, children with SLI did not only present with difficulties learning new words, but they also demonstrated different error patterns. These error patterns only approached the error pattern of children with typical development after repeated exposure. However, the error analysis also revealed that the biggest obstacle for children with SLI appeared to be learning the exact lexeme for new word, as indicated by their phonological errors in the WL and WLTest. Finally, as demonstrated in the error analysis, children with typical language development were drawing on their phonological and semantic skills to learn new words. In contrast, children with SLI presented with a high rate of random errors, indicating that they were not employing phonological or semantic strategies for word-learning. Their limited phonological and semantic skills may have limited their ability to use these skills in learning new words. Therefore, an intervention aimed to improving word-learning in children with SLI should specifically target the underlying phonological and semantic skills.

Findings in Chapter 2 revealed that semantic and phonological awareness skills were significantly correlated to word-learning. Thus, an intervention facilitating semantic and phonological awareness skills in children with SLI appears to hold promise in enhancing word-learning abilities. Intervention outcomes of such a combined treatment on word-learning will be investigated in the next chapter.

CHAPTER 4

THE EFFECTIVENESS OF PHONOLOGICAL AWARENESS AND SEMANTIC INTERVENTION ON WORD-LEARNING ABILITIES OF CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

4.1 Introduction

Children with Specific Language Impairment (SLI) often present with difficulties learning new words compared to age-matched and language-matched children with typical language development (Nash & Donaldson, 2005; Rice, et al., 1990; Riches, et al., 2005). Research findings indicated that phonological and semantic processing skills are critical to the word-learning process and may contribute to the word-learning difficulties experienced by children with SLI (Alt, et al., 2004; Gray, 2005). The current chapter sought to extend this research by investigating whether intervention aimed at facilitating semantic and phonological processing abilities has a direct positive influence on word-learning abilities in children with SLI.

A considerable body of research revealed that the vocabulary deficits displayed by children with SLI are caused by poor word-learning skills (Nash & Donaldson, 2005; Oetting, et al., 1995; Rice, et al., 1990). Although the importance of lexical acquisition for language development has often been highlighted, so far there is no intervention study investigating how word-learning skills may be enhanced in children with SLI.

A feasibility study by Munro, Lee, and Baker (2008) provides very promising results for a combined phonological awareness and semantic intervention in children with SLI. The researchers investigated whether a combination of phonological awareness and semantic intervention enhanced children's abilities to establish stronger representations of words which are already stored in the semantic lexicon. Findings indicated that following the intervention, the children with SLI were able to strengthen their semantic (lemma) and phonological representations (lexeme) of the assessed words. Thus, intervention targeting to improve phonological awareness and semantic skills in children with SLI may not only enhance children‘s phonological and semantic representations of stored words, but also their ability to establish strong representations for new words on the lemma and lexeme level.

Research documenting the contribution of phonological processing and semantic skills on word-learning indicated that both, phonological and semantic processing may impact word-learning in children with SLI in different ways (Gray, 2005; Nash & Donaldson, 2005). Consequently, an alternating treatment design was implemented in the study reported in this chapter in order to examine influences of each treatment individually on word-learning abilities in children with SLI.

In the current study, it was investigated whether an intervention aimed at improving phonological awareness, an intervention targeting the strengthening of semantic skills, or a combination of both phonological and semantic intervention facilitates word-learning abilities in children with SLI. Specifically, it was hypothesised that:

1. Phonological awareness intervention or semantic intervention on their own will enhance phonological awareness ability and semantic skills respectively, but will not be sufficient to significantly improve word-learning,

2. A combination of both phonological awareness intervention and semantic intervention will be necessary to significantly enhance the word-learning abilities in children with SLI, and
3. The order of these interventions (e.g., phonological awareness followed by semantic intervention or vice versa) will not affect learning outcomes.

4.2 Method

4.2.1 Research design

An alternating treatment group design was implemented to evaluate treatment effectiveness individually and whether treatment order influenced word-learning abilities in children with SLI. Children were randomly assigned to either treatment condition A (Group A: 12 hours of phonological intervention followed by 12 hours of semantic intervention) or treatment condition B (Group B: same interventions in reverse order). The three testing occasions were pre-test prior to the intervention, mid-test following the first intervention phase, and post-test immediately following the second intervention phase. Assessment at mid-test allowed evaluation of individual intervention effects and whether one intervention itself was sufficient to enhance the children's word-learning skills. There was a 4-week break between the two intervention phases. Appendix F displays an overview including a timeline of the study design.

4.2.2 Participants

The participants for this study included the same 19 children with Specific Language Impairment (SLI) and 19 children with typical language development described in Chapter 2.

4.2.3 Procedure

At pre-test, all children were assessed on a range of standardised tests and experimental probes including word-learning probes as described in Chapter 2. Children with SLI were re-assessed on the experimental probes (including the word-learning probes) at mid- and post-test, whereas the children in the control group were re-assessed on the experimental probes excluding the word-learning probes at post-test only. All assessments and probes were carried out by a speech language therapist and were administered individually to each child in a quiet setting at the child's school.

<u>Assessment measures</u>

Standardised and norm referenced assessments

Prior to the intervention, the children were assessed on the following range of standardised and norm referenced assessments. Detailed description of these assessments is provided in Chapter 2.

- Test of Nonverbal Intelligence 3rd Edition (TONI-3; Brown, et al., 1997)
- Clinical Evaluation of Language Fundamentals 4th Edition (CELF-4; Semel, et al., 2006)
- Peabody Picture Vocabulary Test 4th Edition (PPVT-4; Dunn & Dunn, 2006)

- Structured Photographic Expressive Language Test 3rd Edition (SPELT; Dawson, et al., 2003)
- Queensland University Inventory of Literacy (QUIL; Dodd, et al., 1996)
- New Zealand Articulation Test (Moyle, 2004)
- Neale Analysis of Reading Ability 3rd Edition (NARA-3; Neale, 1999)
- Burt Word Reading Test New Zealand Revision (BURT; Gilmore, et al., 1981)

Experimental measures

The primary aim of this study was to examine the effects of phonological and semantic intervention on word-learning. In order to evaluate the effects of intervention, word-learning probes were administered. In addition to the word-learning probes, phonological and semantic probes were conducted to determine the efficacy of each intervention. Additional NWR probes were implemented to examine whether children were able to transfer phonological awareness skills to decoding of unfamiliar words. A detailed description of the experimental measures is provided in Chapter 2. All experimental measures were administered on all three testing occasions (pre-, mid- and post-testing) and consisted of the following:

- Word-learning Probes (WL Probes; Gray, 2005)
- Semantic Probes
- Phonological Awareness Probes (PA Probes; Stahl & Murray, 1994)
- Non-Word Reading Probes (NWR Probes; Calder, 1992)

Intervention

The participants with SLI were randomly assigned to treatment condition A or B. In treatment condition A (Group A), the participants received 12 hours of phonological awareness intervention over a 6-week period (2 x 1 hour weekly) followed by 12 hours of semantic intervention over a 6-week period (2 x 1 hour weekly). In treatment condition B (Group B), the participants received the interventions in the reverse order over the same period. All interventions commenced in the same week. For the duration of this study children did not receive any additional intervention, except for two participants who received reading recovery and nine children who attended their learning support group. Children in Group A received an average of 23.6 hours and children in Group B 23.1 hours of intervention. A speech-language therapist implemented all intervention sessions in groups of 2 to 3 children in a quiet withdrawal room at the children's school premises during school hours. If a child missed a session, additional make-up sessions were held in groups or individually. Children in the control group did not receive any intervention. Table 4.1 displays performance of participants with SLI by group (group A or group B) on selected pre-test assessments and probes.

Table 4.1. Participants' performance on selected pre-test assessments and probes

	Group A (*n*=10)		Group B (*n*=9)				
	Mean	SD	Mean	SD	*F*	*p*	*f*
Age	83.6	8.1	85.8	5.2	.472	.502	.17
TONI-3	93.9	5	93.8	5.7	.002	.961	.01
CELF-4	72.2	6.6	71.2	6.3	.107	.747	.08
PPVT-4	86.6	7.7	85.9	6.8	.045	.835	.05
Q-NWS	5.1	1.3	4.4	.5	2.021	.173	.35
Q-NWR	5.7	1.6	3.8	1.3	8.345	.010*	.7
Q-SID	6.1	3	4.6	2.4	1.488	.239	.3
Q-SS	6.1	3.7	6	2.2	.005	.945	.02
Q-RR	6	3.9	3.3	1	3.869	.066	.48
Q-S	6.4	1.8	5.6	1.1	1.487	.239	.3
Q-PD	5.4	2	4.3	2.2	1.169	.295	.26
Q-PS	8.2	2.3	6.3	2.2	3.203	.091	.43
Q-PM	4.5	1.6	3.4	.5	3.358	.084	.44
NARA-Acc	11.1	6.3	8.2	6.9	.908	.354	.23
NARA-Com	3.4	2.4	3.2	1.6	.035	.853	.05
BURT	17.2	9.3	14	8.6	.604	.448	.19

PA	40.3	17.4	32.3	13.4	1.26	.227	.27
NWR-W	15.7	20.7	3.3	5	2.995	.102	.42
NWR-P	30	24.6	15.6	12.1	2.516	.131	.37
Sem	33.4	8.1	33.9	9	.009	.924	.02

Note. Group A, phonological awareness intervention followed by semantic intervention; Group B, semantic intervention followed by phonological awareness intervention; Age in months; TONI-3, Test Of Nonverbal Intelligence 3rd Edition standard scores; CELF-4, Clinical Evaluation of Language Fundamentals 4th Edition standard scores; PPVT-4, Peabody Picture Vocabulary test 4th Edition standard scores; PA, Phonological Awareness Probes percentage scores of all 4 subtests collapsed; NWR-W, Non-Word Reading Probes percentage scores for words correct; NWR-P, Non-Word Reading Probes percentage scores for phonemes correct; Sem, Semantic Probes Percentage scores of all 4 subtests collapsed; * Significant group difference at the level of $p < .05$.

Phonological awareness intervention

The phonological awareness intervention was based on the Phonological Awareness Training Programme (Gillon, 2000). This programme specifically aims to enhance children's phonological awareness skills at the phoneme level and endorses an explicit link between oral and written language. To ensure intervention reliability, each session followed a specific protocol. There were always four tasks in each session. Sessions 1 to 4 included phoneme segmentation, phoneme blending, phoneme manipulation with blocks, and tracking sound changes with letter blocks. Sessions 5 to 12 consisted of phoneme segmentation, phoneme manipulation with blocks, tracking sound changes with letter blocks, and reading real and non-words. According to each child's abilities, each task was adapted (i.e., level of difficulty/complexity for each task was increased or decreased, more cues were provided, etc.). Scoring sheets were utilised for each child individually to follow their progress and plan intervention targets for the next session.

Semantic intervention

The semantic intervention programme aimed to support children in establishing strong representations for words and strong networks of semantic associations. The current intervention programme followed a specific protocol each session and was based on familiar topics and vocabulary (e.g., food: fruits, vegetables, etc.; animals: mammals, birds, insects, etc.). After consultation with a team of linguists, speech-language therapists, and psychologists, the topics and vocabulary for the semantic programme were selected. The resources for this programme were then created using pictures from Microsoft Clipart © that were printed in colour on 10cm x 10cm picture cards. The intervention focused on identifying main features and attributes of these familiar words on three different levels: generation, association and transfer. The generation task required children to gather as many items as possible for certain groups (e.g., ”Find all food items that are fruits”). In the association task, children had to identify the main features or differences of group constellations (e.g., “Why do a scooter, a bicycle and a motorcycle go together?”). A transfer task concluded every session to enable the children to apply and consolidate the acquired skills. One transfer task was a quiz, where the children took turns at describing picture cards of the relevant topic according to the categories and attributes just taught (e.g., “It is a fruit, it is round, yellow, and tastes sour.”) for the other children to identify. The alternative transfer task was a word association game and required the children to identify and describe similarities between picture cards (e.g., “Cow and pig go together because they are farm animals and they both have four legs.”). Both transfer tasks alternated for each group. Scoring sheets were utilised for each child to monitor progress and ensure equal participation and exposure.

Controls for intervention bias

To control for possible intervention bias, both the phonological awareness and the semantic intervention utilised a clinician-directed model. That is, all sessions were highly structured and the clinician provided direct instructions and targets of what was planned for each session. The author implemented all sessions and utilised the same protocols and material for each intervention. Furthermore, the timing of the interventions was balanced for all groups to avoid tiring effects influencing children's performances. Specifically, each small group received the two interventions per week at two different times (i.e., one group received intervention Monday mornings and Thursday afternoons, whereas another group received intervention Tuesday afternoons and Friday mornings).

4.2.4 Reliability

For transcription and reliability purposes, all assessments were recorded on a digital voice recorder (Panasonic; RR-US050). The author administered, transcribed, and scored all assessment probes. All standardised tests were administered and scored according to the examiner's manual. The experimental probes were administered and scored as described. An independent researcher checked 25% of all assessment data on three levels: administration, transcription and scoring. Inter-rater agreement on administration and scoring of the standardised assessments was 100% and 97.6%, respectively. For the PA and Semantic probes, inter-rater agreement on administration was always 100% and point-to-point inter-rater agreement for scoring was 99.7% (97.1% – 100%) at pre-test, 100% at mid-test, and 99.6% (98.6% - 100%) at post-test. Point-to-point inter-rater reliability for administration of the word-learning probes was 99.2% (98.5% - 99.8%) at pre-test, 99.8% (99.7% - 100%) at mid-test, and 100%

at post-test and for scoring was 100%. Any inter-rater discrepancies regarding the transcription were resolved by consensus after repeated listening to the audio files. Prior to data entry, the author rechecked all data and any errors were corrected.

4.2.5 Treatment fidelity

All intervention sessions were videotaped on a digital video camera (Panasonic; NV-GS75GN). Twenty percent of all intervention sessions were viewed by an independent researcher. A protocol was provided for each session defining the contents and goals for each session. All sessions (100%) adhered to the predetermined protocols.

4.3 Results

A range of repeated measures Analyses of Variances (ANOVAs) and Bonferroni adjustments were conducted using the computer programme SPSS 17.0 to evaluate the group performances at pre-, mid-, and post-test. Effect sizes for intervention effects were determined by utilising the effect size index f with the conventional values of small f = .10, medium f = .25 and large f = .40 (Portney & Watkins, 2000). Group differences were evaluated using one-way ANOVAs with each analysis using group as the independent variable (group A vs. group B).

An alpha level of .05 was utilised for all statistical analyses. Mauchly's Test of Sphericity was conducted on all repeated measures ANOVAs utilising the Greenhouse-Geisser adjustment, if the assumption of sphericity was not satisfied. Normality was tested utilising the Kolmogorov-Smirnov test. Data that failed the normality test were transformed into logarithms and re-analysed.

Raw scores were utilised for all data evaluation. First, the data were analysed to evaluate the effectiveness of each treatment. Second, children's word-learning skills and intervention effects on these skills were analysed.

4.3.1 Intervention effects on phonological awareness and semantic skills

Performances at pre-, mid-, and post-test on the PA probes and the semantic probes were analysed to evaluate intervention effectiveness. Scores from all four subtests of the PA probes were combined for the PA measure and scores from all four subtests of the semantic probes were combined for the semantic measure. Prior to the intervention, there were no significant differences between group A and B on the PA measure $F\ (1,17) = 1.26$, $p = .277$, the NWR measures for words $F(1,17) = 2.995$, $p = .102$, or phonemes $F(1,17) = 2.516$, $p = .131$, and the semantic measure, $F(1,17) = .01$, $p = .92$.

Repeated measures ANOVAs with the within-group variable time of testing (pre-, mid-, and post-test) and the between subjects variable group (group A and B) revealed significant main effects for time, $F(2,36) = 75.36$, $p < .001$, and time x group, $F(2,36) = 19.52$, $p < .001$ for performance on the PA probes, a significant main effect for time, $F(2,36) = 38.79$, $p < .001$ for performance on semantic probes, and significant effect for time, $F(2,36) = 24.06$, $p < .001$, and time x group, $F(2,36) = 8.28$, $p = .003$ for performance on NWR probes for words and significant effect for time, $F(2,36) = 42.19$, $p < .001$, and time x group, $F(2,36) = 16.17$, $p < .001$, for performance on NWR probes for phonemes.

Intervention effects for group A

There were significant differences for group A (phonological awareness intervention followed by semantic intervention) on performance over time on PA probes, $F(2,18) = 56.15$, $p < .001$, NWR probes for correct words, $F(2,18) = 10.84$, $p < 0.001$, and phonemes, $F(2,18) = 17.64$, $p < 0.001$, and on semantic probes , $F(2,18) = 21.5$, $p < .001$ as shown by repeated measures ANOVAs with the within-group variable time of testing. Bonferroni adjustments indicated that at mid-test, children in group A, who received 12 hours of phonological awareness intervention demonstrated a significant improvement in their performance with large effect sizes on the PA probes, $p < .001$, $f = 1.06$, on the NWR probes for correct words, $p = .005$, $f = 0.47$, and phonemes, $p < .001$, $f = .62$, as well as on the semantic probes, $p = .001$, $f = .65$. No significant changes were found for the performances from mid- to post-test for group A. There was a significant difference between group A and group B on the PA probes, $F(1,17) = 23.222$, $p < .001$, and on the NWR probes for words correct, $F(1,17) = 12.531$, $p = .003$, and for phonemes correct, $F(1,17) = 22.398$, $p < .001$, at mid-test.

Intervention effects for group B

There were also significant effects over time for group B (semantic intervention followed by phonological intervention) on PA probes, $F(2,16) = 61.66$, $p < .001$, NWR probes for correct words, $F(2,16) = 13.62$, $p < 0.001$, and phonemes, $F(2,16) = 25.49$, $p < 0.001$, and for semantic probes, $F(2,16) = 21.29$, $p < .001$. Bonferroni adjustments revealed that group B, after receiving 12 hours of semantic intervention, demonstrated significant gains on the semantic probes at mid-test, $p = .004$, $f = .63$, but not on the PA probes, $p = .313$, and NWR probes for words, $p =$

1.00, and phonemes, $p = 1.00$. At post-test however, after receiving 12 hours of phonological awareness intervention, group B displayed significant gains with large effect sizes on the PA probes, $p < .001$, $f = 1$, and on the NWR probes for words, $p = .023$, $f = .8$, and for phonemes, $p = .002$, $f = .87$. There were no significant differences at post-test between group A and B on any of the four assessment measures. Figures 4.2 and 4.3 display the performances of all participants on the PA and Semantic probes from pre- to post-test.

Control group comparison

The PA, NWR, and Semantic probes were re-administered to the children in the control group after five months (same interval as pre- to post-testing of children in the experimental groups) to ensure that the accelerated phonological awareness and semantic gains of the children in the experimental groups (group A and B) were a result of the intervention and to exclude maturation or general classroom instruction as the contributor. Pre- to post-test analyses revealed that there were no significant gains (at $p < .05$ significance level) for children in the control group on any of the probes at post-test.

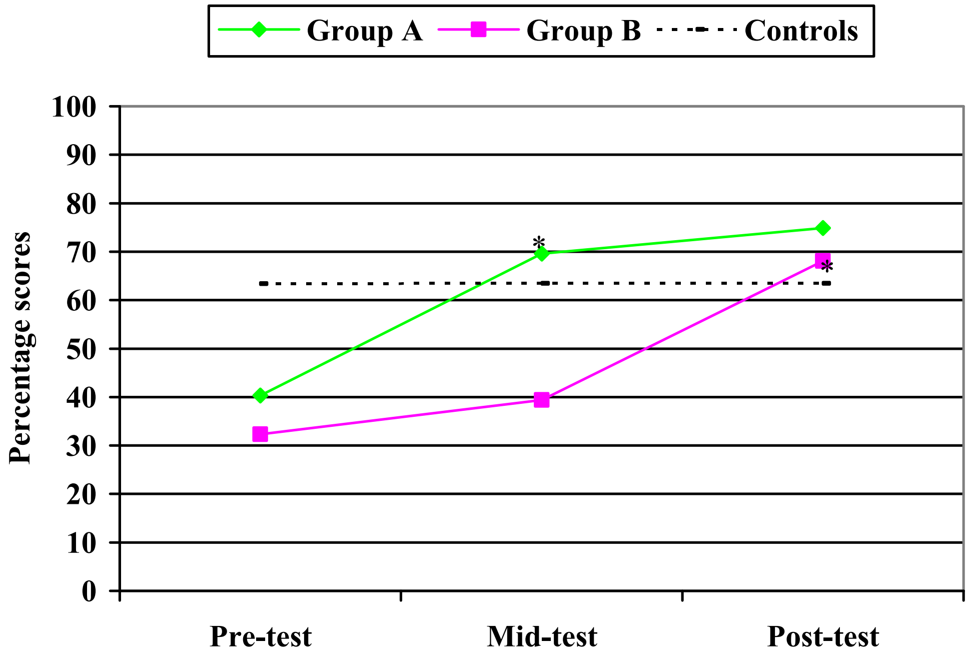

Figure 4.1. Performances of all groups on phonological awareness probes.
Group A received 12 hours of phonological awareness followed by 12 hours of semantic intervention. Group B received the same interventions in the reverse order. * indicates significant gains at the level of *p* < .05.

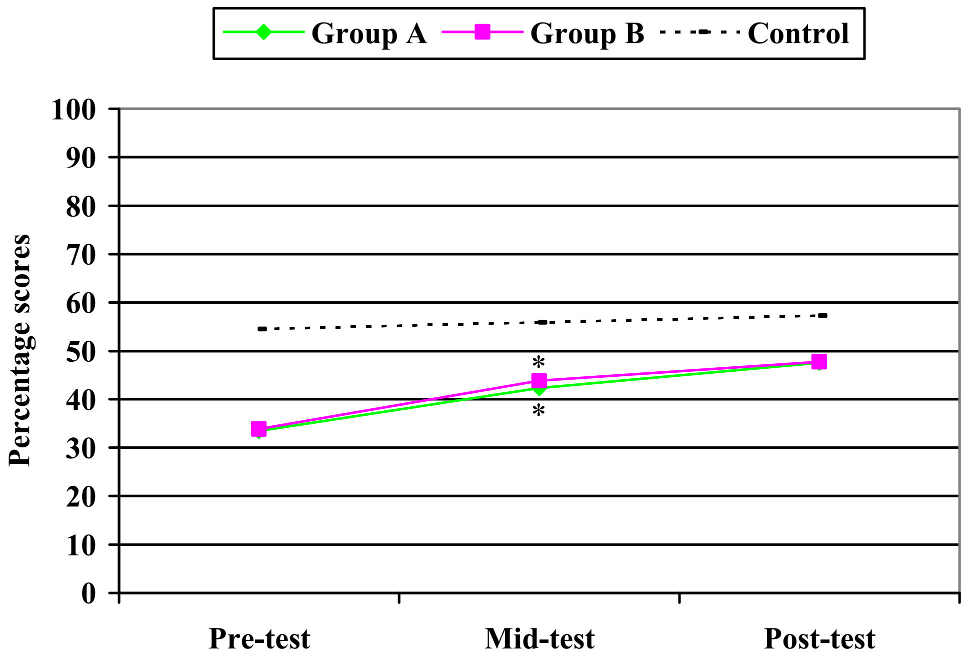

Figure 4.2. Performances of all groups on Semantic probes.
Group A received 12 hours of phonological awareness followed by 12 hours of semantic intervention. Group B received the same interventions in the reverse order. * indicates significant gains at the level of p < .05.

4.3.2 Intervention effects on word-learning

In order to evaluate intervention effects on the children's word-learning skills, performances on the word-learning probes at pre-, mid-, and post-test were analysed. The word-learning probes were separated into its three components for data analyses: fast mapping (FM), word-learning (WL), and word-learning test (WL Test). For the fast mapping and word-learning, scores were given for correct answers on comprehension and production of each new word. The word-learning test additionally assessed recognition abilities of the children for the novel words.

<u>Group comparisons on fast mapping</u>

Prior to the interventions, there was no significant difference between group A and group B on FM Comprehension, $F(1,17) = 1.58$, $p = .226$, and FM Production, $F(1,17) = 0.49$, $p = .494$.

Repeated measures ANOVAs with the within-subjects variable time (pre-, mid- and post-test) and the between-subjects variable group (group A and group B) revealed that there was a significant effect for time, $F(2,36) = 7.809$, $p = .002$ on production of novel words, but not for comprehension, $F(1.46,36) = .012$, $p = .967$. Pre- to post-test performance revealed that both groups significantly improved their production of novel words on fast mapping over time. Table 4.2 displays participants' performance on FM Comprehension and Production on all three testing occasions.

Bonferroni adjustment analyses revealed that at mid-test, group A, who received 12 hours of phonological intervention, improved their performance significantly on production ($p = .029$) with a small effect size ($f = .25$), but not on comprehension ($p = 1$) on the FM task of learning the novel words. Similarly, group B, having received 12 hours of semantic intervention performed significantly higher on production (p = .044) with a large effect size (f = .63), but not on comprehension (p = 1) at mid-test. There was no significant gain for either group from mid- to post-test, after group A and group B received both interventions.

Pre- to post-test calculations of effect sizes revealed medium effect sizes for group A (f = .32) and large effect sizes for group B (f = .82) on production of new words. There was no significant difference between group A and group B at pre-, mid-, and post-test on either the comprehension task or the production task of the FM.

Table 4.2. Group performances in raw scores on FM Comprehension and Production at pre-, mid-, and post-test

	Group A (n=10)		Group B (n=9)	
	Mean	SD	Mean	SD
Comprehension				
Pre-test	10.6	4.1	12.7	2.9
Mid-test	11.5	4.7	11.6	3.2
Post-test	11.8	4.1	11.1	5
Production				
Pre-test	1.1	1.3	0.7	1.4
Mid-test	1.8*	1.6	2.7*	1.9
Post-test	2.3	2.5	2.9	1.5

Note. FM, Fast Mapping; raw scores out of a maximum score of 27; * significant gain between pre- and mid- intervention scores ($p < .05$).

Group comparisons on word-learning

Following the fast mapping task, the children's word-learning abilities were assessed on days 2, 3, and 4 of the word-learning paradigm. For analyses purposes, these word-learning days (days 2 to 4) are referred to as WL1, WL2, and WL3, respectively. To evaluate children's performance over time on each word-learning day individually, only same days were compared to each other (e.g., WL1 pre-test was compared to WL1 mid- and post-test, same for WL2 and WL3).

Group Performances on WL Production

Prior to the interventions, there were no significant differences between group A and group B on any WL day on the production tasks. Repeated measures ANOVAs with the dependent variable time (pre-, mid-, and post-test) and the independent variable group (group A and group B) demonstrated no significant effects over time for group A and B on any word-learning day on the production of novel words. However, Bonferroni analyses revealed significant gains for group A (p = .032) on production probes of the word-learning from pre- to post-test. As results demonstrated a tendency towards an increase in performance for group A and B over time, effect sizes were calculated for all production probes pre- to post-test. Group A displayed medium effect sizes on WL1 (f = .28) and WL3 (f = .25) and small effect sizes on WL2 (f = .23). Small effect sizes were also found for group B on WL1 (f = .23). However, there were no significant effect sizes for group B on WL2 and WL3. Figure 4.3 displays the performances of group A and B on production probes of the word-learning at pre-, mid-, and post-test.

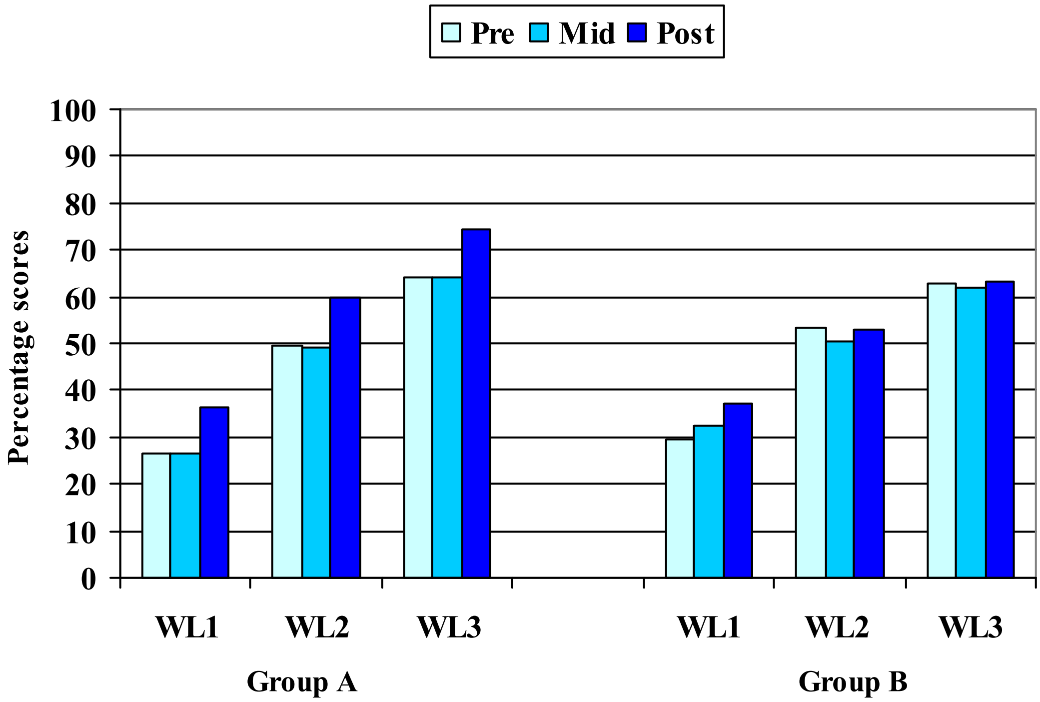

Figure 4.3. Performances of group A and B on all three word-learning days (WL1, WL2, and WL3) at pre-, mid-, and post-test for production in percentage scores.

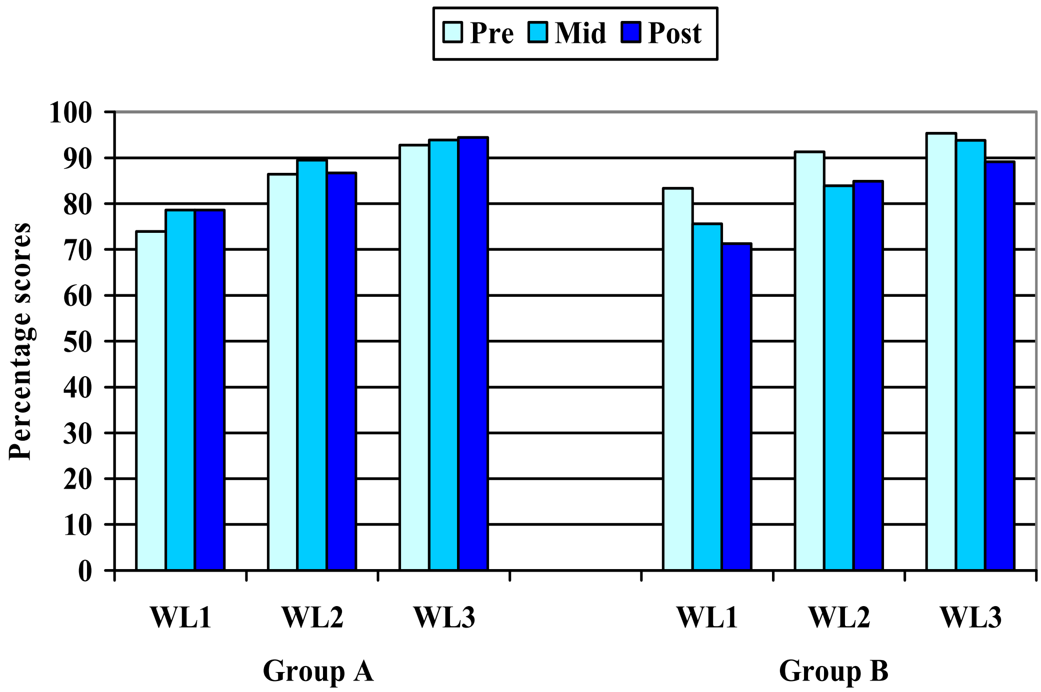

Figure 4.4. Performances of group A and B on all three word-learning days (WL1, WL2, and WL3) at pre-, mid- and post-test for comprehension in percentage scores.

Group Performances on WL Comprehension

Repeated measure ANOVAs demonstrated no significant gains for group A and group B at mid- and post-test on the comprehension tasks of the word-learning. There were no significant differences between group A and group B at WL1, WL2, or WL3 on the comprehension tasks at pre-, mid-, and post-test. Figure 4.4 displays the performances of group A and B on comprehension probes of the word-learning at pre-, mid-, and post-test.

<u>Group comparisons on word-learning test</u>

The word-learning test (WLTest) was administered on day 5, following the fast mapping and the three days of word-learning. The WLTest assessed each word on three different levels: comprehension, recognition, and production.

Between-group-differences of both experimental groups revealed no significant differences on the WLTest at pre-, mid-, or post-test on any of the three components of the test. There were no significant changes for group A or B across time on the three measures of the WLTest.

4.4 Discussion

In this study, the effect of phonological awareness and/or semantic intervention on word-learning abilities in children with SLI was investigated and whether treatment order in which these interventions were implemented influenced outcomes. Nineteen children with SLI were randomly assigned to treatment condition

A (12 hours phonological awareness intervention followed by 12 hours of semantic intervention) or treatment condition B (same intervention in reverse order). Pre-, mid-, and post-tests were conducted to evaluate the proposed hypotheses.

Consistent with hypothesis 1, phonological awareness and semantic intervention enhanced phonological awareness ability and semantic skills respectively, but were not sufficient to significantly improve word-learning. The phonological awareness intervention improved children's phonological awareness skills as demonstrated by the results of the PA Probes. Both experimental groups significantly improved their performances on these probes only after they received phonological intervention. The findings clearly demonstrate the effects of the phonological awareness intervention on the phonological awareness and decoding skills. Results of the NWR Probes additionally supported these findings. Non-word reading performances improved concurrently with phonological awareness skills for group A and B. The significant gains on the NWR Probes indicate that both groups were transferring the acquired phonological awareness skills for decoding the non-words.

Performances on the semantic probes were less conclusive. Children in group B, who received 12 hours of semantic intervention, significantly improved their semantic skills as demonstrated by their performance on the semantic probes at mid-test, indicating that the semantic intervention facilitated semantic skills. However, group A, which did not receive semantic intervention until later, also demonstrated significant gains on the semantic probes at mid-test, indicating that the phonological awareness intervention enhanced children's semantic skills in addition to the phonological awareness skills. This result might indicate that the intensive phonological awareness intervention itself was effective in facilitating children's phonological awareness skills and also in sensitising and prompting children to better perceive cues in their learning environment, which enhanced their semantic abilities.

Each intervention on its own was not effective in significantly improving the word-learning skills of the children with SLI. There were no significant gains in the children's performances for comprehension of new words in the fast mapping, word-learning or word-learning test at mid-test. For production of novel words, changes at mid-test were only observed on the fast mapping task.

Hypothesis 2 proposed that a combination of both, phonological awareness and semantic intervention is necessary to significantly enhance the word-learning abilities in children with SLI. Pre- to post-test analyses of the word-learning measures partially support this hypothesis. Significant gains following both interventions were only found for production of new words on word-learning day 1 (WL1) for children in group A, who received phonological awareness followed by semantic intervention. Further effect size calculations revealed that group A made small to medium gains on all three word-learning days in learning to produce more novel words, whereas group B displayed small gains on WL1 only.

Production on fast mapping for the children with SLI (group A and B) improved significantly following the first intervention phase, but not after the completion of the second intervention phase. This finding indicates that both groups improved their expressive fast mapping skills after one intervention phase, irrespective of the targeted contents.

Over time, the children in group A displayed a general improvement in their performance to produce the novel words. This outcome indicated that the children were beginning to apply the newly acquired skills, but may have needed more time to consolidate these skills before significant changes on all word-learning measures can be observed. These findings are in line with the reviewed literature reporting that both, semantic and phonological skills are necessary for efficient word-learning (Gray, 2005; Nash & Donaldson, 2005).

Findings of this study did not support the third hypothesis which stated that the order of the implemented interventions would not affect learning outcomes. Distinct differences in the performances of each group were evident. Group A, having received 12 hours of phonological intervention followed by 12 hours of semantic intervention, displayed considerable improvement on producing novel words. The apparent trend to improve performance in the production tasks over time was supported by the effect sizes found for group A on all three word-learning days. In contrast, group B, having received the same interventions as group A in the reverse order, did not demonstrate the same improved performances in word-learning from pre- to post-test on production of new words. Gray (2005) reported that semantic cues might influence comprehension of new words, whereas phonological cues influence production of novel words. However, Gray also emphasised the importance of strong links between phonological and semantic representations of words for successful learning of new words.

Considering the intervention effects, findings of this study revealed that phonological awareness intervention not only significantly improved phonological awareness skills, but also significantly improved semantic skills, indicating that the children in group A had access to both improved phonological and semantic abilities to facilitate word-learning at mid- and post-test. Children in group B however, only displayed enhanced semantic skills at mid-test to support their word-learning and not until post-test were they able to employ additional improved phonological awareness skills. Thus, children in group A had more time to consolidate their phonological awareness and semantic skills than children in group B. As children in group A did not demonstrate significant gains in word-learning until post-test, findings suggest that children in group B might have needed more time to consolidate their acquired skills before significant gains in their word-learning abilities could be observed.

In summary, findings demonstrated that children who received phonological awareness intervention prior to instruction on semantic properties were more efficient in learning to produce new words than children who received the interventions in the reverse order. This finding indicates that children might profit more from semantic intervention following a solid foundation in phonological awareness knowledge to be able to use semantic skills for efficient word-learning.

Considering the theory of limited processing capacity in children with SLI (Alt & Plante, 2006; Ellis Weismer, et al., 1999), the results of the current study suggest that improved phonological awareness skills may have enabled children to more efficiently use their processing capacities. By reducing the demand on phonological processing through their enhanced phonological awareness skills, these children had more resources left for processing all further information. Continued research is necessary to further examine this hypothesis.

CHAPTER 5

INTERVENTION OUTCOMES ON NAMING ERRORS IN CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

5.1 Introduction

In the prior chapter, it was investigated whether an intervention focused at improving children's phonological awareness and semantic skills enhanced the word-learning abilities of children with Specific Language Impairment (SLI). Findings revealed that phonological awareness and semantic intervention enhanced children's word-learning abilities to a certain degree and that treatment order had an effect on word-learning outcomes. Chapter 3 revealed that additionally to quantitative differences, children with SLI displayed qualitative differences when learning new words. More specifically, children with SLI presented with a different error pattern than children with typical language development.

This chapter analysed the erroneous responses of children with SLI on the word-learning probes at pre-, mid-, and post-test and compared the error patterns in order to examine whether children with SLI varied their error patterns after receiving intervention that aimed to facilitate their word-learning skills. Although both groups (group A and group B) displayed significantly improved phonological awareness and semantic skills post-intervention, only limited gains from pre- to post-test were found for word-learning. However, the intervention significantly improved children's fast mapping skills, and children in group A demonstrated improved word-learning production post-intervention. This suggests that children may have started to use their newly acquired skills for learning new words, but that they were not yet efficient enough to demonstrate significant quantitative differences. Thus, a comparison of their error patterns at mid- and post-test may provide an insight into qualitative changes in word-learning and consequently offer a better understanding of intervention influences on word-learning in children with SLI.

An investigation of cueing effects on word-learning outcomes (Chapter 3) indicated that children with SLI learned to comprehend more words that were presented with semantic cues and learned to produce more words when phonological cues were provided. This study extends these findings by examining whether children's word-learning was influenced by teaching condition in correspondence with the received intervention. More specifically, it was investigated whether children learned new words more rapidly when presented with semantic cues following the semantic intervention and phonological cues following the phonological awareness intervention.

The following hypotheses were tested:

1. Children with SLI will change their word-error patterns following each treatment and will display an error pattern that is similar to that of children with typical language development at post-test, and
2. Children with SLI will respond differently to teaching condition during word-learning following the intervention.

5.2 Method

5.2.1 Participants

The participants for this study included the same 19 children with SLI who participated in the intervention study in Chapter 4. All children were assessed on their word-learning skills at pre-, mid-, and post-test. For the intervention study in Chapter 4, the children were randomly separated into two groups: Children in group A (n = 10) received 12 hours of phonological intervention followed by 12 hours of semantic intervention and children in group B (n = 9) received the same interventions in the reverse order. Table 4.1 in Chapter 4 provides an overview of the children's performances on language assessments prior to the intervention. The current study employed the same grouping of the 19 participants into group A and group B.

5.2.2 Procedure

Data collection

All 19 children with SLI were assessed on their word-learning skills at pre-test prior to the commencement of the intervention, at mid-test following the first treatment phase, and at post-test immediately after the completion of both treatments. Appendix F depicts an overview of the timeline of the intervention study including the testing occasions. Details of the procedure of the assessment process of children's word-learning abilities are described in Chapter 2. In brief, children's word-learning skills were tested over 5 consecutive days. During that time, the children were exposed to nine unfamiliar words. Receptive and expressive word-learning was assessed on three different tasks: Fast mapping (FM) on day 1, word-learning (WL) on days 2, 3, and 4, and word-learning test (WLTest) on day 5. There were three different sets of new words, each consisting of nine novel words. The three sets were balanced across children and testing occasions.

<u>Data analysis</u>

Data was analysed for both groups separately to examine whether word-learning in children with SLI was influenced by the order of treatments. Performances of both groups were compared to each other in two different analyses.

First, an error analysis was conducted to examine whether children changed their error patterns following the intervention and whether there was a difference between both experimental groups. Then it was analysed, whether cueing influenced word-learning dependent on the received intervention and whether cueing effects changed over time in connection with the received intervention.

Error analysis

For the error analysis, all responses of the children on production of the new words were coded and categorised in the same manner as described in Chapter 3. Error types were classified as phonological errors, semantic errors, substitutions, random answers, or 'don't know' answers. These error types were further differentiated into subtypes of errors according to the responses of the children. The three subtypes for phonological errors were initial sound of the target word, number of syllables, and a phonologically similar word. The four subtypes for semantic errors were superordinate, attribute, description, and co-ordinate. Substitution errors were differentiated whether the substituted word was phonologically correct or not. Chapter 3 provides a list and examples of the subtypes of errors.

Response to cues

In order to evaluate whether treatment influenced children's word-learning abilities in response to a certain combination of cues, responses of all children from mid- and post-test were categorised into the same teaching conditions PP, SS, and PS as described in Chapter 3. Condition PP consisted of the two phonological cues, condition SS of two semantic cues, and condition PS of one phonological and one semantic cue. For both groups, comprehension and production of the new words were separately scored for WL and WLTest. Scores for WL were accounted according to the 'learned' criterion. That is, a child had to correctly identify or name a novel word on three out of four trials on 2 consecutive days of the 3 WL days. Comprehension and production of new words on the WLTest were scored as learned or not learned as required in the WLTest. Effects of cues on FM was not analysed as the items were not presented with any cues during the FM task.

5.2.3 Reliability

An independent researcher checked approximately 25% of the word-learning probes for reliability purposes. Point-to-point inter-rater reliability for administration of the word-learning probes was 99.2% (98.5% - 99.8%) and for scoring was 100%.

An independent speech-language therapist checked 25% of the scoring for the error coding and cueing. Point-to-point inter-rater agreement on the coding of the errors was 99.76% (98.6% – 100%) and for cueing effects 99.7% (98.8% – 100%). All data were rechecked prior to data entry, and any errors were corrected.

5.3 Results

Two different analyses were conducted to evaluate influences of treatment order on two specific word-learning outcomes. First, repeated measure ANOVAs were conducted to evaluate whether the distribution of the error responses of children with SLI changed after the children received intervention. The second part analysed whether intervention changed children's response to cueing in word-learning using Chi Square analyses.

5.3.1 Error analysis

Repeated measure ANOVAs with the between-subjects variable group (group A and group B) and the within-subject variable time of testing (pre-, mid-, and post-test) were computed for all error types. Analyses revealed significant main effects for time of testing, $F(2,36) = 3.824$, $p = .032$, for error 'don't know' on FM. Post-hoc Bonferroni analyses revealed that there was a significant increase in the use of don't know answers ($p = .042$) from pre- to post-test. Separate repeated measures analyses by group revealed that only group B significantly increased the use of 'don't know' responses, $F(2,16) = 5.323$, $p = .018$. There were no significant differences in the occurrence of errors for either group on any other error types or word-learning tasks (FM, WL, and WLTest) across time of testing.

However, despite the failure to reach significant changes in the occurrence of errors for most of the analyses, the hierarchy of error occurrences on FM changed from pre- to post-test for both groups.

With a maximum score of 27 on the FM task, at pre-test, children in group A mainly produced 'don't know' errors (M: 13.6/SD: 7.9), followed by random errors (M: 4.5/ SD: 7.4), substitutions (M: 3.2/SD: 2.7), phonological errors (M: 2.4/SD:

1.3), semantic errors (M: 2.2/SD: 2.9) and no errors (M 1.1/SD1.2). At mid-test, the most common error response for group A was again 'don't know' errors (M: 15.4/SD: 8.1), which was then followed by substitutions (M: 3.4/SD: 2.4), no errors (M: 2.8/SD: 3.9), random errors (M: 2.1/SD: 3.5), semantic errors (M: 2.0/SD: 4.0), and phonological errors (M: 1.3/SD: 1.3). After having received both interventions, the hierarchy of errors occurrences was as follows: 'don't know' errors (M: 15.7/SD: 5.9), phonological errors (M: 3.3/SD: 2.4), substitutions (M: 2.4/SD: 1.8), no errors (M: 2.3/SD: 2.5), random errors (M: 1.8/SD: 2.9), and semantic errors (M: 1.5/SD: 1.8) at post-test.

At pre-test, the most common error response for children in group B was also 'don't know' errors (M: 9.1/SD: 7.8) followed by random errors (M: 5.7/SD: 3.0), semantic errors (M: 4.3/SD: 4.9), phonological errors (M: 4.3/SD: 2.9), substitutions (M: 2.8/SD: 3.0), and no errors (M: .8/SD: 1.4). Following the semantic intervention, children in group B displayed at mid-test mainly 'don't know' errors (M: 12.3/SD: 6.4), and again followed by random errors (M: 5.4/SD: 5.0), phonological errors (M: 3.1/SD: 1.7), no errors (M: 2.8/SD: 1.8), substitutions (M: 2.6/SD: 2.6), and semantic errors (M: .8/SD: 1.6). At post-test, the error occurrences were as follows: 'don't know' errors (M: 15.6/SD: 6.1), no errors (M: 3.7/SD: 2.1), random errors (M: 3.0/SD: 4.4), phonological errors (M: 2.3/SD: 1.5), substitutions (M: 1.8/SD: 1.9), and semantic errors (M: .7/SD: 1.1). At post-test, children in group A demonstrated the same error pattern as children with typical language development displayed in Chapter 3. Figures 5.1 to 5.6 present the distribution of the error types across time for FM, WL, and WLTest for both groups in percentage scores. Table 5.1 displays a comparison of all error subtypes for group A and group B on post-test and for the control group as examined in Chapter 3.

There were no changes in error patterns from pre-to post-test on WL for either group. Children with SLI displayed the same error pattern on WL as children with typical language development at pre-test (as discussed in Chapter 3) and maintained the same error pattern at mid- and post-test. That is, children in both groups mainly produced no errors, followed by 'don't know errors, substitutions, phonological errors, semantic errors and random errors. Table 5.2 presents the distribution of subtypes of errors for both groups on WL at post-test and for the control group as examined in Chapter 3. Responses on WLTest are based on a maximum of 9 correct answers. Consequently, the distribution of errors needs to be carefully interpreted.

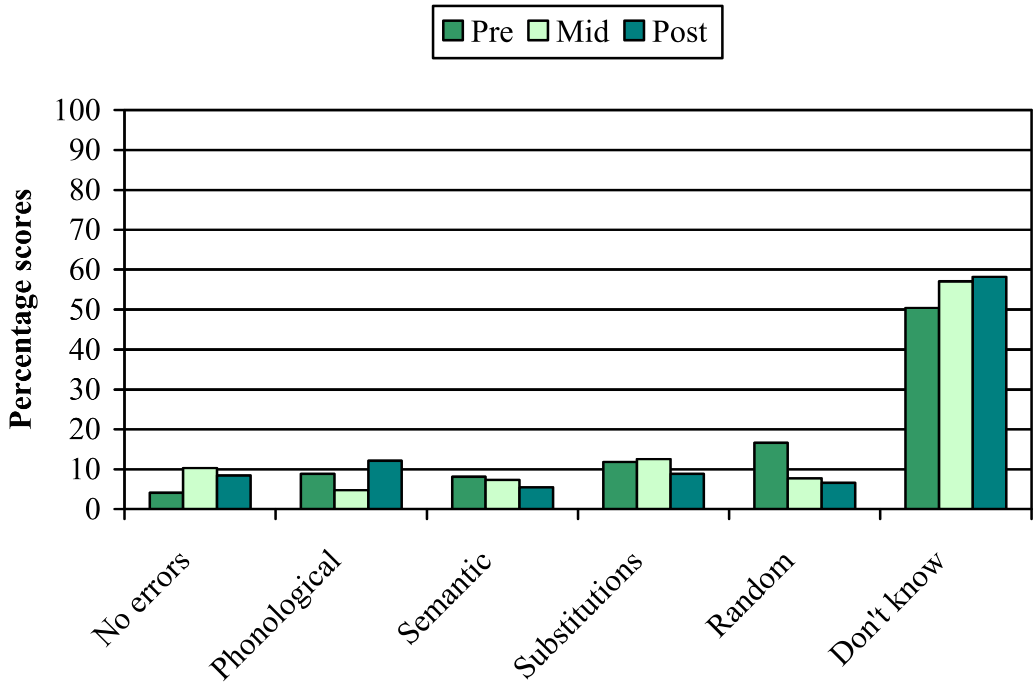

Figure 5.1. Performances of group A on FM on all three testing occasions.

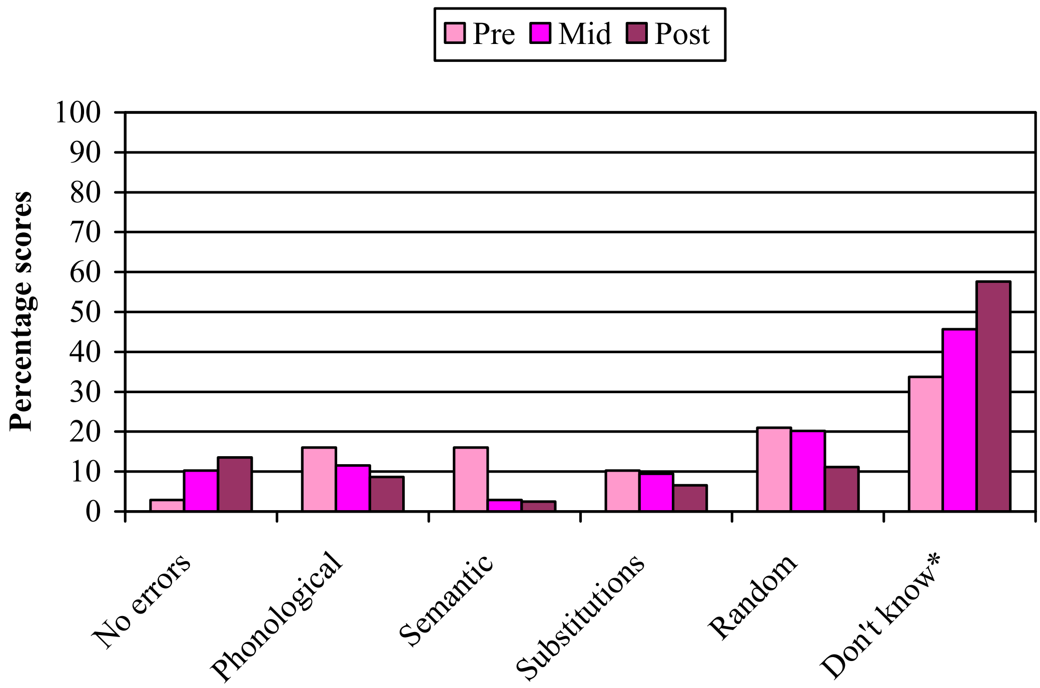

Figure 5.2. Performances of group B on FM on all three testing occasions.
*** indicates significant difference from pre- to post-test at the level of $p < .05$.**

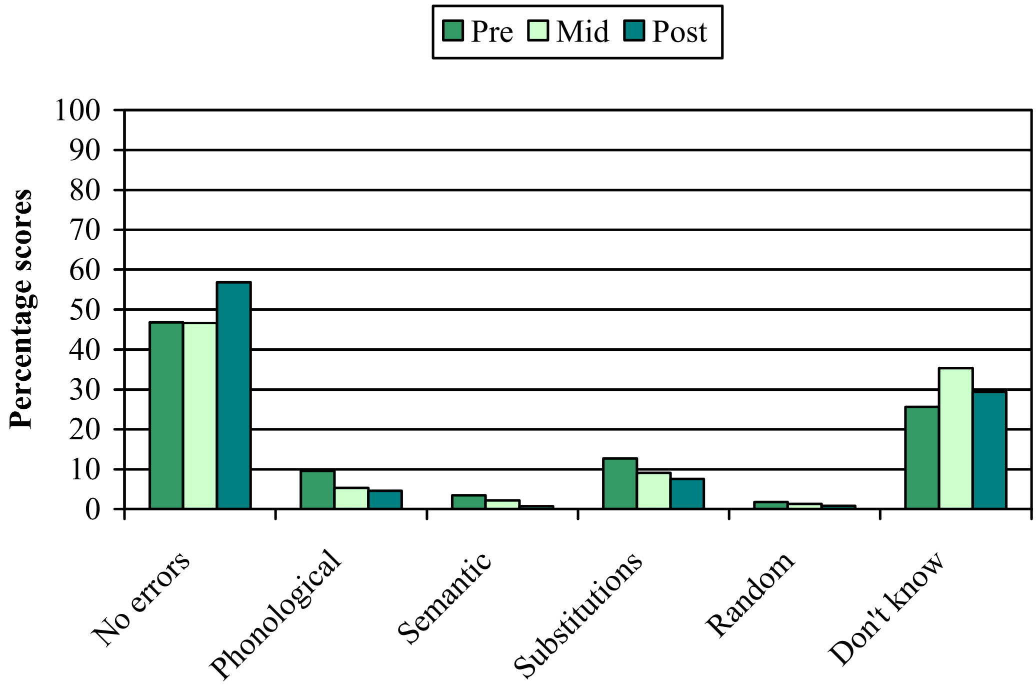

Figure 5.3. Performances of group A on WL on all three testing occasions.

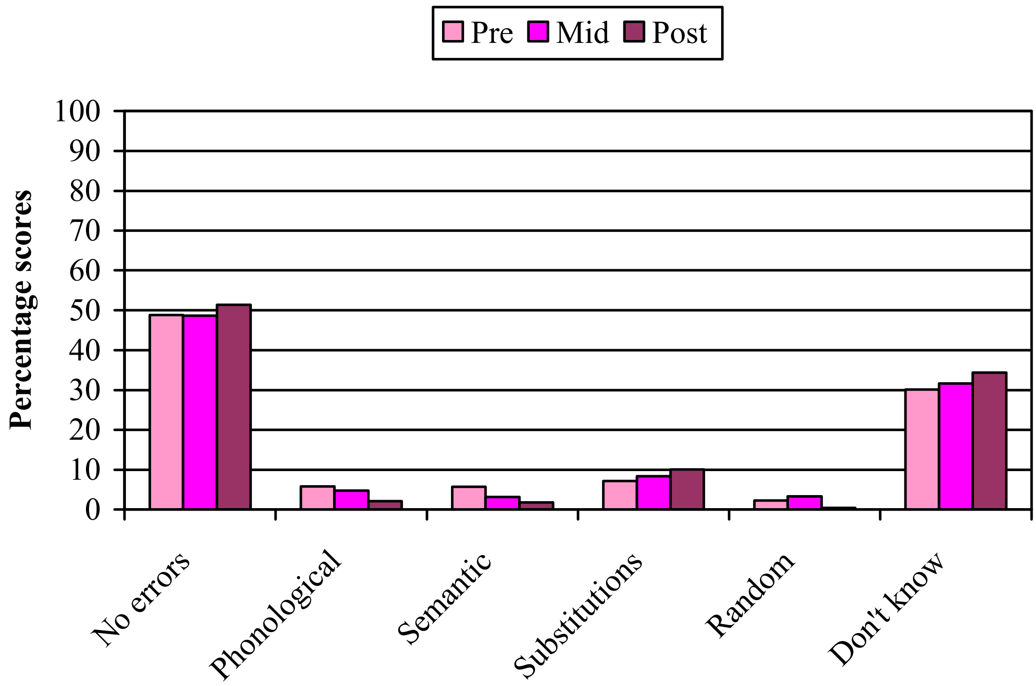

Figure 5.4. Performances of group B on WL on all three testing occasions.

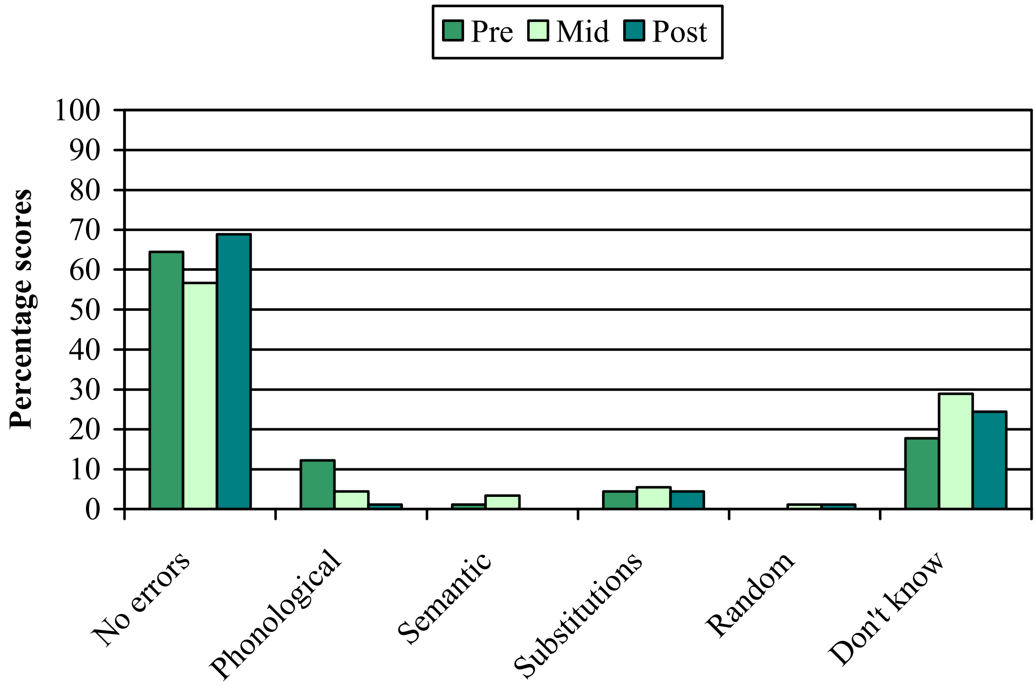

Figure 5.5. Performances of group A on WLTest on all three testing occasions.

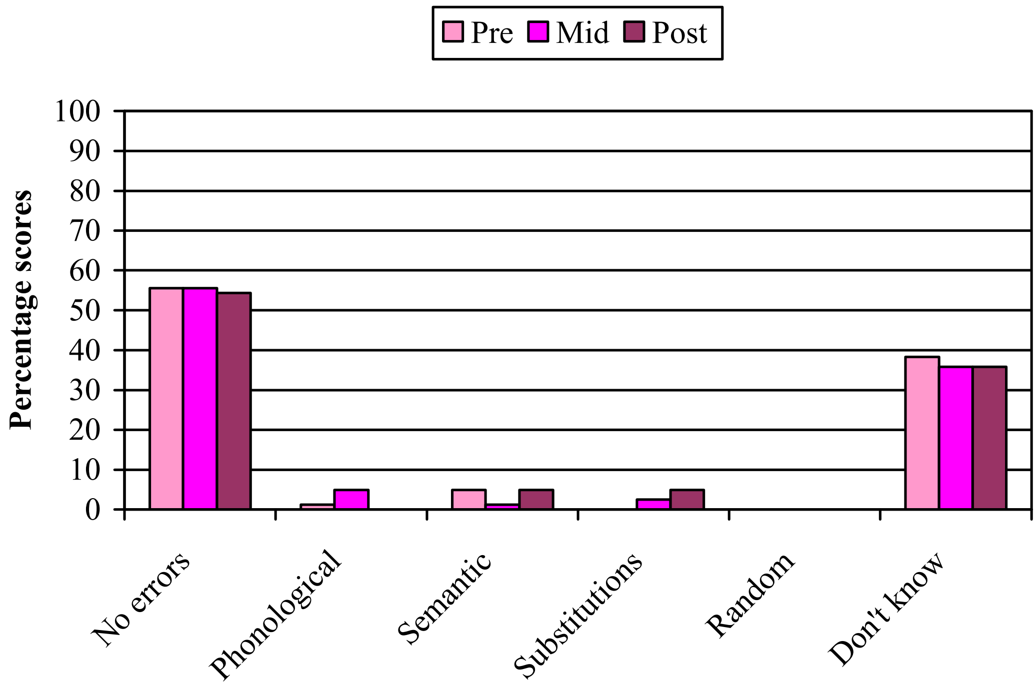

Figure 5.6. Performances of group B on WLTest on all three testing occasions.

Table 5.1. Comparison of distribution of error subtypes for group A and B at post-test and control group at pre-test on FM in percentage scores

		Group A at post-test		Group B at post-test		Control group at pre-test	
Error type	Error subtype	M	SD	M	SD	M	SD
No errors	Correct response	8.52	9.25	13.58	7.86	20.37	14.66
Phonological errors	Initial phoneme	3.70	4.62	2.06	4.94	2.67	3.96
	Syllables	0	-	0	-	0	-
	Phonologically similar word	8.52	7.21	6.58	4.82	11.52	7.48
Semantic errors	Superordinate	3.70	4.94	2.06	3.27	.63	2.63
	Attribute	0	-	0	-	.81	3.48
	Describe	0	-	0	-	.22	.89
	Coordinate	1.85	4.7	.41	1.23	1.22	3.81
Substitution	Wrong item from same set	2.59	2.50	4.53	5.79	2.67	4.89
	Wrong item from same set with phonological errors	6.30	5.80	2.06	2.69	4.33	7.67
Random	Unrelated item	6.67	10.59	11.11	16.25	3.91	5.46
Don't know	'don't know'	58.15	22.02	57.61	22.46	51.85	20.84

Table 5.2. Comparison of distribution of error subtypes for group A and B at post-test and control group at pre-test on WL in percentage scores

		Group A at post-test		Group B at post-test		Control group at pre-test	
Error type	Error subtype	M	SD	M	SD	M	SD
No errors	Correct response	56.85	18.66	51.33	19.75	86.21	12.84
Phonological errors	Initial phoneme	1.30	2.06	.21	.62	.41	.73
	Syllables	0	-	0	-	0	-
	Phonologically similar word	3.24	2.01	1.85	2.41	1.03	1.31
Semantic errors	Superordinate	.46	1	.62	1.85	.21	.40
	Attribute	0	-	.28	.65	0	-
	Describe	0	-	0	-	.05	.22
	Coordinate	.28	.62	.82	1.57	.05	.22
Substitution	Wrong item from same set	6.20	4.49	9.26	5.91	3.14	5.90
	Wrong item from same set with phonological errors	1.39	1.25	.82	1.42	.82	1.68
Random	Unrelated item	.83	1.11	.41	.49	.10	.30
Don't know	'don't know'	29.44	14.55	34.36	19.37	7.97	7.95

5.3.2 Response to cues

Chi-Square tests were conducted in order to analyse whether intervention influenced children's response to cueing during word-learning. Analyses were conducted for each of the three conditions (PP = two phonological cues, SS = two semantic cues, PS = one phonological and one semantic cue), for both comprehension and production on WL and WLTest. Chi-Square test statistics revealed no significant difference ($p > .05$) for group A and B on learning condition at any time of testing. However, there was a near-significant trend for group B to correctly produce more new words on WLTest at mid-test ($p = .058$) in condition SS and PS than in condition PP and to correctly comprehend more new words during WL at post-test ($p = .076$) in condition PP and PS.

An analysis of the descriptive measures was implemented to determine which conditions facilitated the learning of new words most, despite the shortcoming of significant findings. Based on the crosstab data of the Chi-Square tests, percentage scores of correct answers were calculated for production and comprehension on WL and WLTest at each time of testing. Table 5.3 displays the percentage scores of correct answers by conditions PP, SS, and PS for group A and B at pre-, mid-, and post-test.

Following intervention phase 1, group A, having received 12 hours of phonological awareness intervention, learned to produce and comprehend more new words when they were presented with two phonological cues than in conditions SS and PS. Group B, following 12 hours of semantic treatment, learned to comprehend more novel words that were presented with two semantic cues and learned to produce more new words in condition PS. At post-test, after group A and B received both treatments, all children learned to produce more new words that were presented with two phonological cues. Comprehension of new words at post-test varied for both groups: On WL Comprehension, both groups learned more words in condition PP, whereas on WLTest Comprehension group B scored higher in condition PS and group A in condition SS.

Table 5.3. Percentage of correct answers by conditions PP, SS, and PS for group A and B at pre-, mid-, and post-test

	WL Comprehension		WLTest Comprehension		WL Production		WLTest Production	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
Pre-test								
Condition PP	**80.0**	**88.9**	**96.7**	**88.9**	**46.7**	**51.9**	**73.3**	**59.3**
Condition SS	**80.0**	**88.9**	**100**	**100**	**46.7**	**51.9**	**56.7**	**59.3**
Condition PS	**90.0**	**88.9**	**93.3**	**92.6**	**33.3**	**48.1**	**63.3**	**48.1**
Mid-test								
Condition PP	**86.7**	**77.8**	**100**	**88.9**	**46.7**	**40.7**	**63.3**	**37.0**
Condition SS	**83.3**	**81.5**	**93.3**	**92.6**	**43.3**	**37.0**	**53.3**	**63.0**
Condition PS	**83.3**	**81.5**	**90.0**	**88.9**	**43.3**	**51.9**	**53.3**	**66.7**
Post-test								
Condition PP	**86.7**	**85.2**	**93.3**	**88.9**	**63.3**	**59.3**	**76.7**	**59.3**
Condition SS	**83.3**	**63.0**	**96.7**	**88.9**	**50.0**	**37.0**	**70.0**	**44.4**
Condition PS	**76.7**	**85.2**	**93.3**	**92.6**	**53.3**	**51.9**	**60.0**	**59.3**

Note. Condition PP, two phonological cues; Condition SS, two semantic cues; Condition PS, one phonological and one semantic cue.

5.4 Discussion

In this chapter, the effects of the implemented interventions on children's error patterns, when production of new words was tested in a word-learning paradigm, were analysed. Furthermore, this study investigated whether the treatment order of the implemented intervention influenced these outcomes. For this purpose, the erroneous responses of children with SLI were analysed by group at pre-, mid-, and post-test. The second part of this study examined whether the response to cues during word-learning changed for children with SLI after receiving two different treatments.

The first hypothesis stated that children with SLI will adapt their error patterns to the pattern of children with typical language development following intervention. Findings of this study partially supported this hypothesis. Children in group A revealed a different error pattern on FM at mid-test after receiving 12 hours of phonological awareness intervention and at post-test after receiving additionally 12 hours of semantic intervention. The error pattern displayed by group A at post-test is the same as the error pattern demonstrated by children with typical language development as described in Chapter 3. Children in group B, who received 12 hours of semantic intervention followed by 12 hours of phonological awareness intervention, presented with a different error pattern on FM at mid-test and maintained that same error pattern at post-test. These findings indicate that the implemented treatment influenced the responses of children with SLI and that treatment order played a considerable role.

Prior to the intervention (as discussed in Chapter 3), children with SLI displayed a different error pattern on FM of new words compared to children with typical language development. The second most frequent error type during FM for children with SLI was random errors, in contrast to children with typical language development who employed random errors as one of the least frequent error types. The use of random answers is of great concern as discussed in Chapter 3, as it implies that children are most likely not employing phonological or semantic strategies when learning new words. Following the intervention, both, group A and group B, used less random answers and more often the explicit answer ‘don’t know’ when they were not sure of the name of the novel word. However, findings did not reach significance for the occurrence of error types from pre- to post-test, except for ‘don’t know’ answers for group B. This result could be limited by the fact that the groups were small and that there was a wide error distribution.

Children in group A changed their error patterns on FM following the interventions and demonstrated specific error patterns according to the received treatment. After receiving 12 hours of phonological awareness intervention, children in group A presented with considerably less random errors (more than 50% less) at mid-test than at pre-test. Furthermore, the second most frequent error type (after ‘don’t know’) at mid-test for group A was substitutions, indicating that children relied more on phonological representations even if they were not able to match them with the correct semantic representation. At post-test, after children in group A received additional semantic intervention, the second most frequent error type (after ‘don’t know’) was phonological error. This indicated that following both interventions, children in group A were generally able to match the correct semantic representation to the correct item and were trying to label the correct items, but were not able to produce the correct phonological form.

Children in group B presented with different error patterns on FM than children in group A. Following the first treatment phase, where children in group B received 12 hours of semantic intervention, there was a considerable drop in semantic errors from 16% to 3%. The second most frequent error type (after ‘don’t know’) at mid-test remained random answers, as it was at pre-test. After receiving 12 hours of phonological awareness intervention following their 12 hours of semantic intervention, children in group B reduced the production of random errors by approximately 50% at post-test. However, it still remained the second most frequent error type after ‘don’t know’, followed by phonological errors. Thus, findings indicate that depending on the treatment the children received, different error patterns emerged. Phonological awareness intervention appears to support children in reducing the use of random answers, whereas semantic instruction appears to support children to focus on the phonological representation and to match the correct phonological representation with the correct semantic representation.

Findings of this study partially supported the second hypothesis stating that children with SLI will respond to cueing depending on the received treatment. There were no significant effects of cueing on children’s word-learning abilities across all three testing occasions. However, descriptive data revealed that children responded differently to cues over time. After receiving the phonological awareness intervention, children in group A learned more words that were presented with phonological cues at mid-test. Similarly, children in group B learned to comprehend more words in the semantic condition at mid-test, following the semantic intervention. These findings indicate that the implemented interventions positively influenced children’s response to cues. It appears that treatment may have primed the children to focus on the words that were presented with the cues that targeted the same features (semantic or phonological) as facilitated in the intervention children had just received, which consequently facilitated learning the word. However, children in group B responded more positively to the combined condition, where words were presented with one semantic and one phonological cue for producing new words. This suggests that phonological cues play a role in the production of new words, even when children are focussing on the semantic features to learn new words. The degree of this role requires further investigation. The findings are in line with prior results in Chapter 3 and are further supported by the findings from post-test. After the completion of both treatments, group A and B displayed similar rankings, with production of new words highest when the words were presented with two phonological cues.

In summary, a combined phonological awareness and semantic intervention focused at improving word-learning skills demonstrated considerable influence on the qualitative performance of children with SLI during word-learning. Over the course of both treatments, children with SLI were able to change their error patterns and reduce the use of unrelated answers. As in the quantitative analyses in Chapter 4, treatment order also influenced outcomes on the qualitative level: only children in group A were able to approach the same error pattern as children with typical language development displayed following both treatments. The analysis of responses to cues highlighted the importance of phonological cues on the production of new words, indicating that knowledge about phonological features of a word facilitates the ability to produce the new word for children with SLI.

There were some limitations to this study which appear to be caused by the same factor. The shortcoming of almost all statistical data analyses to reach significant levels may be caused by the small sample sizes for analyses of these types. Especially the balancing of the three word-learning sets across time and participants, which was necessary for validity of the word-learning probes, resulted in somewhat small sample sizes for each time of testing. Nevertheless, descriptive analysis revealed emerging patterns that warrant for further investigation.

However, when interpreting the results, it is important to consider the findings of Chapter 4, where children in group A demonstrated improved phonological awareness and semantic skills at mid-test. Thus, children in group A had more time to consolidate their skills by post-test than children in group B who only demonstrated improved phonological awareness skills at post-test. Children in group B might have needed more time to consolidate their skills before similar improvements could have been observed. Consequently, it is important to monitor children's progress over time following intervention to allow them to transfer their acquired skills. The next chapter provides a report on the language profiles of the participants in the current study at 6 months post-intervention.

CHAPTER 6

A FOLLOW-UP STUDY EXAMINING THE EFFECTIVENESS OF PHONOLOGICAL AWARENESS AND SEMANTIC INTERVENTION ON CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

6.1 Introduction

The findings of the study reported in Chapter 4 demonstrated that children with Specific Language Impairment (SLI) made significant gains in their phonological awareness and semantic skills following an intervention that aimed to improve word-learning abilities in children with SLI. This study extends on the intervention study reported in Chapter 4 by examining treatment effects 6 months following the completion of the intervention.

It is important to monitor the progress of the children following the intervention in order to evaluate whether the children were able to maintain their achieved gains and whether they are consolidating and employing their acquired skills. Children with SLI often present with a range of difficulties in various language areas including semantics (i.e., vocabulary deficits), morphosyntax (i.e., difficulties with bound morphemes), and phonology (i.e., poor phonological memory) (e.g., Leonard, 1998). Thus, it is essential to promote the children's underlying skills to support them to become more independent learners so they can profit more efficiently from their learning environment. The implemented intervention enhanced semantic and phonological processing skills, two essential processes underlying word-learning (Gray, 2004), in order to advance the word-learning abilities of children with SLI. Findings of the intervention study demonstrated that the combined intervention was successful in facilitating children's word-learning when phonological awareness was implemented first followed by semantic intervention.

The current study evaluated the phonological awareness, semantic, vocabulary, reading, and general language development in children with SLI 6 months after they had participated in an intervention study that targeted phonological awareness and semantic skills. Specifically, the following questions were addressed:

1. Are children able to maintain their gains 6 months post completion of the intervention,
2. Are children able to transfer their improved skills to other language domains, and
3. Does treatment order effect long-term outcomes for participants by group?

6.2 Method

6.2.1 Participants

Eighteen of the 19 children with SLI, who received the interventions as described in Chapter 4, were re-assessed 6 months following the completion of the intervention. The one child, who was not available, has moved to Australia and could consequently not be re-assessed. Chapter 2 provides an in-depth description of the participants in this study. Following the intervention, one child received reading recovery for 2 terms (20 weeks) and four children attended a learning support group for two terms (6 hours / week). In the learning support group, children's oral language skills were facilitated utilising the *Talk to learn* programme (van der Wal, de Candole, de Vries, & Cameron, 2001). This programme is based on the New Zealand Primary curriculum and aims to support teachers to provide additional language instruction for children aged 5 to 8 years, who present with delayed oral language skills. All other children did not receive any additional support or intervention post-intervention.

6.2.2 Procedure

All children with SLI were re-assessed on the same assessment battery of standardised and norm-referenced tests as described in Chapter 2. Additional experimental probes were administered to evaluate whether children's gains following the intervention were maintained. All assessments and probes were carried out by a speech language therapist and were administered individually to each child in a quiet room at the child's school. The order of assessments and probes was randomised and children were assessed on varying times during the day to avoid that effects of timing may influence children's performances. The Test of Nonverbal Intelligence 3rd

Edition (TONI-3; Brown, et al., 1997) and the word-learning probes (Gray, 2005) were not re-assessed at follow-up testing.

Assessment measures

Standardised and norm referenced assessments

The following assessment battery was administered to all children with SLI 6 months after the completion of the intervention. A detailed description of these assessments is provided in Chapter 2.

- Clinical Evaluation of Language Fundamentals 4th Edition (CELF-4, Semel, et al., 2006)
- Peabody Picture Vocabulary Test 4th Edition (PPVT-4, Dunn & Dunn, 2006)
- Structured Photographic Expressive Language Test 3rd Edition (SPELT-3; Dawson, et al., 2003)
- Queensland University Inventory of Literacy (QUIL; Dodd, et al., 1996)
- Neale Analysis of Reading Ability 3rd Edition (NARA-3; Neale, 1999)
- Burt Word Reading Test New Zealand Revision (BURT, Gilmore, et al., 1981)

Experimental measures

Following the intervention, all participants with SLI significantly improved their performances on the experimental probes, indicating that the intervention was effective in improving children's semantic, phonological awareness, and decoding skills. The same experimental probes were re-administered at follow-up. A detailed description of these assessments is provided in Chapter 2.

The experimental probes consisted of the following:

- Semantic Probes
- Phonological Awareness Probes (PA Probes; Stahl & Murray, 1994)
- Non-Word Reading Probes (NWR Probes; Calder, 1992)

6.2.3 Reliability

All assessments were recorded on a digital voice recorder (Panasonic; RR-US050). The author administered, transcribed, and scored all assessments and assessment probes. All standardised and norm referenced tests were administered and scored according to the examiner's manual. The experimental probes were administered and scored as described. An independent researcher checked 25% of all assessment data on three levels: administration, transcription and scoring. Inter-rater agreement on administration and scoring of the standardised assessments was 100% and 97.6%, respectively and on administration and scoring of the norm referenced tests was 100% and 99.7%, respectively.

For the PA, NWR, and Semantic probes, inter-rater agreement on administration was always 100% and point-to-point inter-rater agreement for scoring was 99.5% (92.5% – 100%). Any inter-rater discrepancies regarding the transcription were resolved by consensus after repeated listening to the audio files. The author rechecked all data prior to data entry and any errors were corrected.

6.3 Results

First, repeated measures ANOVAs were calculated for pre-, post- and follow-up assessment on the experimental probes in order to evaluate whether children with SLI were able to maintain their gains from post-test, immediately following the completion of the intervention. Then, a range of Analyses of variances (ANOVAs) was conducted to evaluate differences on the performances of the children with SLI on the standardised and norm-referenced assessments at pre-intervention and follow-up assessment. Finally, group differences at follow-up between the intervention groups as described in Chapter 4 (group A: 12 hours of phonological awareness intervention followed by 12 hours of semantic intervention and group B: same interventions in reverse order) were calculated using one-way ANOVAs.

The effect size index f with the conventional values of small $f = 0.10$, medium $f = 0.25$ and large $f = 0.40$ was used to calculate effect sizes. An alpha level of .05 was utilised for all statistical analyses. Data that failed the Kolmogorov-Smirnov normality test were transformed into logarithms and re-analysed. If the assumption of sphericity was not satisfied on all repeated measures ANOVAs on the Mauchly's Test of Sphericity, the Greenhouse-Geisser adjustment was utilised. For all standardised assessments, standard scores were utilised for data evaluation, whereas raw scores were utilised for data analyses of the experimental probes and the norm referenced assessments.

6.3.1 *Comparison of performances on experimental probes at pre-, post-, and follow-up assessment*

A range of repeated measures Analyses of Variances (ANOVAs) and Bonferroni adjustment tests were conducted to evaluate the group performances at pre-, post-, and follow-up-assessment on the experimental probes. Participants' scores on the PA, Semantic, and NWR Probes were analysed with the between-subjects variable group (group A and B) and the within-subjects variable time of testing (pre-, post-, and follow-up-test). There was a significant main effect for time of testing for the PA probes, $F(1.35, 34) = 115.76$, $p < .001$, for the semantic probes $F(2,34) = 43.24$, $p < .001$, and for the NWR probes for phonemes, $F(2,34) = 18.85$, $p < .001$. Bonferroni analyses indicated significant gains from pre- to post-test for all three measures ($p < .001$) and no significant changes from post-test to follow-up ($p = 1$ for phonological awareness probes and for NWR probes for phonemes; $p = .529$ for semantic probes). For NWR probes for words, there were significant main effects for time of testing $F(2,34) = 16.77$, $p < .001$, and time of testing x group, $F(2,34) = 4.36$, $p = .021$. Figures 6.1 to 6.4 present participants' performances on all four measures at pre-, post-, and follow-up assessment.

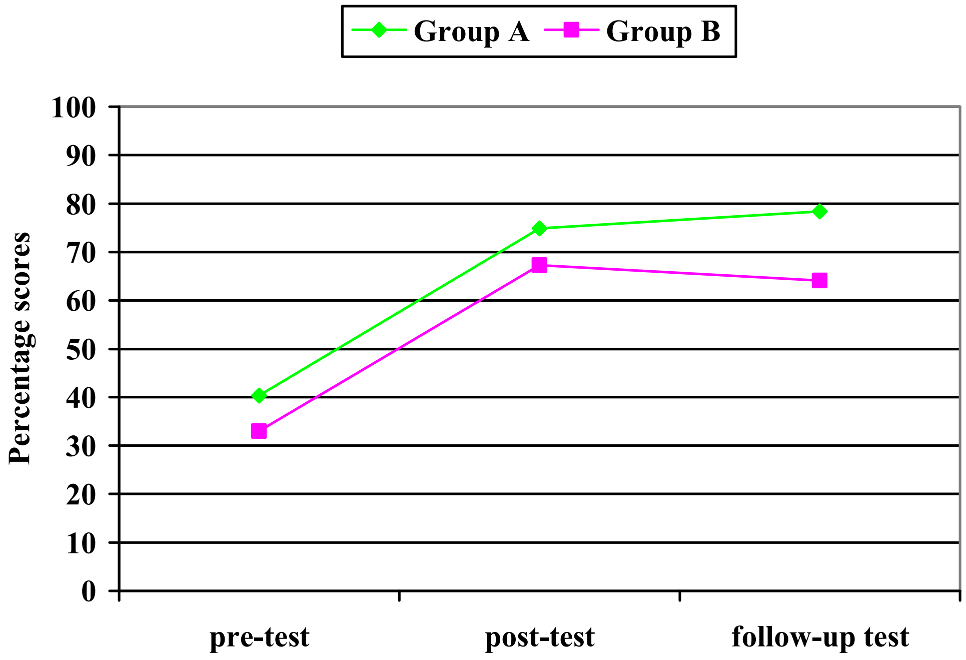

Figure 6.1. Performance of group A and B at pre-, post-, and follow-up testing on Phonological awareness probes in percentage scores.

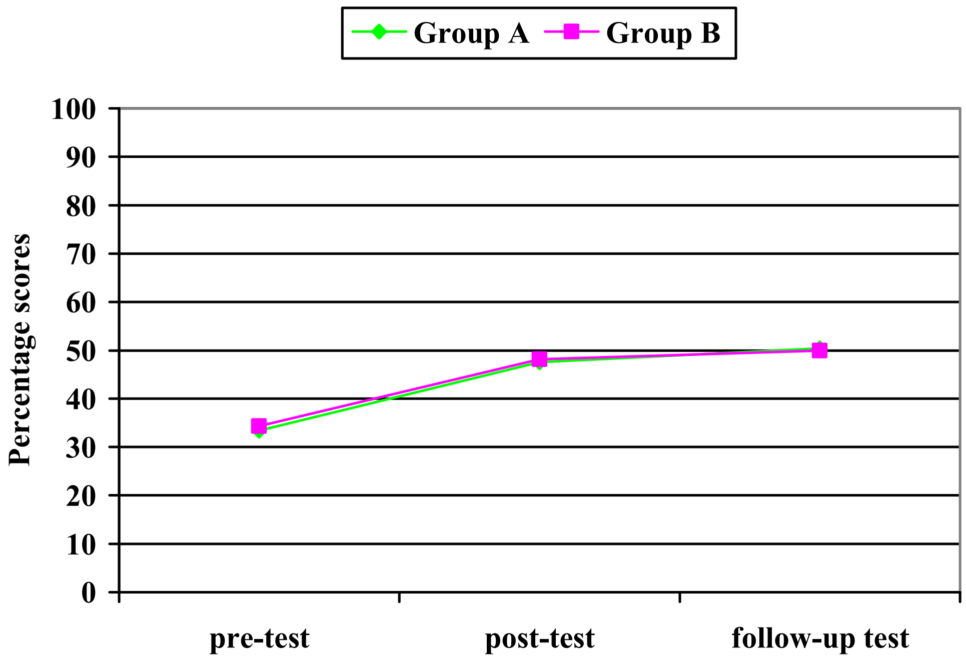

Figure 6.2. Performance of group A and B at pre-, post-, and follow-up testing on Semantic probes in percentage scores.

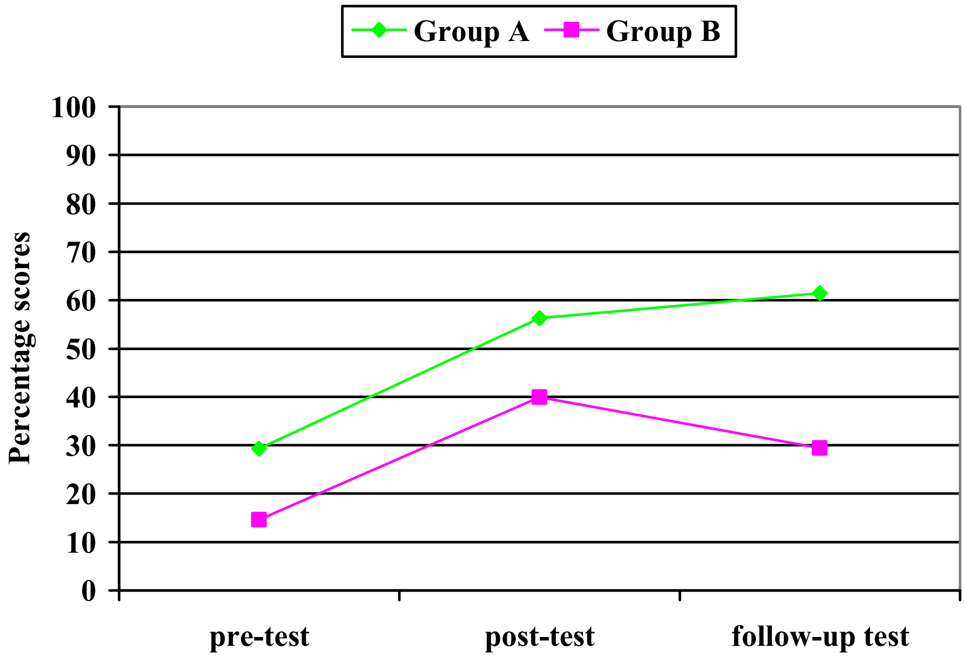

Figure 6.3. Performance of group A and B at pre-, post-, and follow-up testing on Non-word Reading probes for correct phonemes in percentage scores.

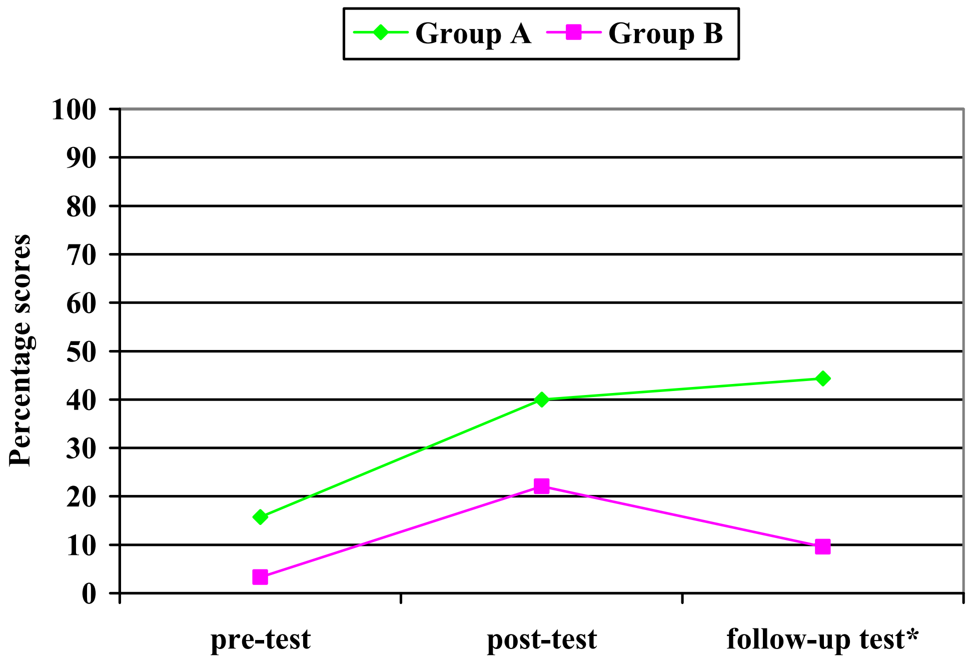

Figure 6.4. Performance of group A and B at pre-, post-, and follow-up testing on Non-word Reading probes for correct words in percentage scores.
* indicates significant group difference at the level of $p < .05$.

6.3.2 *Comparison of pre-assessment to follow-up assessment scores*

One way ANOVAs with the independent variable time (pre- and follow-up-assessment) and the dependent variable tests were conducted to evaluate whether children with SLI improved their scores on standardised and norm-referenced language tests. Following the intervention, children with SLI significantly improved their performances on the broad spectrum language test (CELF-4) as well as on the morphosyntactic language test (SPELT-3). Furthermore, the children's reading accuracy of connected text and single word reading improved significantly after receiving the interventions. Table 6.1 reports the performance scores of the children with SLI at pre- and follow-up-testing.

Table 6.1. Participants' scores on selected assessments at pre- and follow-up-testing

	Pre Ax (n = 19)		FU Ax (n =18)				
	Mean	SD	Mean	SD	*F*	*p*	*f*
PPVT-4	86	7.1	89	6.3	1.647	.208	.22
CELF-4	71.7	6.3	78.7	8.3	8.248	.007*	.49
SPELT	88.8	7.5	95.1	7.3	6.751	.014*	.44
Q-NWS	4.8	1	4.6	1.9	.123	.728	.06
Q-NWR	4.8	1.7	4.8	2.7	.004	.953	.01
Q-SID	5.4	2.8	6.8	3.5	1.838	.184	.23
Q-SS	6.1	3	6.8	2.7	.696	.410	.14
Q-RR	4.7	3.2	4.8	2.8	.002	.967	.01
Q-S	6	1.5	5.7	1.9	.236	.630	.08
Q-PD	4.9	2.2	6.6	2.8	4.127	.05	.34
Q-PS	7.3	2.4	9.8	3	7.507	.01*	.46
Q-PM	4	1.3	5.1	3.6	1.403	.244	.2
NARA-3 Acc	9.7	6.6	17.1	10.3	6.868	.013*	.44
NARA-3 Com	3.3	2	4.6	2.7	2.709	.109	.28
BURT	15.7	8.9	27.6	12.6	11.129	.002*	.56

Note. Pre Ax, Pre-assessment; FU Ax, Follow-up-assessment; PPVT-4, Peabody Picture Vocabulary test 4th Edition standard scores; CELF-4, Clinical Evaluation of Language Fundamentals 4th Edition standard scores; SPELT, Structured Photographic Expressive Language Test 3rd Edition standard scores; Q, Queensland University Inventory of Literacy standard scores; NWS, Non-Word Spelling subtest; NWR, Non-Word Reading subtest; SID, Syllable Identity subtest; SS, Syllable Segmentation subtest; RR, Rhyme Recognition subtest; S, Spoonerisms subtest; PD, Phoneme Detection subtest; PS, Phoneme Segmentation subtest; PM, Phoneme Manipulation subtest; NARA-3, The Neale Analysis of Reading Ability 3rd Edition; Acc, Reading Accuracy raw scores; Com, Reading Comprehension raw scores; BURT, Burt Word Reading Test New Zealand Revision raw scores; * Significant group difference at the level of $p < .05$.

6.3.3 Comparison of follow-up-assessment scores of children with SLI

A range of univariate ANOVAs was conducted to evaluate whether there was a significant group difference between group A and B on follow-up assessments with consideration of pre-assessment performances. The between-subjects variable was group (group A and B), the dependent variable was the assessment at follow-up testing, and the WLS weight was performance on the same assessment at pre-test. Performances of both groups on the standardised and norm-referenced tests are displayed in Table 6.2. There were significant group differences on all reading measures, with group A outperforming group B on all measures. Additionally, group A scored significantly higher on some subsets of the QUIL, namely the non-word spelling subtest and two phoneme level subtests: detection and manipulation.

Table 6.2. Performances of group A and B on standardised and norm-referenced assessments at follow-up testing

	Group A (n = 10)		Group B (n =8)				
	Mean	SD	Mean	SD	F	p	f
PPVT-4	91.2	6	86.5	6.1	2.701	.12	.41
CELF-4	79.3	9.3	77.9	7.3	.125	.728	.09
SPELT	94.9	5.2	95.4	9.7	.018	.895	.03
Q-NWS	5.6	2.1	3.4	.5	8.327	.011*	.72
Q-NWR	6.1	3.1	3.3	.7	6.534	.021*	.64
Q-SID	7.6	3	5.8	4	1.255	.279	.28
Q-SS	7.2	2.7	6.4	2.7	.412	.53	.16
Q-RR	5.5	3.2	3.9	2.1	1.498	.239	.31
Q-S	6.3	1.7	5	2.1	2.142	.163	.37
Q-PD	7.7	2.9	5.1	2	4.579	.048*	.54
Q-PS	10.8	2.3	8.5	3.5	2.816	.113	.42
Q-PM	6.7	4.3	3	0	5.932	.027*	.61
NARA-3 Acc	22.1	9.8	10.9	7.2	7.298	.016*	.68
NARA-3 Com	5.9	2.6	3	2.1	6.579	.021*	.64
BURT	34.4	11.2	19	8.5	10.357	.005*	.81

Note. PPVT-4, Peabody Picture Vocabulary Test 4th Edition standard scores; CELF-4, Clinical Evaluation of Language Fundamentals 4th Edition standard scores; SPELT, Structured Photographic Expressive Language Test standard scores; Q, Queensland University Inventory of Literacy standard scores; NWS, Non-Word Spelling subtest; NWR, Non-Word Reading subtest; SID, Syllable Identity subtest; SS, Syllable Segmentation subtest; RR, Rhyme Recognition subtest; S, Spoonerisms subtest; PD, Phoneme Detection subtest; PS, Phoneme Segmentation subtest; PM, Phoneme Manipulation subtest; NARA-3, The Neale Analysis of Reading Ability 3rd Edition; Acc, Reading Accuracy raw scores; Com, Reading Comprehension raw scores; BURT, Burt Word Reading Test New Zealand Revision raw scores; * Significant group difference at the level of $p < .05$.

6.4 Discussion

In this study it was investigated whether children with SLI were able to maintain their improvements 6 months following the completion of an intervention and whether they were able to transfer their improved skills to other language domains. Furthermore, this study examined whether treatment order affected the long-term outcomes of participants.

The findings revealed that children with SLI were able to maintain the gains they achieved following a combined intervention that targeted phonological awareness and semantic skills 6 months after the completion of the treatment. Group A, which received phonological awareness intervention prior to semantic intervention demonstrated continuous gain on phonological awareness, semantic, and non-word reading skills, both for phonemes and for words, post intervention. Similarly, group B, having received the same interventions in the reverse order, also displayed continuous improvement in their semantic skills and despite a slight decline in performance on phonological awareness and non-word reading for words and phonemes, maintained the abilities as there were no significant differences between the scores at post-test, immediately following the intervention, and 6 months later at follow-up testing. However, there were significant group differences at follow-up testing on non-word reading for words, as children in group A were continuing to improve their skills, whereas children in group B demonstrated a decline in their abilities to decode nonwords.

Findings furthermore revealed that children were also able to transfer their acquired skills to other areas that were not directly targeted, as significant improvements were found in reading skills and performances in both a morphosyntactic and a broad spectrum language test at follow-up testing. These results suggest that intervention targeting underlying language skills also improves language abilities independently. More specifically, facilitating children's phonological awareness and semantic processing skills appears to enhance not only semantic and phonological skills, but also morphosyntactic abilities. Considering the theory of limited processing capacity in children with SLI, these findings highlight the importance of strengthening the underlying language skills of children with SLI. Providing the children with strategies that strengthen their phonological and semantic processing skills allows them to more efficiently use the available processing resources and access further information that might have been inaccessible before.

However, results also demonstrated significant group differences at follow-up testing. Children in group A outperformed children in group B at follow-up testing on all reading measures. This indicates that children in group A, who had more time to consolidate their phonological awareness skills, benefited from early phonological awareness intervention in their reading abilities. These findings are in line with the results from the first analysis in this chapter, demonstrating that children in group A continued to improve on their reading skills following the intervention. As discussed in Chapter 4, the same order of treatments (phonological awareness followed by semantic intervention) also appears to be more beneficial for word-learning than the reverse order. Children who received phonological awareness intervention first, demonstrated a better prognosis for improved word-learning skills than children who received the semantic intervention first. However, the current study did not provide additional information on children's word-learning skills over time. No significant changes in the receptive vocabulary test results were found at follow-up testing, which indicated that the children may have needed more time to consolidate their word-learning skills before changes in the standardised test results could be observed. Word-learning probes at follow-up testing might have been more informative.

To summarise, children with SLI often display difficulties in several areas of language that require treatment. The findings in this study suggest that a combination of phonological awareness and semantic intervention not only enhances phonological awareness development, semantic skills, and word-learning abilities in children with SLI, but also facilitates children's reading skills and improved general language skills. Findings also revealed better outcomes for children who received phonological awareness intervention prior to semantic intervention.

CHAPTER 7

GENERAL DISCUSSION

7.1 Introduction

Children with Specific Language Impairment (SLI) often exhibit word-learning deficits. Difficulties in learning new words can hinder children's language and literacy development. This is particularly problematic as children with SLI are at great risk of reading difficulties in addition to the language difficulties they are already experiencing. Word-learning in children with SLI has been investigated in numerous studies. Findings from a these studies demonstrated that semantic and phonological knowledge are crucial to the word-learning process. However, intervention studies targeting to improve the word-learning abilities in children with SLI are sparse.

The aim of this thesis was to investigate the word-learning abilities of New Zealand school-aged children with SLI and whether an intervention aimed at advancing semantic and phonological processing abilities, two crucial underlying skills for word-learning, enhanced their abilities to learn new words. Specifically, the following three broad questions were addressed:

1. What are the word-learning skills of school-aged children with SLI compared to children with typical language development and which underlying language skills influence word-learning?

2. What are the immediate and longer term effects of phonological awareness and semantic intervention on word-learning and language skills in children with SLI?
3. What are the error patterns of children with SLI compared to children with typical language development when learning to produce new words and do these patterns change following phonological awareness and semantic intervention?

In order to answer these questions, a series of five experiments was conducted. The following section briefly describes the research methodology employed in each experiment. A discussion of the findings with regard to the research questions follows.

7.2 Research Methodology

7.2.1 Experiment 1: Examining word-learning skills in children with SLI

In this study, the word-learning abilities of 19 children with SLI, aged between 6;2 and 8;3 years, were compared to the word-learning skills of age-matched children with typical language development. Word-learning was assessed over 5 consecutive days utilising a word-learning paradigm developed by Gray (2005). All children were additionally assessed on a battery of language assessments including vocabulary, phonological awareness, semantic, morphosyntactic, and reading tests to evaluate their language profiles. Furthermore, correlation and best subsets regression analyses were conducted to examine the relationship and influence of the various language measures on word-learning.

7.2.2 Experiment 2: Error analysis and item analysis

In this descriptive study, an error analysis was conducted in order to examine which naming errors occurred most frequently in children with SLI. For this purpose, the word-learning data from the first experiment was utilised for further investigation. All word-learning responses of children with SLI were analysed by error category to determine the error patterns. Errors were categorised into phonological, semantic, or random errors, and substitutions. The error patterns were then compared to the error patterns of children with typical language development. Additionally, two analyses were carried out to identify further influencing factors on word-learning outcomes: An item analysis evaluated whether certain word-specific criteria (e.g., word length, phonotactic probability of words, category of the word) influenced the word-learning outcomes for children. The second analysis examined the influence of teaching conditions on word-learning outcomes. The latter analysis investigated whether words were more rapidly learned when they were presented with phonological cues, semantic cues, or a combination of both.

7.2.3 Experiment 3: Intervention study

This study investigated the effectiveness of semantic and phonological awareness intervention on word-learning skills in the 19 children with SLI who were identified in the first experiment. As a group, children with SLI learned significantly fewer new words than their age-matched peers. Thus, intervention to improve their word-learning skills was warranted. An alternating treatment group design with random assignment of the participants was implemented. One group (n = 10) received

12 hours of phonological awareness intervention (phase 1) followed by 12 hours of semantic intervention (phase 2), whereas the other group (*n* = 9) received the same interventions in reverse order. Interventions were implemented in small groups of 2 to 3 children at their school. Children's word-learning skills were assessed following the first intervention phase (mid-test) and after the second intervention phase (post-test) utilising the same word-learning paradigm as in the first experiment.

7.2.4 Experiment 4: Intervention effects on error patterns and teaching condition

This descriptive study investigated the error patterns of children with SLI on word-learning following the intervention. The second experiment revealed that children with SLI presented with different error patterns compared to children with typical language development. Thus, the error patterns of children with SLI at pre-, mid-, and post-test were compared in order to assess whether their error patterns changed from pre- to post-intervention. In order to evaluate whether there were treatment specific influences on the erroneous responses, data were separately analysed by intervention group as determined in the third experiment. Similarly, it was investigated whether the intervention influenced how the children responded to the teaching conditions for learning new words. Word-learning outcomes at pre-, mid- and post-test were compared with regards to the teaching condition to examine whether children learned words with phonological cues, semantic cues, or a combination of both more rapidly following specific intervention (phonological awareness or semantic intervention).

7.2.5 Experiment 5: Follow-up study

The final study examined the vocabulary, phonological awareness, semantic, morphosyntactic, and reading skills of the children with SLI 6 months following the completion of the intervention. The results were compared to the scores immediately following the intervention in order to evaluate whether children were able to maintain or improve the gains they achieved immediately following the intervention. It was also investigated whether the children with SLI were able to transfer their improved phonological, semantic, and word-learning skills to vocabulary and reading performance.

7.3 Word-learning and language profiles of New Zealand children with SLI

The first part (experiments 1 and 2) of this thesis investigated the word-learning skills of school-aged children with SLI and their error patterns during word-learning compared to the performance of age-matched children with typical language development. For more thorough language profiles, all children were additionally assessed on vocabulary, phonological awareness, semantic, morphosyntactic, and reading skills. The relationship between language and word-learning abilities was assessed to understand which underlying factors may influence word-learning.

7.3.1 Word-learning deficits

Findings from the current study revealed that children with SLI performed significantly poorer on word-learning than age-matched children with typical language development. Commensurate with prior research, children with SLI learned to comprehend and produce significantly less new words than their age-matched peers (Gray, 2003b, 2004, 2005; Nash & Donaldson, 2005; Oetting, et al., 1995). Particularly the production of new words appeared to be more severely affected than comprehension. After repeated exposure to novel words, children with SLI in this study approached the same performance levels of children without SLI in comprehending new words. However, even after 5 days of repeated exposure, children with SLI were not able to produce as many new words as children with typical language development. These findings are in line with previous studies investigating word-learning in children with and without SLI, highlighting the considerable difficulties of children with SLI with producing novel words (Gathercole, 1993; Gray, 2003b).

In addition to differences in the number of learned words during word-learning, findings of this thesis demonstrated that children with SLI also present with qualitative differences. More specifically, when attempting to produce the new words, children with SLI displayed a different error pattern than children with typical language development. Nash and Donaldson (2005) observed in their study that children with SLI presented with a different error pattern than their age matched controls. While children with SLI mainly produced semantic errors, followed by miscellaneous and only a few phonological errors, children without SLI displayed a relatively even distribution of all three error types, whereas the most frequent error type was miscellaneous errors. In the current study, children displayed different error patterns according to the various word-learning tasks (fast mapping, word-learning, and word-learning test). During fast mapping, children with typical language development primarily produced ‘don’t know’ answers (over 50%) followed by phonological errors and substitutions. Substitutions included errors where a child named a wrong item from the same word-learning set as the target word. Children with typical language development made only a few semantic and random errors (less than 5%). Contrastingly, the second most frequent error type of children with SLI was random errors (answers that did not phonologically or semantically relate to the target word), followed by a relatively even distribution of phonological, semantic, and substitution errors. Thus, it appears that children with SLI may have less clear concept of the words than children with typical language development.

The error analysis of the responses during word-learning and word-learning test supports the theory that children with SLI may have more difficulties in establishing clear concepts of new words. After repeated exposure and additional presentation of cues to facilitate word-learning, children with SLI changed their error pattern to resemble the one of children with typical language development, displaying the same error pattern for word-learning and word-learning test as in fast mapping. For example, during word-learning, children with SLI produced more phonological and substitution errors than semantic and random errors. In the word-learning test, children with SLI made no random errors. Therefore, the more familiar the children were with the words, the less likely they produced random errors. Rather, after repeated exposure, they clearly stated that they didn’t know a word or attempted to produce the word by approaching its phonological form or semantic category, which was the same error pattern of children with typical language development. Thus, children with SLI require more exposure to new words compared to age-matched children with typical language development to not only learn to produce and comprehend the words, but also to establish strong phonological and semantic concepts of the words.

7.3.2 Language deficits

The data analysis also revealed that children with SLI presented with significantly lower vocabulary, phonological awareness, morphosyntax, and reading skills than age-matched control children. This result may not be surprising, considering that SLI was the inclusion of the current study. However, children had to score 1.25 SDs below the mean on the CELF-4 (Semel, et al., 2006), a broad spectrum language test, not on any other test. Nevertheless, as a group, children with SLI in this study performed significantly lower on all assessments compared to their age-matched controls with same nonverbal intelligence scores. This indicates that the children were not able to catch up to their peers on these language measures even though they were attending school for at least 1 year. This becomes particularly problematic, as none of the children with SLI in the current study received Speech-Language Therapy (SLT) services and only a few received specific supports. Considering that the children with SLI presented with difficulties in various language domains, it is important to support them most effectively, especially as these children were already attending school and struggling to follow regular classroom instruction (which was reason for recruitment in the first place). It can be concluded that without further support, the gap between the performance of the children with and without SLI will widen with time, particularly when the children are displaying additional reading difficulties.

7.3.3 Word-learning and language correlation

In the prior sections, the word-learning and language profiles of the children with SLI in this study were discussed, revealing that overall, the children with SLI presented with significantly lower performances than their age-matched peers. In order to understand whether and how the word-learning and language abilities may be related, correlation and multiple regression analyses were separately conducted for children with typical language development and for children with SLI. For these analyses, the relationship between all three word-learning tasks (fast mapping, word-learning, and word-learning test) and the following language measures was assessed: PPVT-4, CELF-4, phonological awareness, and semantic skills.

The findings of this study showed that the only significant correlations were between word-learning and the language measures of the children with typical language development. Phonological awareness skills were significantly correlated to word-learning and word-learning test, whereas fast mapping was correlated to semantic skills and performance on the CELF-4. Similarly, the best predictors for fast mapping were semantic skills and CELF-4 performance, and for word-learning were phonological awareness skills. For children with SLI, no correlations between the language measures and word-learning were found and none of the language measures predicted word-learning outcomes. These findings suggest that in typical language development, word-learning is strongly influenced by the underlying language abilities. However, children with SLI appear be unable to access or utilise these abilities for their word-learning as demonstrated in experiments 1 and 2.

7.4 Intervention effectiveness

The second part (experiments 3, 4, & 5) of this thesis examined the effectiveness of a combined phonological awareness and semantic intervention on the word-learning and language skills of children with SLI. The immediate effects of the combined intervention were evaluated to examine whether the children with SLI were able to improve their word-learning abilities and whether their error patterns when learning new words changed following the intervention. The longer term intervention effects were investigated to monitor whether the children maintained or improved their gains and whether they were able to transfer their improved skills to other language domains.

7.4.1 Immediate intervention effects

The findings of this thesis demonstrated that a combined phonological awareness and semantic intervention was effective in enhancing the phonological awareness, semantic, and word-learning abilities of children with SLI. The implemented alternating treatment group design gave insight into the effectiveness of each treatment (phonological awareness and semantic) individually. There were differences in the performances of the children in group A, who received phonological awareness followed by semantic intervention and the children in group B, who received the interventions in the reverse order, indicating that treatment order influenced intervention outcomes.

Both, phonological awareness and semantic treatment were effective in improving children's phonological awareness and semantic skills as demonstrated in the children's performances at mid-test (following the first intervention phase) and at post-test (immediately following the completion of the second intervention phase). Children in both groups also demonstrated transfer skills of their improved phonological awareness skills, as shown by their significant improvement in the decoding of non-words, concurrent with their gains in phonological awareness abilities. However, findings also revealed that children in group A, who received phonological awareness intervention first, significantly improved their performance in semantic skills following the phonological awareness intervention. This indicates that the phonological awareness intervention was not only effective in enhancing phonological awareness and decoding skills, but it also prompted children to perceive information from their learning environment more efficiently, which enhanced their semantic skills.

Data analysis revealed that each intervention (phonological awareness and semantic) was effective in improving children's fast mapping skills. Both groups demonstrated significant gains in their fast mapping abilities to produce new words at mid-test. All children continued to improve their fast mapping skills for production of new words following the second intervention phase, however, findings were not significant. The results suggest that the abilities of children with SLI to fast map new words was facilitated through either phonological awareness or semantic intervention. Considering that children with SLI often present with limited processing capacities (Alt & Plante, 2006; Ellis Weismer, 1996; Ellis Weismer, 2008), these findings can be interpreted in the following way: Children's enhanced phonological or semantic abilities (two important aspects in the word-learning process) enabled the children to more efficiently process all necessary information for learning new words. As the phonological awareness and semantic interventions were effective in improving the children's phonological and semantic skills, the children needed to employ fewer resources to learn the semantic and phonological information of the new words, leaving more processing capacity for efficient word-learning.

Even though the phonological awareness and semantic intervention individually improved children's fast mapping abilities, in order to significantly improve the word-learning abilities of children with SLI, a combination of both treatments was necessary. Commensurate with prior research, these findings indicated that semantic and phonological skills are crucial for efficient word-learning (Gray, 2005; Nash & Donaldson, 2005). There were no significant gains by either group at mid-test, after both groups received only one intervention. Pre- to post-test data evaluation revealed that the production of new words significantly improved only for children in group A, who received phonological awareness intervention first. Thus, the order of the implemented intervention significantly influenced the word-learning outcomes. Children who received phonological awareness intervention followed by semantic intervention learned to produce more words immediately following the completion of both interventions, whereas children who received the same interventions in the reverse order did not. However, as mentioned earlier, children in group A significantly improved their phonological awareness and semantic skills at mid-test and consequently had more time to consolidate both skills when they learned the new words at post-test. On the other hand, children in group B demonstrated only improved semantic skills at mid-test, and improved phonological awareness skills not until post-test. This suggests that children with SLI significantly profit from a combination of phonological awareness and semantic intervention, but they may need some time to consolidate their enhanced abilities before they can employ them for efficient word-learning.

An analysis of the error patterns during word-learning at mid- and post-test revealed that the intervention not only improved children's ability to learn more new words, but it also affected the error patterns during word-learning. The findings demonstrated that children with SLI changed their error patterns during word-learning following the intervention and that erroneous responses displayed treatment-specific effects. Treatment-specific effects were that phonological awareness intervention appeared to reduce children's use of random answers, and semantic intervention appeared to enable children to focus on the phonological representation and to match correct phonological representations with the correct semantic representations (i.e., reduction of substitution errors).

Treatment order significantly influenced the error patterns of children with SLI. Prior to intervention, children with SLI presented with a different error pattern to children with typical language development when attempting to name the new words during the fast mapping test. After receiving phonological awareness followed by semantic intervention, children in group A presented with the same error pattern as the children with typical language development. Children in group B approached the same error pattern as demonstrated by the children without SLI, however, their (group B) second most frequent error type remained random error, which were errors that were not semantically or phonologically related to the target word. As discussed earlier, the use of random answers suggests that the children were not using semantic or phonological strategies to learn the new words. This is particularly problematic as the children have received semantic and phonological awareness intervention, but appeared to not employ their skills. However, these findings support the results from the quantitative word-learning analysis, which revealed that children in group A learned to produce more new words post-intervention, whereas children in group B did not learn more words after the completion of both interventions. This again indicates that children in group B required more time before any improvement in their word-learning abilities could be recorded.

7.4.2 Longer-term intervention effects

Findings of the study revealed that the implemented intervention improved children’s general language, phonological awareness, semantic, and reading skills longitudinally. Children in both groups were able to maintain their gains in phonological awareness and semantic skills 6 months following the completion of the intervention programme. Their improved language abilities (as demonstrated at follow-up testing on the broad spectrum language assessment CELF-4) indicated that the children with SLI were able to access their classroom curriculum more efficiently following the intervention. However, there were differences in longer-term development between the children who received phonological awareness prior to semantic intervention and the children who received the interventions in the reverse order.

Children who received phonological awareness followed by semantic intervention (group A) demonstrated significantly better progress in their reading abilities than the children who received the interventions in the reverse order (group B). The reading abilities of single non-words and real words, as well as connected text improved significantly from pre- to follow-up testing for children in group A. A comparison of the children's non-word reading skills immediately following the intervention (post-test) and 6 months later (follow-up test) demonstrated that the ability of children in group B to read non-words declined once they did not receive any intervention, whereas children in group A continued to improve their reading skills even without receiving any further intervention. The same order of treatments (phonological awareness followed by semantic intervention) revealed better word-learning outcomes for children with SLI than the reverse order. Thus, children in group A, who had more time to consolidate their phonological awareness and semantic skills, benefited from early instruction in phonological awareness for their word-learning abilities as well as their reading abilities.

The implemented phonological awareness intervention of the current study was based on a programme that has been consistently successful in enhancing children's reading skills in addition to improving phonological awareness skills (Gillon, 2000, 2004; Gillon, Moran, Hamilton, et al., 2007; Moriarty & Gillon, 2006). A follow-up study revealed that the children who received the phonological awareness intervention programme continued to improve their reading abilities 11 months after the completion of the intervention (Gillon, 2002). In line with these findings, children in group A of the current study also demonstrated continuous gain in their reading abilities following the intervention. However, children in group B presented with a decline in their reading abilities from post- to follow-up test, which even resulted in significant group differences on all reading measures at follow-up testing. Based on this evidence, intervention should directly target phonological awareness skills first, and once a strong base in phonological awareness skills is established, facilitate children's semantic skills for more effective long-term reading development.

7.5 Summary of findings

This thesis examined the word-learning skills in New Zealand school-aged children with SLI compared to children with typical language development. Furthermore, the effect of combined phonological awareness and semantic intervention on improving the word-learning abilities of children with SLI was investigated. The following findings can be summarised:

1. Children with SLI perform significantly worse when learning to produce and comprehend new words than age-matched peers with typical language development.
2. The production of new words presents a particular difficulty for children with SLI.
3. Fast mapping abilities in children with typical language development are predicted by semantic and general language skills, whereas word-learning abilities are predicted by fast mapping and phonological awareness skills.

4. When learning new words, children with SLI produce considerably more random errors than age-matched peers, which indicates that children with SLI have weaker semantic and phonological representations of the new words after minimal exposure.
5. Phonological awareness intervention improved the phonological awareness, semantic, fast mapping, and reading skills in children with SLI.
6. Semantic intervention significantly improved semantic and fast mapping skills in children with SLI.
7. A combination of phonological awareness intervention followed by semantic intervention improved the word-learning skills of children with SLI and has significantly better longer-term effects on reading skills than a combination of the same interventions in the reverse order.
8. The children were able to maintain the gains of the implemented intervention after completion of the intervention programme.

7.6 Clinical implications

Several clinical implications can be derived from the findings of this thesis. Firstly, the necessity for additional support for children with SLI needs to be highlighted. All children with SLI in the current study were attending school for at least one year and were identified by their teachers as struggling to follow the classroom curriculum. Their language profiles demonstrated significant deficits in their language and literacy development indicating that the high quality literacy and language instruction in the classroom was not sufficient for children with SLI to efficiently access the curriculum. However, none of the participants in the current study was receiving Speech-Language Therapy (SLT) services and only a few received specific supports for their language difficulties at the start of the intervention. This is particularly problematic, considering that the long-term outcomes for children with SLI predict the risk of persistent language impairment throughout their life and influence their academic and vocational careers (e.g., Snowling, et al., 2001; Stothard, et al., 1998). Thus, it is critical to provide children with SLI with specific support throughout school to allow them to access the school curriculum more efficiently.

The analysis of the word-learning abilities of children with SLI demonstrated that children with SLI present with significant difficulties learning new words compared to children with typical language development. Children with SLI required more exposure to new words before they were able to receptively recognise them. Thus, in order to support children's word-learning when they encounter new words, it is important to bear in mind that the children benefit from repeated exposure. The findings revealed however, that repeated exposure was not effective in improving the production of new words. Consequently, in order to support children in the production of new words, an intervention specifically targeting the skills that enhance word-learning is warranted.

The findings of the intervention study (experiment 3) demonstrated that a combination of phonological awareness intervention followed by semantic intervention implemented in small groups was effective in improving children's word-learning abilities. Enhancing underlying phonological and semantic skills furthermore enabled the improvement of core language and reading abilities. Thus, these findings add to the existing pool of research demonstrating that implicit instruction in phonological awareness not only improved phonological awareness skills but also literacy skills (e.g., Gillon, 2004).

The findings of the intervention study also revealed that phonological awareness intervention facilitated children's semantic skills, indicating that the focus on phonological awareness may have prompted children to attend differently to their learning environment. In light of the limited processing capacity framework (Ellis Weismer, 1996; Ellis Weismer & Hesketh, 1996) these findings may indicate that the implemented phonological awareness intervention provided the children with tools (strategies) to more rapidly process phonological information in their learning environment, resulting in more capacity resources for the processing of other information.

In consideration of a preventative framework and best practice, intervention for children with SLI should employ treatments that have been scientifically demonstrated to be effective or were derived from empirical theories on the cause for the language impairment (Gillon, Moriarty, & Schwarz, 2005). These issues were addressed in this thesis and the findings provide valuable clinical implications.

7.7 Limitations of the current research

Findings of this series of studies are limited by some factors. A longer term follow-up assessment of children's word-learning abilities would have given insight into the children's word-learning development and would have more adequately addressed whether the children required more time to internalise the acquired skills before they were able to use them to further enhance their word-learning skills. In particular, children in group B would most likely have profited from delayed word-learning probes as it would have given them time to consolidate their improved skills before they were tested on word-learning abilities.

Another shortcoming of the implemented assessment battery is the lack of a phonological memory measure like nonwords-repetition tasks. Children with SLI frequently present with deficits in phonological memory skills (e.g., Dollaghan & Campbell, 1998) and it has been documented that phonological memory is correlated to vocabulary development (e.g., Gathercole, et al., 1999). A study by Gray (2006) investigating the correlation of phonological memory and fast mapping skills, revealed that the production of new words was significantly correlated to performance on a digit span test but not on a non-word repetition test. It would have been very valuable to add more data to this existing body of research.

The findings of the intervention study revealed that the intervention was not effective at improving comprehension skills in any word-learning task. However, pre-assessment data demonstrated that children with SLI were able to catch up to the performance of children with typical language development in comprehending new words. In contrast, repeated exposure to new words did not reveal similar success for the production of new words in children with SLI. Thus, the production of new words in particular needs to be addressed through intervention.

The lack of error distribution in children with typical language development limited the analysis of the error patterns during word-learning as they reached ceiling on almost all word-learning tasks after the first day. In contrast, children with SLI displayed flooring effects on day 1. This demonstrates the difficulty in selecting appropriate stimuli for word-learning probes. While the same set of words appears too easy for children with typical language development, children with SLI struggle to learn to produce them. The author specifically chose to utilise real words of varying length and phonological structures to additionally investigate whether there are word-specific features that facilitate word-learning for school aged children. However, no facilitative word-specific features could be identified which may have been caused by the small sample sizes. Even though there were 38 participants for the primary word-learning assessment, each set of words was only learned by 12 or 14 children. As each set of words consisted of nine words, there was a wide distribution within each set, resulting in a lack of significant findings. This thesis also failed to provide significant word-learning effects by teaching condition. Even though specific patterns could be derived, findings were not significant. This again may be caused by the small sample sizes as the word-learning conditions were counterbalanced within and among each set.

This thesis tried to address the intervention effectiveness of a combined phonological awareness and semantic intervention on word-learning including a thorough analysis of influencing factors (choice of stimuli, cueing effects) and how these factors may even be influenced through the intervention. However, only limited data was available for the items analysis and for the analysis of the teaching conditions, which resulted in small subgroups for both analyses. It may have been more useful to separately investigate some of these issues prior to the intervention study. Furthermore, the difficulties in finding word-learning items that are suitable for children with SLI and their age-matched peers with typical language development suggest that word-learning comparison studies should also include language-matched children with SLI (Nash & Donaldson, 2005; Riches, et al., 2005). The following section discusses how the limitations of this thesis can be avoided in future research and provides further directions for future investigation.

7.8 Directions for future research

Findings of this thesis indicated that word-learning skills in children with SLI can be enhanced through phonological awareness and semantic intervention. However, only children who received phonological awareness prior to semantic intervention significantly improved their word-learning abilities immediately following the intervention programme. It was argued that children who received the same interventions in the reverse order may have needed more time to consolidate their skills before changes were observed. Thus, a longer term investigation of the intervention effects on children's word-learning abilities would provide further insight into their word-learning development.

The language and literacy profiles of children in group B in the thesis raised several issues that warrant further investigation. After receiving the same interventions as the children in group A in the reverse order, their word-learning skills did not improve in contrast to group A. Furthermore, longer term follow-up testing revealed that the non-word reading skills of children in group B declined from post-test to follow-up test, whereas the skills of children in group A continued to increase. It needs to be investigated whether these considerable differences in children's performance were solely caused by the implemented treatment order or whether there were other influencing effects. Replication studies might provide more clarification on the current results.

Findings of the thesis also demonstrated that phonological awareness intervention improved children's semantic skills to the same degree as the semantic intervention (group A). It can be concluded that the phonological awareness intervention itself was therefore sufficient in enhancing children's word-learning skills after they had a few weeks to consolidate the skills. However, the question remains whether the children would have made the same progress if the semantic intervention would not have been additionally implemented.

Children with SLI present with difficulties in various language domains which highlights the necessity for efficient interventions that target the specific difficulties experienced. Phonological awareness intervention demonstrated to effectively improve the reading abilities of children with SLI. Followed by semantic intervention, it additionally improved children's word-learning abilities. This study adds to the body of research investigating effective and efficient intervention approaches for children with SLI as it demonstrated the effectiveness of enhancing the underlying language skills in children with SLI. The children not only improved their phonological awareness and semantic abilities, but they were also able to transfer these acquired skills to other language domains (i.e., word-learning, reading, morphosyntax). This intervention study showed how children with SLI may be supported to become more independent and efficient learners. Future research is needed investigating effective and efficient intervention approaches that enable children with SLI to maximise their efficiency in learning from their environment.

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APPENDIX A
WORD-LEARNING PARADIGM

Day 1	Day 2	Day 3	Day 4	Day 5
FM	**WL1**	**WL2**	**WL3**	**WLTest**

FM = Fast Mapping
WL1 = Word-learning day 1
WL2 = Word-learning day 2
WL3 = Word-learning day 3
WLTest = Word-learning test

APPENDIX B
WORD-LEARNING PROTOCOL

Fast Mapping (Day 1)

Model **(all items)**	"This is a …"
Comprehension probe **(all items)**	"Show me …" No feedback
Production probe **(all items)**	"What is this?" No feedback

Repeat 2x with all items

Word-learning (Days 2 to 4)

Model Elicit Imitation Cue 1 **(all items)**	"This is a …" "Say …" "… is a x/…starts with x"
Model Elicit Imitation Cue 2 **(all items)**	"This is a …" "Say …" "… is a x/it has x parts: …-…-…"
Comprehension probe **(all items)**	"Show me …" Feedback
Production probe **(all items)**	"What is this?" Feedback

Repeat 2x with all items

Additionally after all words have been presented 3 times:

Comprehension probe **(all items)**	"Show me …" Feedback
Production probe **(all items)**	"What is this?" Feedback

Word-learning Test (Day 5)

Production of all 9 items	"What is this?"
Recognition of all 9 items	"What is the name for this picture: a,b,c, or d?
Comprehension of all 9 items	"Show me …"

APPENDIX C
WORD-LEARNING STIMULI

	Syllable length	Affiliation	Phoneme probability	Biphone probability
Set1				
compass	2	science	0.3318	0.024
beaker	2	science	0.144	0.0059
ampoule	2	science	0.1546	0.0177
whippet	2	science	0.2597	0.0135
mandolin	3	art/music	0.4667	0.0424
cobalt	2	art/music	0.3149	0.0076
furnace	2	art/music	0.239	0.0066
lychee	2	food	0.1839	0.0078
radicchio	4	food	0.2824	0.0169
Set 2				
protractor	3	science	0.5095	0.0442
iris	2	science	0.1805	0.0174
amphora	3	art/music	0.1266	0.0049
lynx	1	science	0.3235	0.0199
kalimba	3	art/music	0.2989	0.0167
bassoon	2	art/music	0.2556	0.009
ruin	2	science	0.154	0.0058
shalot	2	food	0.2465	0.0106
mangosteen	3	food	0.5162	0.0395
Set 3				
rhombus	2	science	0.271	0.0143
scalpel	2	science	0.317	0.0151
sapphire	3	science	0.2194	0.0064
longan	2	food	0.176	0.0092
ocarina	4	art/music	0.215	0.0088
cloister	2	art/music	0.2727	0.018
caraffe	2	art/music	0.2806	0.0214
salak	2	food	0.3101	0.0165
artichoke	3	food	0.38	0.0106
Mean	2.37		0.275189	0.015952

APPENDIX D
WORD-LEARNING TEST

Set 1

1. Production Test
Instruction for tester: Randomly present all 9 items
Question: "What is this?"

	Score
compass	
beaker	
ampoule	
whippet	
mandolin	
cobalt	
furnace	
lychee	
radicchio	
Total	

2. Recognition Test
Instruction for tester: Randomly present all 9 items
"Which one is the right name for this picture?
Listen first, then tell me the right name."

Target	Distracter 1	Distracter 2	Distracter 3	Score
compass	fompass	beaker	compost	
beaker	zeaker	ampoule	seater	
ampoule	umpoule	cobalt	ambers	
whippet	lippet	furnace	pipette	
mandolin	vandolin	compass	mandarine	
cobalt	nobalt	raddicchio	cohort	
furnace	burnace	mandolin	funnel	
lychee	mychee	whippet	leech	
radicchio	sadicchio	lychee	cockatoo	
			Total	

3. Comprehension Test
Instruction for tester: Present all 9 items and randomly ask for all 9 items
"Show me…"

	Score
compass	
beaker	
ampoule	
whippet	
mandolin	
cobalt	
furnace	
lychee	
radicchio	
Total	

WORD-LEARNING TEST

Set 2

1. Production Test

Instruction for tester: Randomly present all 9 items
Question: "What is this?"

	Score
protractor	
iris	
amphora	
lynx	
kalimba	
bassoon	
ruin	
shalot	
mangosteen	
Total	

2. Recognition Test

Instruction for tester: Randomly present all 9 items
"Which one is the right name for this picture?
Listen first, then tell me the right name."

Target	Distracter 1	Distracter 2	Distracter 3	Score
protractor	frotractor	amphora	projector	
iris	oris	lynx	organ	
amphora	umphora	kalimba	abacus	
lynx	mynx	ruin	harp	
kalimba	salimba	bassoon	calendar	
bassoon	nassoon	mangosteen	racoon	
ruin	shuin	shalot	zion	
shalot	galot	iris	scallop	
mangosteen	langosteen	protractor	harpsichord	
			Total	

3. Comprehension Test

Instruction for tester: Present all 9 items and randomly ask for all 9 items
"Show me…"

	Score
protractor	
iris	
amphora	
lynx	
kalimba	
bassoon	
ruin	
shalot	
mangosteen	
Total	

WORD-LEARNING TEST

Set 3

1. Production Test

Instruction for tester: Randomly present all 9 items
Question: "What is this?"

	Score
rhombus	
scalpel	
sapphire	
longan	
ocarina	
cloister	
caraffe	
salak	
artichoke	
Total	

2. Recognition Test

Instruction for tester: Randomly present all 9 items
"Which one is the right name for this picture?
Listen first, then tell me the right name."

Target	Distracter 1	Distracter 2	Distracter 3	Score
rhombus	nombus	sapphire	cactus	
scalpel	calpel	rhombus	trombone	
sapphire	lapphire	longan	safari	
longan	vongan	scalpel	turquoise	
ocarina	icarina	cloister	accordion	
cloister	floister	salak	grater	
caraffe	saraffe	ocarina	fossil	
salak	balak	artichoke	thistle	
artichoke	irtichoke	caraffe	agave	
			Total	

3. Comprehension Test

Instruction for tester: Present all 9 items and randomly ask for all 9 items
"Show me…"

	Score
rhombus	
scalpel	
sapphire	
longan	
ocarina	
cloister	
caraffe	
salak	
artichoke	
Total	

APPENDIX E
WORD-LEARNING STIMULI BY GROUP AND SUBGROUP

Set 1					Set 2					Set 3				
compass	P	starts with c	S	maths tool	protractor	P	starts with p	S	maths tool	rhombus	P	starts with r	S	shape
	P	com-pass	S	make circles		P	pro-trac-tor	S	for measuring		P	rhom-bus	S	like kite
beaker	P	starts with b	S	cup	iris	P	starts with i	S	flower	scalpel	P	starts with s	S	knife
	P	bea-ker	S	for measuring		P	i-ris	S	wrinkly petals		P	scal-pel	S	doctors use it
ampoule	P	starts with a	S	bottle	amphora	P	starts with a	S	vase	sapphire	P	starts with s	S	jewel
	P	am-poule	S	very little		P	am-pho-ra	S	pointy bottom		P	sa-pphi-re	S	blue
whippet	P	starts with w	S	dog	lynx	P	starts with l	S	cat	longan	P	starts with l	S	fruit
	P	whi-ppet	S	skinny		P	lynx	S	wild		P	lon-gan	S	grows like grape
mandolin	P	starts with m	S	music instrument	kalimba	P	starts with k	S	music instrument	ocarina	P	starts with o	S	music instrument
	P	man-do-lin	S	round body		P	ka-lim-ba	S	play with thumb		P	o-ca-ri-na	S	from clay
cobalt	P	starts with c	S	colour	bassoon	P	starts with b	S	music instrument	cloister	P	starts with c	S	part of building
	P	co-balt	S	dark blue		P	ba-ssoon	S	you blow in it		P	cloi-ster	S	church hallway
furnace	P	starts with f	S	heater	ruin	P	starts with r	S	building	caraffe	P	starts with c	S	bottle
	P	fur-nace	S	make fire in it		P	ru-in	S	broken down		P	ca-raffe	S	round belly
lychee	P	starts with l	S	fruit	shalot	P	starts with sh	S	onion	salak	P	starts with s	S	fruit
	P	ly-chee	S	very sweet		P	sha-lot	S	little		P	sa-lak	S	skin like snake
radicchio	P	starts with r	S	vegetable	mangosteen	P	starts with m	S	fruit	artichoke	P	starts with a	S	vegetable
	P	ra-di-cchi-o	S	purple		P	man-go-steen	S	thick red skin		P	ar-ti-choke	S	leaves on a stem

APPENDIX F
STUDY OVERVIEW

Timeline	Group A	Group B	Control Group
Pre-test	**Standardised tests** **PA probes** **Sem probes** **WL Probes**	**Standardised tests** **PA probes** **Sem probes** **WL Probes**	**Standardised tests** **PA probes** **Sem probes** **WL Probes**
Intervention phase 1 (6 weeks)	**12 hours** **PA intervention**	**12 hours** **Sem intervention**	
Break and Mid-test (4 weeks)	**PA probes** **Sem probes** **WL Probes**	**PA probes** **Sem probes** **WL Probes**	
Intervention phase 2 (6 weeks)	**12 hours** **Sem intervention**	**12 hours** **PA intervention**	
Post-test	**PA probes** **Sem probes** **WL Probes**	**PA probes** **Sem probes** **WL Probes**	**PA probes** **Sem probes**

Note. Group A, phonological awareness intervention followed by semantic intervention; Group B, semantic intervention followed by phonological awareness intervention; PA, phonological awareness; Sem, semantic; WL, word-learning.