LEXICAL ACCESS IN SCHOOL-AGED CHILDREN WITH AND WITHOUT SPECIFIC LANGUAGE IMPAIRMENT

BY

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Abstract

LEXICAL ACCESS IN SCHOOL-AGED CHILDREN WITH AND WITHOUT SPECIFIC LANGUAGE IMPAIRMENT

by

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One of the hallmarks of school- aged children with Specific Language Impairment (SLI) is word-finding difficulty. Semantic or phonological deficits were postulated to underlie this difficulty. The present study was designed to investigate the process of lexicalization during language production in children with and without SLI using the *Cross Modal Picture-Word Interference Paradigm*. Picture presentations were manipulated in time relative to the presentation of auditory interfering stimuli (i.e., Stimulus Asynchrony - SA). Interfering stimuli appeared before (SA–150ms), with (SA0ms), and after (SA+150, +300, & +500ms) the presentation of the pictures. The interfering stimuli were either related semantically or phonologically to the target pictures, or unrelated. Subjects were instructed to name the pictures as quickly as possible while ignoring the interfering stimuli. Reaction times to naming were measured.

Fourteen children with SLI (ages 8-10), 20 children with Typical Language Development (TLD) (ages 8-10), and 20 adults participated in the study. Results revealed similar temporal patterns of lexical access in the adult and TLD groups, supporting the notion of similar underlying mechanisms of lexicalization in children and adults. Qualitative differences in the process of lexical access were apparent in the SLI group compared to the TLD and the Adult groups. Persistent semantic inhibition effects over

time and the presence of a late semantic inhibition effect at SA +300 in the SLI group suggested a breakdown at the semantic level. A strong phonological facilitation effect suggested that children with SLI are capable of utilizing phonological primes to ease lexical access. Reaction times on a simple naming task (in the absence of distractors) revealed no differences between the SLI and the TLD groups. However, slower reaction times in the presence of distractors in the SLI group suggested that these children's deficits are localized to the lexical system and not to a general slowing mechanism. The children's data support the predictions of the time course of lexical access made by the interactive model, *Cascaded Processing Model*. Clinical implications of the results of this study are discussed.

DEDICATION

I would like to dedicate this dissertation to my dear parents, Chanan and Nava Seiger, who are my source of strength, inspiration, love, and support. Even though oceans apart they were with me every step of the way in the journey towards the Ph.D. They taught me to reach for the stars and strive for the best and I thank them for that with all my heart. I feel fortunate to have them in my life.

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CHAPTER 1: INTRODUCTION

Word-finding difficulties are the most frequently observed lexical limitation in school-aged children with Specific Language Impairment (SLI) (Faust, Dimitrovsky, & Davidi, 1997; German 1979; 1984; 1987; Leonard, Nippold, Kale & Hale, 1983; McGregor & Leonard, 1989; Nippold, 1992; Wiig & Backer-Caplan, 1984). Word-finding deficits are defined as a difficulty in generating a specific word for any given situation (Rapin & Wilson, 1978). Children with SLI have difficulty retrieving known words. Their language is characterized by repetitions, reformulations, pauses, substitutions, circumlocutions, production of fillers, and by the use of nonspecific words (e.g., *stuff, thing*) (Faust, Dimitrovsky, & Davidi, 1997; German, 1987; McGregor & Leonard, 1989).

Naturally-occurring speech errors in adults' productions and speech errors produced by adults with aphasia have led to theories of lexical access from the initial stage of intention to the final stage of articulation. The most common view is that lexical access proceeds in a two-stage fashion (Levelt, 1992; Dell & O'Seaghdha, 1992). The initial stage, *lexical selection*, involves the activation of semantic and syntactic properties of lexical items. The second stage, *phonological encoding*, involves the activation of phonological properties of lexical items. Theories of lexical access vary in discreteness of these two stages (e.g., cascading of activation vs. discrete non-overlapping stages) and the degree of modularity (e.g., forward vs. backward activation). Adults' language production has been the focus of numerous investigations. The language production of children with typical and atypical language development has been relatively unexamined.

The limited research investigating the lexical abilities of children with SLI focused on finding the loci of breakdown in their lexical system that gives rise to word-finding difficulties. However, these deficits and their remediation have not been tied to the existing theoretical models of lexical access. By employing various offline techniques in their investigation, varying the elicitation context, stimuli, primes used, and dependent variables (speed of naming response, response pattern, tip of the tongue information), previous studies were able to learn only about the end-products of lexical processing, rather than about the lexicalization process as it occurs.

The present study was designed to investigate the process of lexical access in children. The *Cross-Modal Picture-Word Interference Paradigm*, an online technique adopted from studies of lexical access in adults' speech production (Jescheniak & Schriefers, 1998; Schriefers, Meyer, & Levelt, 1990; Cutting & Ferreira, 1999), was used to examine the temporal and parametrical properties of lexical access in children with and without SLI. In this paradigm, participants are presented with line drawings of common objects and are instructed to name them as quickly as they can. Interfering Stimuli (IS) are presented auditorily at different points in time relative to the onset of the picture presentation, also referred to as Stimulus Asynchrony (SA). The IS can precede the onset of the picture (e.g., SA-150), appear simultaneously with the picture (e.g., SA0), or follow the onset of the picture (e.g., SA+150). The participants are instructed to ignore the IS and focus on naming the pictures. Response time to picture naming is the main dependent variable in this paradigm. The experimental conditions differ in the type of IS they involve. The IS vary with regard to their relationship to the target picture. In the *semantic condition*, the IS and the picture are semantically related (i.e., belong to the same semantic category such as "cat-sheep"), in the *phonological condition* they are phonologically related (e.g., "cat-car"), and in the *unrelated condition* they are neither related in form nor in meaning. An additional condition, referred to as the *silent condition,* where no IS are presented, is administered to determine the response time to naming without any interference. The response times in the semantic and phonological conditions are compared to the unrelated condition, which in turn is compared to the silence condition. In adults, the presentation of semantic IS typically results in longer response times relative to the unrelated IS in early SAs, hence, an inhibition effect. The semantic IS serve as competitors to the target items, thus, hindering their quick retrieval. On the contrary, the presentation of phonological IS typically result in shorter response times relative to the unrelated IS in later SAs, hence, a facilitation effect. The phonological IS and the target items share some segments. These segments become activated as soon as the IS are presented, which contributes to a quicker retrieval of the target items (Schriefers et al., 1990; Jescheniak & Schriefers, 1998). These effects are the core assumptions of most of the current models of lexical access.

Lexical Access in Adult Speech Production

Lexical access in adults' speech production begins with an initial stage of lexical selection, also referred to as *lemma* selection, followed by a later stage of phonological encoding, also referred to as *lexeme* selection (Kempen & Huijbers, 1983). During the initial stage, the semantic and syntactic properties of the lexical item are specified. During the latter stage, the phonological properties of the lexical item are specified. Evidence to support the distinction between these two levels of processing comes from various sources. One phenomenon that supports the notion of two distinct levels of lexical processing, is the "tip of the tongue" (TOT) phenomenon. Speakers in the TOT state cannot retrieve the intended word. However, they appear to have access to semantic and syntactic information and partial phonological information (e.g. initial sound, number of syllables, stress pattern) (Brown, 1991; Faust et al., 1997; Burke, MacKay, Worthley & Wade, 1991). TOT state has been attributed to an incomplete spread of activation between the lemma and the phonological levels. Similarly, aphasic patients with anomia exhibit semantic circumlocutions when they are unable to retrieve the target word (Badecker, Miozzo, & Zanuttini, 1995; Lambon Ralph, Sage, & Roberts, 1999). Despite their difficulties, they are able to generate the semantic and syntactic properties of the word, but are unable to access its phonological properties. This evidence was taken to suggest two distinct levels of lexical representation.

Naturally occurring speech errors in normal adult speakers suggested a distinction between word and sound exchange errors (Garrett, 1975). Word exchange errors, such as "*Slips and kids – I've got **both** of **enough** (enough of both)*" (Garrett, 1975, pp. 149), are bound by syntactic constraints. They usually occur between syntactic phrases or clauses, preserve their word class (e.g., nouns exchange with nouns and verbs with verbs), and fulfill similar grammatical functions. In contrast, sound exchange errors, such as "*Children interfere with your **nife lite** (night life)*" (Garrett, 1975, pp. 141), are not bound by syntactic constraints. They usually occur between adjacent words that belong to different syntactic categories but share form-related characteristics. Word exchange errors appear to arise from a mis-selection at the lemma level, whereas sound exchange errors arise from a mis-selection at the phonological encoding level. Behavioral studies

(Jescheniak & Schriefers, 1998; Schriefers, Meyer, & Levelt, 1990; Cutting & Ferreira, 1999) and electrophysiological studies (Schmitt, Munte, & Kutas, 2000; van Turennout, Hagoort, & Brown, 1997; 1998) exploring the time course of lexical access in adult language production have provided additional evidence for two distinct levels of lexical processing: an early stage of semantic-syntactic activation followed by a later stage of phonological activation (see Figure 1).

Although the distinction between these two levels of processing (e.g., lemma and phonological encoding) is widely agreed on, there is a continuing debate regarding the discreteness of these two levels of processing. The debate is concerned with the modularity of these levels of processing and their serial relationship. Three models address these issues, the *Spreading Activation Model* (Dell, 1986), the *Discrete Two-Stage Model* (Levelt, Schriefers, Vorberg, Meyer, Pechmann, & Havinga, 1991), and the *Cascaded Processing Model* (Peterson and Savoy, 1998).

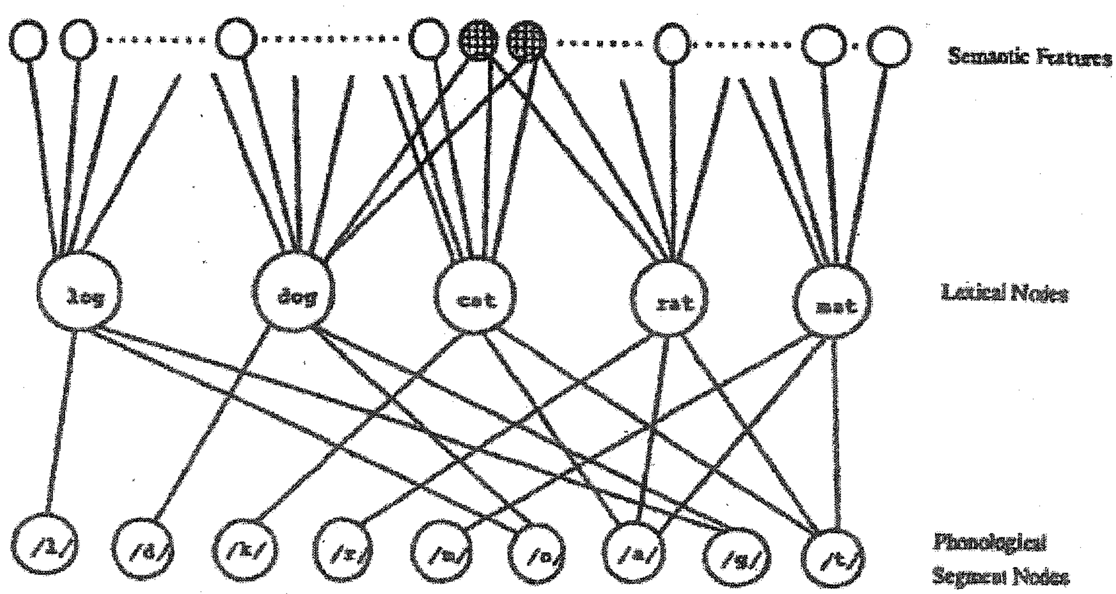


Figure 1. Lexical access in the spreading activation model (From Dell & O'Seaghdha, 1991)

The Discrete Two-Stage Theory of Lexical Access

The discrete two-stage model postulates a modular system of lexical access with two serially ordered, non-overlapping, and independent stages that operate on different inputs (Levelt et al., 1991; Schriefers, Meyer, & Levelt, 1990; see Levelt, Roelfs, & Meyer, 1999 for a review). According to this model, only semantic-syntactic information is activated during lemma selection, and only phonological information is activated during phonological encoding. Naturally occurring speech errors support the distinction between lemma and phonological levels as two discrete stages. Word substitution errors, in particular, are taken as direct evidence for two independent stages. They can be of two types, words that are semantically but not phonologically related to the target word (i.e., *mother* for *wife*) (Garrett, 1988, pp.72) and words that are phonologically, but not semantically, related to the target word (i.e., *mushroom* for *mustache*) (Garrett, 1988, pp. 72), also referred to as malapropisms. Errors of the first type are postulated to arise at the lemma level, whereas errors of the second type are postulated to arise during phonological encoding.

Additional support comes from experimental studies employing the cross modal picture-word interference paradigm. Inhibition effects at early stages of lexicalization followed by phonological facilitation effects at later stages of lexicalization were taken as evidence to support the presence of two distinct levels of processing (Schriefers, et al., 1990). Electrophysiological studies have provided additional information about the time course of lexical access and, specifically, the relative timing of lemma selection and phonological encoding (Schmitt, Munte, & Kutas, 2000; van Turennout, Hagoort, & Brown, 1997; 1998). LRP and N200 data. (Schmitt et al., 2000) suggested that semantic information becomes available approximately 90ms prior to phonological information. Although these findings demonstrated that semantic activation precedes phonological activation, the authors suggested that the final stage of lemma selection and the initial stage of phonological encoding may still overlap. Inequality in the difficulty of the semantic and phonological tasks was offered as an alternative explanation for the apparent results. Semantic information may have been processed prior to phonological information simply because the semantic task was easier. A pretest with a simple decision-making task for phonological or semantic information revealed significantly faster mean reaction times in the semantic task (e.g., 617ms) versus the phonological task (e.g., 841ms) (Schmitt, Munte, & Kutas, 2000), suggesting that the latter was a more difficult task. Thus, further studies using electrophysiological methods are needed.

According to the discrete two-stage model, lexical access proceeds with activation spreading forward from the semantic-conceptual level to the lemma level. Activation spreads to the target lemma as well as to its semantic alternatives. However, only the target lemma, upon selection, will undergo phonological encoding. During lemma selection, activation of the target lemma increases to a critical level where the target lemma is being selected. At this point, activation of semantic alternatives decreases to its resting level. As soon as the target lemma has been selected, activation spreads forward to the phonological level as the phonological properties of the target word are specified (Levelt et al., 1991) (see figure 2a).

The Spreading Activation Theory of Lexical Access

The spreading activation model describes the process of lexical access in more continuous terms. It views the production system as "globally modular but locally interactive" (Dell & O'Seaghdha, 1991, pp. 604). Activation is predominantly semantic during lemma access, and predominantly phonological during phonological encoding. It assumes some activation of phonological information during lemma access and some activation of semantic-syntactic information during phonological encoding. The interaction between the stages comes into play in two processes, cascade of activation and backward activation (Dell, 1988). During the first stage of lemma access, activation cascades to the phonological level, yielding partial activation of phonological information of the target and alternative words, prior to lemma selection. As the target lemma is selected, activation of phonological properties of alternative words decreases, while activation of phonological properties of the target word increases until the moment of selection. Bi-directional spread of activation between units of adjacent levels allows activation to spread back from the phonological level to the lemma level, influencing the selection of the lemma (Dell & O'Seaghdha, 1992) (see Figure 2c). Backward activation serves as a "lexical editor" (Dell, 1985). By allowing information to flow from lower levels (e.g., phonological level) to higher levels (e.g., lemma level), potential non-word slips can be edited out prior to articulation.

The occurrence of mixed errors, which are semantically and phonologically related to the target word (e.g., *Cat-Cow*), in adults' speech production suggests an interaction between the two levels of processing (Dell & Reich, 1981). Malapropisms serve as additional evidence for the interaction between the semantic and phonological levels. Malapropisms are real words that are not related in meaning to the target words, but are closely related to them in pronunciation (Fay & Cutler, 1977). These errors reflect a process of mis-selection of a word based on phonological similarity between the uttered word and the target word. In a corpus of 183 malapropisms, the target item and the error shared the same number of syllables 87% of the time and the same stress pattern 98% of the time. However, these errors tended to be, very frequently, real words that belonged to the same grammatical category as the target items (Fay & Cutler, 1977). This phenomenon is referred to as the lexical bias effect (Dell & Reich, 1981). According to the Spreading Activation model, if lexical access proceeded in serially ordered, independent stages, then following lemma selection, at which semantic and grammatical aspects are being specified, phonological encoding should proceed with no semantic or grammatical constraints. It should be blind to whether a string of sounds create a real word or not. Thus, phonological mis-selection should yield non-word errors more often than real word errors (Dell & Reich, 1981). The lexical bias effect, however, suggests that the phonological encoding level is not entirely blind to the information accessed during lemma selection due to backward activation, resulting in the production of mixed errors and malapropisms.

One investigation directly examined the modularity of these stages (Damian & Martin, 1999). The picture-word interference paradigm included three distractor types, phonologically (e.g., *camel-cash*), semantically (e.g., *camel-pig*), and semantically-phonologically (e.g., *camel-calf*) related to the target item. When the pictures and the distractors were presented simultaneously, response latencies were longer in the presence of semantic distractors, revealing interference effects (e.g., +31ms relative to the unrelated distractors), and shorter in the presence of phonological distractors, revealing facilitation effects (e.g., -19ms relative to the unrelated distractors). Semantic-phonological distractors revealed facilitation effects similar in magnitude to the interference effects observed by the semantic distractors (e.g., -26msec relative to the unrelated distractors). Thus, the semantic interference observed in the presence of semantic distractors was eliminated in the presence of distractors related both in meaning and form to the target items. This result could not be explained by an additive relationship. However, it is consistent with an interactive relationship between the semantic and phonological levels of lexical access. Additive relationship refers to successive, independent stages. The reaction time in an additive relationship is the sum of all-stage-durations. An experimental manipulation affecting processing at a particular stage (e.g., phonological or semantic distractors) would affect the total reaction time. Similarly, an experimental manipulation affecting processing at two different stages (e.g., semantic-phonological distractors) would result in independent effects on the total reaction time, with no one manipulation modifying the other. Thus, the effects occurring in the two stages should be additive (Pachella, 1974; Sternberg in Posner & Raichle, 1994). The effects of the semantic-phonological distractors, however, suggested an interactive relationship between the two levels of processing (i.e., semantic and phonological) that was postulated to be possible via backward activation. Backward activation seems to be the only possible explanation for the frequent occurrence of mixed errors and malapropisms in speech production. However, to date no examination of the temporal patterns of lexical access has revealed a late semantic activation, which would indicate backward activation.

Cascaded processing model of lexicalization

The cascaded processing model (Peterson & Savoy, 1998) proposes a time course for lexical access similar to that of the spreading activation model. However, it does so by proposing unidirectional activation. The cascaded processing model allows for activation to spread only forward, whereas the spreading activation model allows for a backward activation as well (i.e., bi-directional flow of activation). This difference is reflected in the absence of a late semantic activation during the later stage of phonological encoding in the cascaded processing model. The premise behind the cascaded processing model is a period of simultaneous activation of semantic and phonological information. The supporting evidence is the phonological co-activation of semantic alternatives (Cutting & Ferreira, 1999; Griffin & Bock, 1998; Jescheniak, & Schriefers, 1997, 1998; Peterson & Savoy, 1998). Like the spreading activation model, this model postulates a spread of activation from the lemma level to the phonological level prior to the completion of the initial stage of lemma selection. Partial phonological information is activated during the initial stage of lemma selection for both the target item and the semantic alternatives. Thus, there is a period of parallel processing, where both semantic-syntactic and phonological information are activated (see figure 2b).

Phonological co-activation of semantic alternatives was examined using near-synonyms (e.g., "*sofa-couch*"), which exhibit a high degree of semantic relatedness (Peterson & Savoy, 1998). Visual probes were phonologically related to each synonym (e.g., "*couch – count*", "*sofa – soda*"). Both types of probes showed facilitative effects early on in the process of lexical access, during lemma selection. Thus, in the process of response preparation, multiple lexical candidates and not merely the target item were phonologically activated. These results were replicated by Jescheniak and Schriefers (1997; 1998) using a similar paradigm with auditory probes.

Homophones were also used to demonstrate phonological co-activation (Cutting & Ferreira, 1999). Homophone words share the same phonological representations (e.g., *ball* (game) – *ball* (dance)) but have different meanings, thus, different lemmas. Participants were presented with probes that were semantically related to the inappropriate meaning of the target picture (e.g., *dance* for *ball* (toy)). Because the probes were semantically related to lexical items that were identical in their phonological properties to the lexical items depicted in the pictures, any effect of these probes on response time would have indicated simultaneous activation of semantic and phonological information. Results revealed facilitation effects, suggesting simultaneous processing of semantic and phonological information.

The cascaded processing model received additional support when two factors (i.e., contextual constraint and frequency) that usually influence different levels of lexical processing showed interaction by modulating each other (Griffin & Bock, 1998). Both the discrete two-stage model and the cascade models posit that contextual constraint affects lemma selection by reducing the number of competitors. Frequency effects are attributed to accessing the phonological forms of words, influencing the phonological encoding level. The models diverge in their predictions regarding the interplay between the two factors and their influence on language production. The discrete two-stage model posits that the effects of these factors are confined to different processing levels; phonological encoding is unaffected by the amount of evidence guiding lemma selection. In contrast, the interactive models postulate that due to spread of activation from the lemma level to the phonological encoding level, the effects of contextual constraint indirectly affect phonological encoding and thus, modulate frequency effects. These models postulate that increased contextual constraint will facilitate production of low frequency words more than high frequency words, thus, diminishing the difference between them. Results supported the interactive models. The premise behind cascade of activation is maximum efficiency in minimum time. Cascade of activation between the two levels of processing allows phonological encoding to begin its course as soon as possible, speeding lexical access (Cutting & Ferreira, 1999).

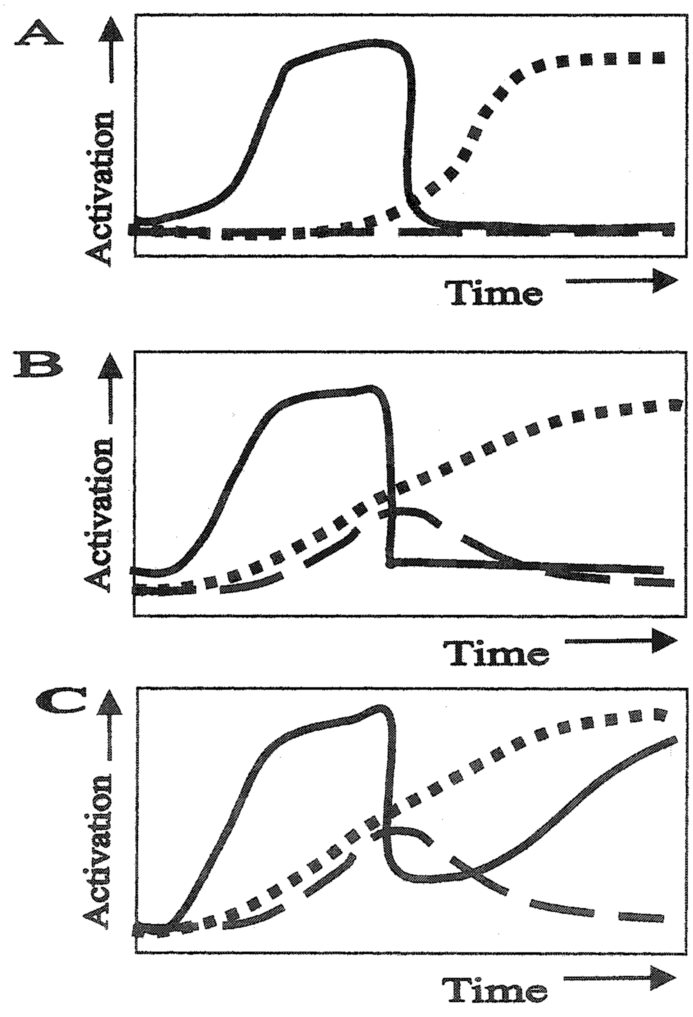


Figure 2. The time course of semantic (solid line) and phonological (dotted line) activation of targets and phonological activation of semantic alternatives (dashed line) for the discrete two-stage (A), the cascaded processing (B), and the spreading activation (C) models (From Levelt, Schriefers, Vorberg, Meyer, Penchmann, & Havinga, 1991)

Lexical Access in Children with Typical Language Development

The temporal and structural processes of lexical access in child language production have not yet been examined in detail. Previous research focused on diaries and laboratory-evoked spontaneous speech that involved descriptive analysis of children's speech errors in early word productions (Dapretto & Bjork, 2000; Gershkoff-Stowe, 2001; Gershkoff-Stowe & Smith, 1997; Jaeger, 1992; Stemberger, 1989; Warren, 1986; Wijnen, 1992). The word-finding and naming abilities of preschool and school-aged children have been examined using offline techniques varying in context and stimuli (Clark & Johnson, 1994; Johnson, 1992, 1994; Kirk, 1992; Wiegel-Crump & Dennis, 1986). The primary goal of that research was to learn about lexical development and vocabulary growth in children, and the various factors that influence the course of development.

Research on lexical access in children focused on whether the differences in the mechanism of lexical access in children and adults are structural or parametric. A structural difference involves the addition or elimination of subsystems. It reflects a difference in the architecture of the lexical system, indicating a qualitative difference (Wijnen, 1992). Structural changes in the architecture of children's lexical system were postulated to occur during language acquisition (Wijnen, 1990). A transition from "pre-grammatical" or "telegraphic" speech to morphosyntactically governed language was associated with the modification of the planning mechanism underlying speech production; specifically, with the addition of the *positional planning component* (Garrett, 1975) that is responsible for serial order planning. The development of the positional planner was associated with two changes that occur in children's productions between the ages of two and three years of age. The first change involves the development of grammatical morphology and the separation between closed and open-class vocabulary. The second change involves the development of morpho-phonological and morpho-syntactic processes. It was argued that the development of the positional component takes a toll on processing capacity, which results in increased dysfluencies. The distribution of these dysfluencies shifts over time from sentence middle positions toward sentence initial positions, marking the presence of the positional component. The architecture of the production system in children changes over the course of language development, evolving from a one-stage into a two-stage system (Wijnen 1990).

A parametric difference is a quantitative difference involving the size of the storage buffers and the temporal aspects of lexical access (e.g., cascade of activation, backward activation, automaticity, etc.) (Levelt, 1989). The majority of studies (Jaeger, 1992; Stemberger, 1989; Warren, 1986; Wijnen, 1992) suggest a parametric difference between the mechanisms underlying lexical access in children and adults. These studies examined the error patterns in adults' and children's productions and found quantitative but not qualitative differences. Children produced more errors than adults, reflecting their less automated speech production processes (Stemberger, 1989; Wijnen, 1992). They produced more errors on function words compared to adults, which might be attributed to their lack of experience in producing these words (Wijnen, 1992). In addition, children made more phonological errors than adults reflecting their less integrated phonological representations (Jaeger, 1992; Stemberger, 1989; Wijnen, 1992). Finally, children exhibited fewer incomplete utterances compared to adults reflecting less efficient selfmonitoring skills. Adults tend to monitor their speech and thus, tend not to complete an utterance when an error is noticed (Jaeger, 1992; Wijnen, 1992).

Despite the differences, the similarities between adults' and children's error patterns suggest comparable underlying mechanisms of lexical access. Both children and adults exhibit grammatical class constraints, where incorrect words are inserted into the syntactic slots, but the syntactic structure of the sentence remains intact. This suggests similar syntactic planning. The most prominent speech error type produced by children and adults is semantic substitution, suggesting similar semantic processing mechanisms. Finally, the majority of segment errors in adults' and children's productions involve segments from parallel syllable positions, suggesting similar phonological encoding mechanisms (Stemberger, 1989; Wijnen, 1992). These similarities also support the models of language production proposed for adults, which postulate independent levels of processing. However, children's language production data does not differentiate between the different models of lexical access. Two types of speech errors in children's productions support the spreading activation model, malapropisms (Wijnen, 1992) and perseverations (Stemberger, 1989). Children exhibit lower proportions of malapropisms (e.g., lexical substitutions that bear phonological similarities) compared to adults. According to the spreading activation theory of lexical access, malapropisms result from backward activation from the phonological encoding level to the lemma level. The low proportion of malapropisms in children's productions was taken as evidence for minimal backward activation in children's lexical system. Children also make more perseveratory errors compared to adults. These errors may reflect a slow decay rate of previously activated lexical items in children's productions. This phenomenon can be explained only by the interactive models that allow for cascade of activation and not by the discrete two-stage model.

Additional support for the parametric changes that occur in children's lexical system come from studies investigating the vocabulary spurt (Dapratto & Bjork, 2000; Gershkoff-Stowe & Smith, 1997; Gershkoff-Stow, 2001). Towards the end of their second year, children exhibit dramatic developments in their productive vocabularies, which are referred to as the *vocabulary spurt*. These developments involve an increase in the productive lexicon, the emergence of two-word combinations, an increase in the ability to use language to refer to things that are not physically present, and a decrease in the use of overextended, onomatopoeic, and idiosyncratic words (Dapratto & Bjork, 2000). Despite these developments, children tend to make more errors during the period of vocabulary spurt. Children's lexical system undergoes two parametric changes during this period that may contribute to the increase in speech errors, the dramatic increase in vocabulary size and an increase in speaking rate. The initial lexicon of children is very sparse, and there is less competition among lexical items. As vocabulary grows, the lexicon becomes denser, and greater interference from lexical competitors is expected (Gershkoff-Stowe & Smith, 1997; Charles-Luce & Luce, 1990; 1995). The new demands of a denser lexicon cause word retrieval processes to undergo major changes, resulting in increased error rate. As word retrieval processes become more efficient, a decrease in error rate is evidenced. An increase in the rate of speaking also increases the rate of speech errors (McKay, 1971). The frequency of production attempts not only increases as newly acquired words are produced, but these productions also occur more closely together in time (Gershkoff-Stowe & Smith, 1997). Related factors that influence production are word frequency and word familiarity. High frequency words are accessed faster and produced more accurately than low frequency words (Forster & Chambers, 1973; Leonard, Nippold, Kail, & Hale, 1983). Their high activation strength makes them more resistant to interference from lexical competitors (Forster, 1990). However, words in children's initial vocabularies are not as frequent or as familiar as in the mature lexicon, which results in more speech errors. Practice of newly acquired words by frequently producing them enhances correct productions by increasing the words' activation strength (Dell, Burger, & Svec, 1997).

Perseverations were the most frequent speech errors found in children during the period of vocabulary spurt (Gershkoff-Stowe & Smith, 1997; Gershkoff-Stowe, 2001). Slower decay rate, or inefficient deactivation of previously activated lexical items may underlie these errors (Stemberger, 1989). An increase in activation strength as a result of practice decreased perseverations in adults (Dell, Burger, & Svec, 1997). However, a different mechanism may underlie the production of perseverations in children, inefficient inhibitory mechanisms (Clark & Johnson, 1994; Johnson, 1994). Inhibitory mechanisms prevent inappropriate lexical items from reaching sufficient activation that would make them available for selection and retrieval. Inhibitory processes gradually mature over the course of development (Johnson, 1994). The function of the inhibitory mechanisms during lexical selection was examined in children ages five, seven, and nine years of age (Johnson, 1994). Children were asked to name high uncertainty objects, objects with multiple possible names (e.g., TRICYCLE can be referred to as bike, bicycle, tricycle, or trike) under two conditions. In the biased condition, the target picture was presented in the context of two pictures (e.g., *cat*, and *tiger*) that limited the child to the use of only a subset of the object's possible names (e.g., *kitten, kitty, kittycat*). In the neutral condition, the target picture (e.g., *kitten)* was presented in the context of two pictures (e.g. *zebra*, and *kangaroo*) that allowed the child to use any of the object's possible names (e.g., *kitten, kitty, kittycat, cat, pussy, pussycat*). If the selection of a target lexical item requires the suppression or inhibition of competing lexical items, selection and retrieval of the word in the biased condition would take longer than in the neutral condition. Results revealed subtle developmental changes in the efficiency of the inhibitory mechanisms during lexical access at the cost of longer reaction times for naming. The five-year-olds had difficulty in suppressing interfering stimuli, whereas the nine-year-olds showed increased evidence of inhibition with more accurate responses at the cost of longer reaction time.

The typical development of naming-skills is not a simple linear improvement in performance with age, but instead the course of development is more complex. Although naming performance did improve over the course of development (Wiegel-Crump & Dennis, 1986; Kirk, 1992), it was modulated by the availability of words for retrieval under different access conditions. For the same set of lexical items, confrontation naming was easier than naming in response to a description, which in turn was easier than naming to a rhyme. The difficulty of naming under the rhyming condition suggested that school-aged children do not use segmental information as much to access their lexicon. Taken with the fact that the most prominent speech errors in children were semantic substitutions, the organizational basis of children's lexicon appears to be more dominantly semantic (Wiegel-Crump & Dennis, 1986).

Previous studies used off-line techniques in their investigation of naming abilities in typically developing children. More recent studies (Brooks & McWhinney, 2000; Jerger, Martin, & Damian, 2002) used the online paradigm of cross-modal picture-word interference, used previously in adult studies, to examine developmental changes in semantic and phonological encoding during language production in children. The time course of lexical access in children, as indexed by their performance on the cross-modal picture-word interference paradigm, was found to be remarkably similar to that of adults, with semantic distractors inhibiting production only at the early stage of lexical access (Jerger, Martin, & Damian, 2002). In a study examining phonological processing during language production children in all age groups (e.g., 4;11-5;11, 6:11-7;11, and 9:5-11;9 year-olds) named pictures faster in the presence of phonological primes that shared the onset consonants with the target pictures. When the phonologically related primes rhymed with the target pictures, only the youngest group revealed faster response times to naming. This result suggested a developmental shift in focus from the rhyme to the onset of a word in language production. Over time, the lexicon of children is reorganized into an onset-based structure, as in adults, allowing for more rapid lexical access (Brooks & McWinney, 2000).

In summary, the vast majority of research supports a parametric change rather than a structural change in lexical access over the course of language development in children. This is in agreement with Pinker's (1984) continuity assumption, which postulates that children and adults have similar cognitive mechanisms for language production and comprehension. It assumes continuity between these mechanisms over the course of development, with the child's system being in its intermediate stage, eventually developing into the adult system (Pinker, 1984). Further research exploring the temporal and structural aspects of the mechanisms underlying lexical access in children and adults is imperative. One of the drawbacks of previous studies in children is the use of off-line techniques. Diaries and speech error patterns were used to infer the mechanisms of lexical access in children. Data were collected and analyzed from a very small group of children. These data provided information about the end-products of the lexicalization process rather than about the specific levels of lexicalization on a moment-by-moment basis. The present study applied an on-line technique, measuring reaction time, which allowed for an examination a larger group of children, providing insight into the process of lexicalization as it occurred.

Lexical Access in Children with Language Impairment

Word-finding difficulties have been well documented as the most frequently observed lexical limitation school-aged children with Specific Language Impairment (SLI) exhibit (Faust, Dimitrovsky, & Davidi, 1997; German 1979; 1984; 1987; Leonard, Nippold, Kale & Hale, 1983; McGregor & Leonard, 1989; Nippold, 1992; Wiig & Backer-Caplan, 1984). Children with SLI typically have performance IQ's within normal limits, normal hearing sensitivity, no behavioral or emotional disorders, and no gross neurological deficits in the presence of significant deficits in language comprehension and production (Leonard, 1998). The lexical limitations these children exhibit in the early stages of acquiring the lexicon are late emergence of first words and slow vocabulary growth (Leonard 1998). Word-finding difficulties are more prominent in these children in later stages of lexical development (German, 1987; McGregor & Leonard, 1989).

Children with SLI manifest word-finding difficulties, not only in single-word naming tasks, but also in discourse (German & Simon, 1991). Two types of language profiles are representative of children with word-finding difficulties. The first is characterized by reduced language production and a small number of errors reflecting failure in word-finding (e.g., repetitions, reformulations, substitutions, etc.). The other is characterized by numerous errors with no decrease in language production (German, 1987).

Word-finding difficulties are usually defined according to three measures, response time, number of speech errors, and error patterns (German, 1984). Children with SLI name pictures more slowly than children with typical language development (Lahey & Edwards, 1996; Leonard et al., 1983). They also produce significantly more errors than their typically developing peers (German & Simon, 1991; Lahey & Edwards, 1999; McGregor, 1997). However, children with SLI exhibit similar error patterns to those of children with typical language development (German & Simon, 1991; McGregor, 1997), with semantic errors predominating in both groups. Several error types distinguished children with SLI from their typically developing peers. Children with SLI made more phonological errors, most of which were distortions of the target items (Lahey & Edwards, 1999; McGregor, 1997). They exhibited significantly more unrelated errors (i.e., "don't know" response) (Faust et al., 1997; McGregor, 1997) and used more circumlocutions when the target word was inaccessible (Lahey & Edwards, 1999). Finally, compared to their typically developing peers, they exhibited more insertions, which are comments regarding the word-finding process as it occurs (e.g., "I know that word but I can't remember it now") (German & Simon, 1991). These differences reveal the specific difficulties children with SLI exhibit in lexical access during language production.

For the last two decades, research investigating the lexical abilities of children with SLI focused on finding the specific locus of breakdown in their lexical system that gives rise to word-finding difficulties. Earlier studies were interested in the role of lexical storage and lexical retrieval in word-finding difficulties. Breakdowns in either lexical storage, referred to as the *Storage Hypothesis*, or lexical retrieval, referred to as the *Retrieval Hypothesis* were postulated as possible underlying causes for word-finding difficulties (Kail, Hale, Leonard, & Nippold, 1984). The premise behind the storage hypothesis was the delayed acquisition of first words and the slow lexical development evidenced in children with SLI. The assumption was that these children have difficulties accessing words that are either not yet well-established in their lexicon or are represented in a less elaborated form. In contrast, the retrieval hypothesis postulated a comparable lexicon for children with SLI and children with typical language development. Their difficulties were postulated to be in the accessibility to that lexicon. It was suggested that children with SLI use less efficient strategies to access the lexicon and retrieve the target items.

An examination of these two theories was carried out in a study of the abilities of children with SLI to recall words under free and cued recall conditions (Kail, Hale, Leonard, & Nippold, 1984). Under the free recall condition, children were asked to recall as many words as they could. Under the cued recall condition, the category name was provided as a retrieval cue. If the breakdown in the lexical system occurred in lexical storage, performance on free and cued recall would be expected not to differ. However, if the breakdown occurred in lexical retrieval, performance would be expected to be better on cued recall than on free recall. Children with SLI recalled fewer words under both conditions compared to their typically developing peers, supporting the storage hypothesis. However, cueing did improve the ability of children with SLI to recall names, supporting the retrieval hypothesis. Thus, this study was unsuccessful in identifying the specific locus of breakdown in the lexical system of children with SLI.

Increased response time on a confrontation-naming task (Leonard, Nippold, Kail, & Hale, 1983) could have been attributed to either lexical retrieval or storage deficits in children with SLI. However, the appearance of both receptive and expressive deficits on standardized tests of word knowledge emphasized the fact that these children may have less distinct representations of lexical items in their memory compared to their typically developing peers. These two hypotheses did not address the different levels of lexical processing (e.g., semantic versus phonological levels) and the temporal interplay between them. More recent research concerning the word-finding abilities of children with SLI focused on the specific levels of lexical access, semantic and phonological levels, rather than on the general aspects of lexical storage and retrieval. Breakdowns were postulated at one or both of these processing levels.

Breakdown in the phonological level of processing

The fact that children with SLI exhibit deficits in language form (e.g., phonology, morphology, and syntax) led researchers to believe that this might be the underlying cause for their word-finding difficulties. More specifically, children with SLI exhibit deficits in phonological working memory (Gathercole & Baddeley, 1990). Successful lexical access depends on efficient and accurate encoding and decoding of phonological information in working memory (Rubin & Liberman, 1983). The difficulties children with SLI exhibited in repeating nonsense words and recalling lists of real words suggested imprecise phonological representations, limited phonological storage capacity, or rapid decay of phonological traces in phonological working memory (Gathercole & Baddeley, 1990; Montgomery, 1995).

The speech errors produced by children with language impairment led to similar conclusions (Rubin & Liberman, 1983). Semantic errors, which were the most frequent errors in the speech of children with SLI, were attributed to a complete failure in lexical accessing due to weak phonological representations. Phonologically-based treatment for word-finding deficits in children with SLI (McGregor, 1994) revealed that practicing of phonological information, such as initial sound and number of syllables, reduced the amount of semantic errors. Phonological errors, however, suggested successful access to at least the generic phonological information most frequently retrieved while in the tip of the tongue state (e.g., initial sound, stress pattern, number of syllables). A phonological processing deficit was postulated as the underlying cause for the word-finding deficit in a 7-yr-old child with severe word-finding difficulties (Constable, Stackhouse, & Wells, 1997). This child exhibited poor performance compared to chronologically and vocabulary-matched controls on tasks that tap phonological processing (e.g., auditory discrimination task, rhyme generation task, auditory lexical decision task, and words and non-words repetition task) in contrast to a fairly good performance on tasks that tap semantic processing (e.g., word association task, and word class task). The child's poor performance on the phonological tasks suggested imprecise phonological representations or a deficit in motor programming. Thus, difficulties in accessing and retrieval of phonological information due to imprecise or vulnerable phonological representations were offered as the underlying cause of word finding deficits.

Breakdown in the semantic level of processing

Several characteristics of children with SLI suggest a breakdown in the semantic level of lexical processing. Children with SLI are late in acquiring their first words and are slow in developing their lexicons (Leonard, 1998). Semantic errors are the most frequent speech errors produced by children with SLI. These errors were suggested to be the result of poorly differentiated semantic representations of lexical items (Lahey & Edwards, 1999; McGregor, 1997). In addition, children with SLI exhibit low scores on lexical comprehension tests (e.g., The Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1981), although performing at age level, suggesting that their underlying semantic representations of lexical items might be impoverished and not well elaborated (Lahey & Edwards, 1999; McGregor, 1997).

Additional evidence for a semantic deficit came from a study investigating the hierarchical organization of the semantic system in children with language impairment (McGregor & Waxman, 1998). Naming performance on multiple levels of noun hierarchy (e.g., superordinate, coordinate, and subordinate) suggested insufficient depth and breadth of lexical storage. Children with language impairment named subordinate nouns less frequently and produced indeterminate errors (e.g., "I don't know") at the subordinate level more frequently than their typically developing peers. A similar conclusion was reached in a study examining the ability of children with word-finding difficulties to use semantic cues (McGregor & Windsor, 1996). These children did not benefit from semantic cues compared to their typical language developing peers. Their lexical system differed from the typical one by having "fewer lexical entries" (i.e., limited vocabulary), "inadequate connection among the lexical entries", and "informationally impoverished lexical entries" (pp.1055). The results of this study and the low scores children with SLI exhibit on vocabulary tests (i.e., PPVT) suggest the importance of semantic knowledge as a basis for successful lexical access.

The degree of semantic knowledge was found to be predictive of naming accuracy in typically developing children. The relations between semantic representations and naming skills were examined (McGregor, Friedman, Reilly, & Newman, 2002). Semantic errors were postulated to occur when either a semantic representation of a lexical item was missing (e.g., lexical gap), was present but fragile (e.g., the child has a limited knowledge about the meaning of the word), or was present but temporarily inaccessible. Lexical gaps or fragile semantic representations were the most frequent in causing semantic errors in early stages of typical lexical development. Despite the evidence supporting a breakdown in the semantic level of processing, the presence of a small proportion of phonological errors in children with SLI suggests that there might not be a single locus of deficit. Instead, semantic and phonological deficits may co-occur.

Dual Deficit – Breakdown in the semantic and phonological levels of processing

Evidence for a dual deficit came from a study using the Tip of the Tongue (TOT) paradigm (Faust, Dimitrovsky, & Davidi, 1997). Children with language impairment produced more TOT and Don't Know (DK) responses and fewer correct responses than children with typical language development. DK responses reflect lack of word knowledge, whereas TOT responses reflect partial word knowledge and possible retrieval limitations. A high percentage of semantic substitutions suggested a deficit in the semantic level. However, the appearance of phonological errors, which rarely occurred in typically developing children, and the invalid phonological information provided by the children with language impairments, suggested a breakdown in the phonological system.

The search for the underlying cause of word-finding difficulties in children with SLI is ongoing. Whether the locus of breakdown is in the retrieval or storage of lexical information or more specifically, in the semantic or phonological levels of lexical processing is still unclear. All four potential loci of breakdown were addressed in an intervention program aimed to improve word-finding abilities in children with language impairment (Leonard & McGregor, 1989; Wright, 1993). Training focused on the increased use of semantic and phonological cues to ease retrieval, and storage strategies with the aim of elaborating phonological and semantic representations of the trained items. Word-finding abilities improved, as measured by an increase in naming accuracy. Although the combined approach seems to be highly beneficial in facilitating word-finding difficulties, one has to wonder about the contribution of each strategy to the overall success in word retrieval. This shotgun approach does not seem particularly efficacious. However, focusing future research on finding the underlying cause for word-finding deficits and the specific locus of breakdown in the lexical system of children with SLI will allow for the development of more explicit, focused remedial programs.

Word-finding deficits in aphasia

Adults with aphasia have a high prevalence of word-finding deficits (i.e., anomia). It is a persistent disturbance, which remains long after substantial improvements in other domains have taken place. Some of the linguistic characteristics of adults with aphasia are similar to those of children with SLI and, thus, they can serve as a comparison group.

The research investigating the origin of word-finding difficulties in adults with aphasia has followed a similar path to that in SLI. The analysis of speech errors initially led researchers to speculate about the locus of breakdown in the lexical system of adults with aphasia (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Dorze & Nespoulous, 1989; Foygel & Dell, 2000; Laine & Martin, 1996). However, in contrast to the research in children with SLI, research in aphasia has been driven by theoretical models of lexical access in normal adults.

The time course of lexical access in adults with aphasia differs from that observed in normal adults. Semantic interference is expected at early SA (-150), and phonological facilitation is expected at later SAs (0 & +150); no phonological or semantic effects are expected at SA+300 in normal adults (Schriefers et al., 1990). Adults with aphasia and apraxia of speech exhibited phonological and semantic effects even at late SAs (e.g., +300 & +500) (Rogers, Redmond, & Alarcon, 1999). Due to the phonological impairment, phonological activation may take longer to develop and reach the threshold level for selection. Consequentially, semantic activation is prolonged in order to enhance phonological activation.

The application of the theoretical models of lexical access to research in aphasia led several investigators to postulate a deficit in the link between the semantic and the phonological levels of lexical processing (Bedecker, Miozzo & Zanuttini, 1995; Dorze & Nespoulous, 1989; Laine & Martin, 1996; Lambon Ralph, Sage & Roberts, 2000). Their patients exhibited word-finding difficulties despite the absence of clear semantic and phonological deficits. The presence of semantic substitutions and the ability of the patients to retrieve morphological information about the target words provided evidence for partial lemma access. Similarly, their ability to retrieve partial phonological information (e.g., number of syllables, initial sound) demonstrated partial phonological access. Thus, the link between these two levels of processing was postulated to be deficient.

Foygel and Dell (2000) postulated a continuum between semantic and phonological deficits in the lexical system of adults with fluent aphasia varying along two dimensions, severity and error type. Contrary to previous research that associated semantic errors with semantic deficit and phonological errors with phonological deficit, Foygel & Dell demonstrated that a semantic deficit in aphasia is associated with a high incidence of word errors (i.e., semantic, phonological, mixed and unrelated errors) and a phonological deficit is associated with a high incidence of nonword errors. The frequency of each error type varies with the severity of the aphasia. A semantic deficit reflects deficient connections between the semantic-conceptual level and the lemma level. In this case, lemma selection is random. However, the connections between the lemma and the phonological levels are assumed to be intact, allowing normal phonological encoding to proceed. The result is the occurrence of all types of word errors (i.e., semantic, phonological, mixed and unrelated errors) and rarely of nonwords. A phonological deficit, however, reflects deficient connections between the lemma and the phonological levels. In this case, lemma selection undergoes normal processing, but its phonological encoding is disrupted, resulting in a high incidence of nonword errors. The application of this computational model to the speech errors produced by 21 patients with aphasia suggested that 11 patients had semantic deficits and 10 had phonological deficits. This suggests that word-finding deficits differ in the speech errors associated with them, reflecting a breakdown in distinct places in the lexical system; in either of the processing levels (i.e., semantic or phonological) or in the connections between the levels. The premise of this computational model parallels the earlier proposed notion of a breakdown in lexical retrieval but not in lexical storage as the underlying cause for word finding difficulties. However, it places it in the context of the theoretical framework underlying the static representation and active processes of lexical access. The computational model was derived from an interactive two-step theory of typical lexical access based on the spread of activation. It was then used to account for impaired or atypical lexical access in adults with aphasia. Computational models allow for an examination of different theoretical models of typical language processing and their application to pathological behaviors.

PURPOSE AND RESEARCH OBJECTIVES

The purpose of the present study was to investigate the language processes involved in lexical access during language production in children with and without SLI. Previous studies employed off-line techniques, providing information about the end-products of the lexical access process. This information was then used to make inferences about the process of lexical access in typical language developing (TLD) children and to identify the loci of breakdown in the lexical system of children with word-finding difficulties. However, these data are inadequate for these purposes. The present study employed an on-line technique, *the cross-modal picture-word interference paradigm.* This paradigm directly taps the temporal and parametrical properties of lexical access on a moment-by-moment basis, permitting a more accurate and detailed specification of the loci of breakdown in the lexical system of children with SLI that give rise to word-finding difficulties.

The first objective was to determine whether lexical access in children with and without SLI proceeds in a two-stage fashion as in adults, with the initial stage of lemma selection followed by a later stage of phonological encoding. Similarities found between adults and children's error patterns suggested comparable underlying mechanisms of lexical access (Jaeger, 1992; Stemberger, 1989; Warren, 1986; Wijnen, 1992). The first hypothesis is that children with TLD will access words in the same manner as adults; early semantic inhibition should be followed by later phonological facilitation effects. Recent studies on lexical access in TLD supported this notion (Brooks & MacWhinney, 2000; Jerger, Martin, & Damian, 2002). Additional support comes from a study examining the manner in which children with TLD utilize primes. Semantic primes were less beneficial in facilitating lexical access for naming compared to phonological primes (Kindlon & Garisson, 1984).

In contrast, children with SLI, due to their notable word finding difficulties are expected to show a somewhat different pattern of lexical access. A semantic deficit reflected by fragile, semantically unelaborated lexical items should reveal a smaller semantic inhibition effect due to less competition from semantic alternatives. However, the opposite of a larger semantic inhibition effect or a semantic inhibition effect over a longer period of time might also be a plausible outcome. The presence of semantic inhibition can be explained by: (1) A breakdown in the phonological level due to imprecise phonological representations, which might reveal a longer period of lemma activation that serves as additional support for the retrieval of form-related properties; (2)

A breakdown in the semantic level due to an inadequate lateral inhibition mechanism that suppresses semantic competitors; and (3) A breakdown in the semantic level due to a slow decay rate of activation of semantic competitors leaving the lexical system susceptible to interference. If children with SLI exhibit word-finding difficulties due to imprecise phonological representations, phonological primes would be less beneficial for children with SLI, resulting in a smaller phonological facilitation effect or its absence.

The parametric characteristics of children and adults' lexical systems are manifested in the time course of lexical access. The second objective was to determine whether the time course of lexical access in children with and without SLI follows the predictions of the discrete two-stage model of two serially ordered, non-overlapping stages, or of the interactive models, indicating parallel processing. Two temporal features will be examined: the cascade of activation from the semantic level to the phonological level prior to lemma selection, and the backward activation from the phonological level to the semantic level. It was hypothesized that children with TLD would exhibit temporal characteristics similar to adults, revealing some degree of parallel processing at early-mid SAs. Children with SLI, due to their difficulty in lemma selection or the retrieval of phonological features, were expected to show more evidence of parallel processing. In this case, the cascade of activation can be viewed as an internal mechanism that facilitates the retrieval of lexical items (Rogers, Redmond, & Alarcon, 1999). Because previous studies in adults failed to reveal a late semantic inhibition, which would indicate a flow of activation backward from the phonological level to the semantic level, we would not expect to see evidence for backward activation in the present study for in the adult participants and the children with and without SLI.

The information gathered in the present study is valuable for several reasons. It provides insights into the process of lexical access during language production in typical language developing children. This information is important developmentally and also as a reference point for children with language impairments. By detailing the time course of lexical access on a moment-by-moment basis, we can better understand the language deficits of children with SLI. More precisely, these data may better specify the locus of breakdown in the lexical system of children with SLI that gives rise to word-finding deficits. Remedial programs for word-finding deficits can be developed, targeting the specific locus of deficit. Finally, by utilizing the same methodology used with adults, data from children can provide additional evidence that can be used to evaluate the three models of lexical access discussed previously.

CHAPTER 2: METHODS

Participants

Fifty-four subjects participated in the study constituting three groups, a group of 20 young adults (9 males and 11 females), a group of 14 children with Specific Language Impairment (SLI) (6 males and 8 females), and a group of 20 children, age-matched controls, with typical language development (TLD) (7 males and 13 females). The adult participants were students recruited from the Graduate Center, the City University of New York. Additional participants were recruited by fliers posted in public places. All participants were monolingual English speakers who had no history of speech, hearing, or language deficits. All participants filled out a language background questionnaire (see Appendix A) and gave their consent for participation in the study (see Appendix B). Participants attended the laboratory for one session for which they were paid $10. All participants passed a hearing screening (at 20dB HL at 500, 1000, 2000, & 4000 Hz).

All children were recruited through personal advertisements and private schools in NYC. They were drawn from households where English was the primary language spoken, as verified by a parent questionnaire (see Appendix C). All children passed a hearing screening (at 20dB HL at 500, 1000, 2000, & 4000 Hz). Children were excluded from the study if they exhibited gross motor, emotional and neurological deficits, or fluency deficits as documented in the parent questionnaire. Children with and without SLI exhibited non-verbal intelligence within normal limits defined by a score of 85 or above (*SD* >-1) on the Test of Nonverbal Intelligence-Second Edition, TONI-2nd (Brown, Sherbenou, & Johnson, 1990). In addition, all children had age-appropriate language comprehension skills defined by a score of 85 or above (*SD* >-1) on the Peabody Picture

Vocabulary Test Revised (PPVT-R) (Dunn & Dunn, 1981). All children came from upper-middle class homes (See Table 1 for more details).

Children with SLI ranged in age from 8;3 to 10;8 (years;months) with an average age of 9;3. The presence of a language impairment was determined using the following criteria: (a) a speech-language pathologist diagnosis of language impairment or the child's enrollment in speech and language therapy, and or (b) a composite score of 81 or lower (corresponds to 1.3 *SD* below the mean) on the Clinical Evaluation of Language Fundamentals, CELF 3 or CELF 4 (Semel, Wiig, & Secord, 1995; 2003). All children with SLI, except one child, who have been receiving language therapy since the age of three, obtained a failing composite score on the CELF Test. Fifty percent of the children with SLI have been enrolled in language therapy programs. The word-finding difficulties were documented through a word-finding referral checklist (German & German, 1992) administered to the parents and through the Test of Word Finding - TWF (German, 2000). A summary of all the test results is presented in Table 2.

Children in the TLD group ranged in age from 8;0 to 10;8 with an average age of 9;4. Each child in the TLD group was age-matched with a child with SLI ± 3 months. All children in this group exhibited typical language development as documented by a parent questionnaire. All children participating in the study gave their assent for participation and were paid $15 per hour. All parents gave their permission for their children's participation in the study (see Appendix D).

	SES			
	Lower-Middle	**Middle**	**Upper-Middle**	**Upper**
TLD	-	5	10	5
SLI	1	6	7	-

Table 1. Summary of the TLD and SLI groups socioeconomic status.

Group	Sub	Gender	AGE	CELF Receptive	CELF Expressive	CELF Total	TONI	PPVT	TWF
TLD	1	F	8.0	125	108	117	118	117	101
	2	M	8.1	114	100	107	108	103	118
	3	M	8.4	NA	96	NA	92	98	NA
	4	F	8.6	104	116	110	99	122	122
	5	F	8.6	122	108	115	119	116	97
	6	F	8.11	110	114	112	121	104	112
	7	M	9.0	96	90	92	108	117	90
	8	F	9.1	102	110	106	117	119	102
	9	F	9.1	102	102	102	92	98	105
	10	M	9.3	96	99	98	98	94	93
	11	F	9.3	93	96	94	91	86	133
	12	F	9.7	96	106	101	102	98	77
	13	F	9.8	116	106	111	90	122	126
	14	F	10.2	120	114	117	125	106	126
	15	F	10.2	99	91	94	111	102	136
	16	F	10.3	110	108	109	115	104	86
	17	M	10.4	106	114	110	118	150	131
	18	M	10.5	128	116	123	113	128	128
	19	F	10.5	112	100	106	105	118	113
	20	M	10.8	106	114	110	92	124	122
SLI	1	M	8.3	92	67	78	118	85	NA
	2	F	8.4	86	75	81	94	101	111
	3	F	8.7	67	67	66	85	72	66
	4	F	8.7	NA	NA	NA*	89	NA	NA
	5	M	9.1	76	77	76	102	98	69
	6	F	9.1	69	80	73	102	99	102
	7	M	9.2	72	75	72	89	85	65
	8	M	9.4	76	67	62	83	94	81
	9	M	9.5	80	102	90	83	104	118
	10	F	9.5	83	73	76	82	68	58
	11	F	9.11	73	53	58	85	73	70
	12	M	10.1	85	73	78	84	99	99
	13	F	10.3	75	69	70	87	94	87
	14	F	10.8	93	95	88**	112	106	125
Average (*SD*)	TLD			108.3 (10.5)	105.4 (8.3)	107.1 (8.5)	106.7 (11.5)	111.3 (14.7)	111.5 (17.5)
	SLI			79.0 (8.3)	74.8 (12.5)	74.5 (9.2)	92.5 (11.6)	90.6 (12.8)	87.6 (22.9)

Table 2. Summary of test results (e.g., CELF-Clinical Evaluation of Language Fundamentals; TONI-Test of Nonverbal Intelligence; PPVT-Peabody Picture Vocabulary Test; TWF-Test of Word Finding) for TLD and SLI groups.

* Failed (score of 4) on 2 subtest of the CELF. ** Have been receiving services since age 3;6.

Materials

Forty-one black and white line drawings of common objects were used as the visual stimuli. All pictures, except one, were taken from the Snodgrass & Vanderwart (1980) set of pictures. Twenty pictures were selected as target stimuli, 15 pictures were selected as practice pictures, and six as foils. All pictures, except for one, were referents of monosyllabic words. They were referents of highly familiar words that are part of young children's productive vocabulary (Cycowicz, Friedman, Rothstein, & Snodgrass, 1997). Word familiarity was the attribute by which the target stimuli were selected rather than word frequency. Word familiarity reflects experience with a word through more than one modality (e.g., visual, auditory, naming, and writing) (Gernsbacher, 1984). Familiarity effects were found across different modalities (visual and auditory) and tasks (naming and lexical decision), whereas word frequency effects vary across the two modalities and tasks (Connie, Mullennix, Shernoff, & Yelen, 1990). The paradigm also involved 43 monosyllabic words that served as Interfering Stimuli (IS). Thirty IS were used with the target pictures, 12 IS were used with the training items, and one was used with the foils (e.g., the word "*go*"). All words, although presented auditorily, were selected from the Snodgrass & Vanderwart's (1980) set of items, to insure that they were familiar words that are part of the children's productive vocabulary. The words were recorded by a female adult and were digitized and edited to control for intensity. Each experimental picture was paired with three IS based on their relationship to the picture: semantically related, phonologically related, or unrelated. The semantically related IS were members of the same semantic category as the target stimuli, the phonologically related IS shared the initial consonant or consonants with the target stimuli, and the unrelated IS were neither semantically nor phonologically related to the target pictures. The complete list of the stimulus materials is presented in Appendix E.

Design

The *Cross-Modal Picture-Word Interference* paradigm was used to present the IS and the experimental pictures (see Appendix F). Each of the 20 experimental pictures was presented under four conditions:

SILENT Condition. In this condition, the target pictures were presented without the IS and reaction times were measured for a simple naming task. This condition provided a naming reaction time baseline for each group of participants. Establishing a baseline was important because of the findings that children with SLI tend to name pictures slower than children with TLD (Lahey & Edwards, 1996), and that children with TLD name pictures slower than adults (Kail, 1991,1992; Kail & Hall, 1994). This condition also verified that the words for the target pictures were part of the participants' productive vocabulary.

UNRELATED Condition. In this condition, the experimental pictures were paired with words that were neither phonologically nor semantically related. This condition was compared to the silent condition revealing interference by the presence of the IS. This condition served as a reference to which the semantic and phonological conditions were compared.

PHONOLOGICAL Condition. In this condition, the experimental pictures were paired with words that shared the onset consonant or consonants with the target picture names. This condition was compared to the unrelated condition.

SEMANTIC Condition. In this condition, the experimental pictures were paired with words that belonged to the same semantic category as the target pictures. Semantic-categorical words (e.g., *frog-turtle*) and semantic-associate words (e.g., *frog-pond*) affect naming differently, with the first inhibiting and the latter facilitating production (Cutting & Ferreira, 1999). Thus, in the present study the IS were selected such that they had a very weak associative relationship to the experimental pictures as measured by the Word Association, Rhyme, and Word Fragment Norms (Nelson, McEvoy, & Schreiber, 1998). This condition was compared to the unrelated condition.

The IS were presented at four stimulus asynchronies (SAs) for the adult participants and at five SAs for the SLI and TLD groups. Previous studies in adults showed that semantic and phonological effects are no longer apparent in the late SA +300 (Schriefers, Meyer, & Levelt, 1990; Levelt et al., 1991). However, because slower response times were expected from the TLD and SLI groups, an additional SA of +500ms was added. At SA-150, the offset of the IS preceded the onset of the picture by 150ms; at SA0 the onset of the IS and the onset of the picture coincided; at SAs +150, +300, & +500 the IS presentation began 150ms, 300ms, & 500ms (respectively) after the onset of the picture.

The experimental design included three within-subject factors and one between-subject factor. The between subject factor (GROUP) had three levels (SLI, TLD, and ADULTS). The two within-subject factors were the IS type with four levels (SILENT, UNRELATED, PHONOLOGICAL, and SEMANTIC) and the SA with four or five levels (SA -150, 0, +150, +300, and +500). Each participant was presented with each experimental picture 15/17 times (adults/children respectively); three times (i.e., three IS types) under each of the four or five SAs, and twice under the silent condition. The silent condition was administered at the beginning of the experiment and after the experimental paradigm was completed. That allowed us to determine whether there were repetition effects due to multiple presentations of the experimental pictures.

SA was blocked, creating four/five blocks (adults/children respectively). Each SA block consisted of 66 experimental trials, 20 experimental pictures paired with each of the three IS types and six foils paired with the IS "*go*". The order of presentation of the SA blocks was counterbalanced between subjects such that in each of the SLI or TLD groups, one-fifth of the participants received the five blocks in the order of SA [–150,0, +150, +300, and +500], one-fifth in the order of SA [0, +150, +300, +500, and –150], one-fifth in the order of SA [+150, +300, +500, -150 and 0], one-fifth in the order of SA [+300, +500, -150, 0, and +150], and one-fifth the order of SA [+500, -150, 0, +150, and + 300]. For the adult participants, one-fourth of the participants received the four blocks in the order of SA [-150, 0, +150 and +300], one-fourth in the order of SA [0, +150, +300, -150], one-fourth in the order of SA [+150, +300, -150, 0], and one-fourth in the order of SA [+300, -150, 0, +150].

Each block of 66 trials was divided into 3 sub-blocks of 22 trials each. The order of presentation of the experimental pictures within a block was pseudo-random applying the following criteria: no picture was presented on two consecutive trials and no picture was preceded by a phonologically or semantically related picture or IS from the previous trial. The foil pictures in each SA block were preceded, followed, and simultaneously presented with the auditory stimuli of the word "go" to remind the participants to respond as fast as they can.

Procedure

Participants were tested individually in a quiet room at the Developmental Psycholinguistics Laboratory at the CUNY Graduate Center. The SLI and TLD groups attended three sessions, each lasting approximately an hour. The sessions were scheduled approximately a week to two weeks apart. The first session was devoted to the speech, language, and hearing evaluation. The remaining two sessions were devoted to the experimental task. The experiment was administered to the adult participants in a single session. All participants were seated comfortably in front of the computer and wore headphones.

The experiment consisted of four parts, a training phase, silent condition-I, the main experimental paradigm, and silent condition-II. During the training phase, the pictures were presented to the participants on the computer one at a time. The participants were asked to name the pictures with no time pressure. In the event that a participant used a different word than the target, the experimenter provided the participant with the correct target name and made sure that the participant was familiar with the target name. The participants were instructed to avoid the use of articles (e.g., "*a* fork", or "*the* cat") when naming the pictures. The experimenter emphasized the importance of using a strong voice when naming the pictures, and avoiding making any additional sounds (e.g., sighing, coughing, etc.) that might trigger the voice key prior to naming. During the training phase, the experimenter had the opportunity to monitor the accuracy of the participants' productions and to correct them if necessary. The participants were allowed to continue to the next phase if they accurately produced all the target items. When necessary, the list of target pictures was administered for a second time.

Following the training phase, the first silent condition was administered. During this condition participants were presented with the experimental pictures, but this time they were instructed to name the pictures as fast as they can. Reaction time to naming was measured by the computer program from the onset of the picture to the triggering of the voice key by the participant's response. Triggering the voice key caused the picture to disappear. If no response was given by the participant, the picture disappeared after four seconds. A pause of two seconds separated one trial from the other. Following the completion of the silent condition, the experimental paradigm was administered. The participants were told that they would hear words over the headphones while they see the pictures on the computer. They were asked to ignore the words they hear and to concentrate on naming the pictures as fast as they can. The five blocks of SAs were then administered (two in the second session and three in the third session). At the end of each block the participants were given a break. Finally, after completing the five blocks, the silent condition was administered once again (see Appendix F). All experimental sessions, including the silent conditions, were tape-recorded. The tapes were later analyzed in cases where the children made noises and triggered the voice key prior to giving a response. This procedure minimized the loss of trials, especially for children with SLI who had word-retrieval difficulties. In addition, the experimenter recorded the participants' responses by hand and took notes about any technical problems that occurred during the experiment.

Apparatus

The pictures were presented as black and white line drawings on a PC computer. The IS were recorded and digitized using a sampling rate of 22,050Hz, and were normalized to a -19dB level. The IS was presented to the participants at 70dBSPL through Telephonic TDH-50P headphones. The volume was monitored by a volume device to ensure delivery at 70dBHL (see Appendix G). The experiment was delivered to the participant via *E-Prime* 1.1 (2003), which controlled the presentation of the experimental pictures and the IS. Reaction time was measured by the E-Prime program from the onset of a picture to the triggering of the voice key by the participant's response. The participants' responses were recorded by the E-Prime program for reaction time measurements using an ATR20C Audio-technica microphone connected to the voice key and the computer. The children's responses were also recorded by a Digital Auditory Tape (DAT) recorder using an EV 635N/D-B dynamic omnidirectional microphone. A light detector attached to the monitor generated a pure tone every time a picture appeared on the screen. The pure tone was generated as long as the picture was presented on the screen. As soon as the participant vocalized and the picture disappeared, the light detector no longer generated the pure tone. The pure tone generated by the light detector device was recorded on the right channel of the DAT recorder and the participants' responses were recorded on the left channel of the DAT recorder (see diagram in Appendix H). In the analysis of the children's data, because of the use of the light detector, trials were excluded only due to technical problems with the computer/program. The children's sessions were digitally audiotaped. Any trials missed due to the production of non-speech sounds prior to a verbal response were later analyzed using *Sound Forge* 4.5 (1998). This program permitted calculation of RT for those trials where a verbal response was provided after the voice key was triggered by non-speech sounds.

CHAPTER 3: RESULTS

General analysis

The data were analyzed for accuracy and reaction time. Mean reaction time (RT) for correct responses for each group (e.g., Adults, TLD, & SLI) under each SA condition and IS type are presented in Table 3. A 4 (SA) x 3 (IS) x 3 (Group) mixed analysis of variance (ANOVA) was conducted on the participants' response latencies with GROUP serving as a between-subject variable and with SA (-150, 0 +150, and +300) and IS (semantic, phonological, and unrelated) serving as within-subject variables. The TLD and SLI groups were tested on an additional SA (i.e., +500). However, no effects were apparent in this SA, which permitted its exclusion from the general ANOVA. In the analysis, participants were used as the random factor. An F_2 analysis was conducted with the target items as the random factor. For all analyses, an alpha level of 0.05 was used. Effect size was calculated for each analysis, varying in strength from medium to large.

Any response time more than 2 *SD* above the participant's or the target item's means was excluded from the analysis. This cutoff removed 9.3%, 10%, and 7.3% of correct observations in the SLI, TLD, & Adult groups respectively. Observations where the participants used an incorrect picture name, stuttered, or failed to make a response within four seconds, were excluded from the RT analysis. Errors accounted for 8.5%, 6.8%, and 2.8% of the trials in the SLI, the TLD, and the Adult groups respectively. Observations in which the voice key malfunctioned were considered missed trials and accounted for less than 1% of all trials.

Group		SA –150			SA 0			SA +150			SA +3	
		P	S	U	P	S	U	P	S	U	P	S
Adults	**RT**	575.45	570.85	557.07	597.54	621.92	609.09	543.11	572.74	564.98	537.89	527.(
	SD	47.18	47.46	48.50	65.74	58.64	71.97	65.22	59.78	58.98	42.40	43.5
TLD	**RT**	757.70	766.13	696.26	890.61	959.08	905.16	803.51	848.05	865.59	633.19	635.9
	SD	98.33	89.69	81.21	162.94	170.82	165.84	195.89	177.98	208.60	94.14	92.9
SLI	**RT**	783.61	781.32	736.06	945.01	1016.75	949.27	905.69	971.78	948.83	808.29	839.7
	SD	116.47	140.77	122.89	207.48	256.65	208.71	255.76	296.0	270.06	235.73	239.5
Overall	**RT**	696.92	697.74	655.03	796.17	849.16	806.94	733.56	778.16	775.84	643.29	648.4
	SD	128.60	135.05	113.62	213.85	243.54	214.86	233.85	248.59	249.92	169.92	182.(

Table 3. Mean RTs and SDs (in milliseconds) for each group under each of the SA and the IS conditions (P=p
S=semantic, U=unrelated).

	SA –150		SA 0			SA +150			SA +300			SA +500		
	S	U	P	S	U	P	S	U	P	S	U	P	S	U
5	570.85	557.07	597.54	621.92	609.09	543.11	572.74	564.98	537.89	527.08	532.86	-	-	-
;	47.46	48.50	65.74	58.64	71.97	65.22	59.78	58.98	42.40	43.58	41.76	-	-	-
0	766.13	696.26	890.61	959.08	905.16	803.51	848.05	865.59	633.19	635.98	632.64	631.77	612.52	619.47
;	89.69	81.21	162.94	170.82	165.84	195.89	177.98	208.60	94.14	92.99	100.24	70.55	63.05	72.84
1	781.32	736.06	945.01	1016.75	949.27	905.69	971.78	948.83	808.29	839.70	782.46	702.82	683.07	701.33
7	140.77	122.89	207.48	256.65	208.71	255.76	296.0	270.06	235.73	239.58	171.69	156.71	166.94	155.17
2	697.74	655.03	796.17	849.16	806.94	733.56	778.16	775.84	643.29	648.46	634.53	661.02	641.56	653.17
0	135.05	113.62	213.85	243.54	214.86	233.85	248.59	249.92	169.92	182.04	145.40	117.47	120.46	119.22

SDs (in milliseconds) for each group under each of the SA and the IS conditions (P=phonological,
=unrelated).

Reaction Times

Mean reaction times, in milliseconds, for correct responses for each group under each SA condition and IS type are presented in Table 3 and Figures 3-7. Significant main effects were obtained for SA condition ($F_1(3,153) = 39.92$, $p < 0.001$, $\eta = 0.44$; $F_2(3,57)=159.23$, $p < 0.001$, $\eta = 0.89$), and IS type ($F_1(2,102) = 17.37$, $p < 0.001$, $\eta = 0.25$; $F_2(2,38)=4.59$, $p < 0.05$, $\eta = 0.2$) for both subject and item analysis. The interaction between SA and IS type was also found to be significant ($F_1(6,306) = 9.57$, $p < 0.001$, $\eta = 0.2$; $F_2(6,114)=9.31$, $p < 0.001$, $\eta = 0.33$). Figures 8-12 display for each SA the mean reaction time differences between the unrelated condition and the semantic and phonological conditions for each of the three participant groups. Positive values indicate interference and negative values indicate facilitation relative to the unrelated condition.

Significant differences were found between the mean reaction times for the SLI, the TLD, & the Adult groups ($F_1(2,51) = 33.22$, $p < 0.001$, $\eta = 0.57$; $F_2(2,38) = 318.92$, $p < 0.001$, $\eta = 0.94$). A post hoc Fisher-LSD test for the main effect of GROUP revealed that the adults were significantly faster than the SLI and TLD groups in naming ($p < 0.001$) and the TLD group was faster than the SLI group in naming under the experimental conditions ($p < 0.05$).

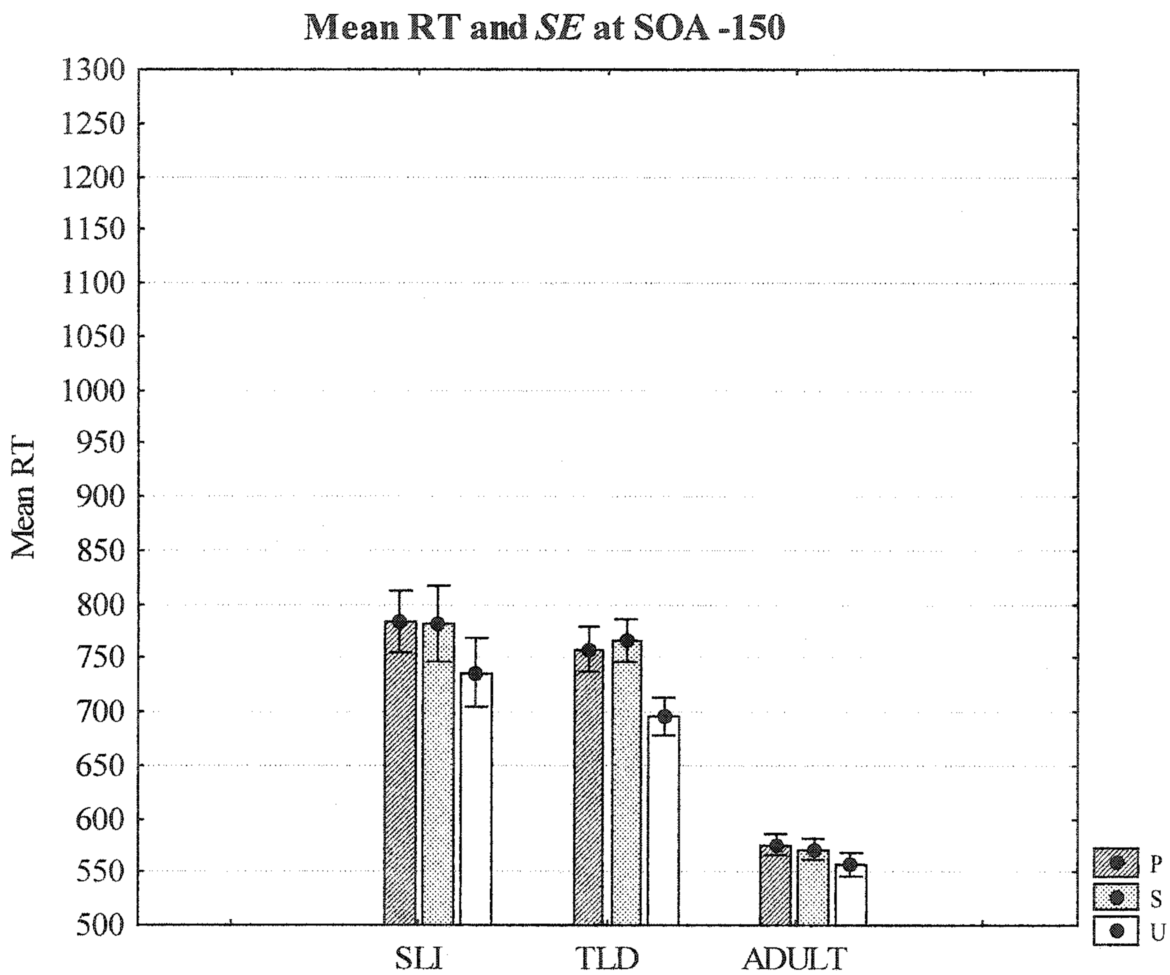


Figure 3. Mean reaction times, in milliseconds, under the phonological (P), semantic (S), and unrelated (U) IS types for each group under SA-150.

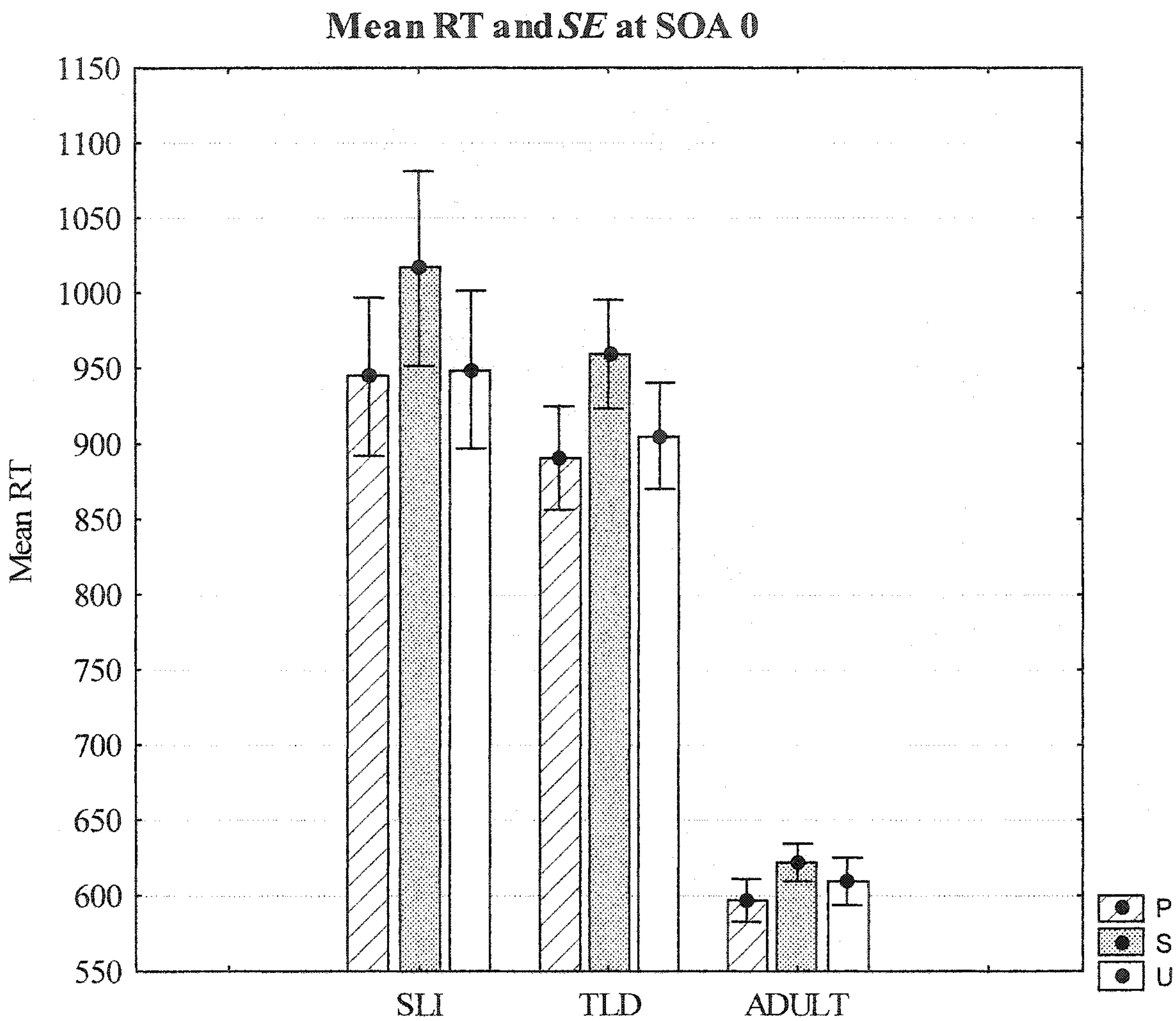


Figure 4. Mean reaction times, in milliseconds, under the phonological (P), semantic (S), and unrelated (U) IS types for each group under SA0.

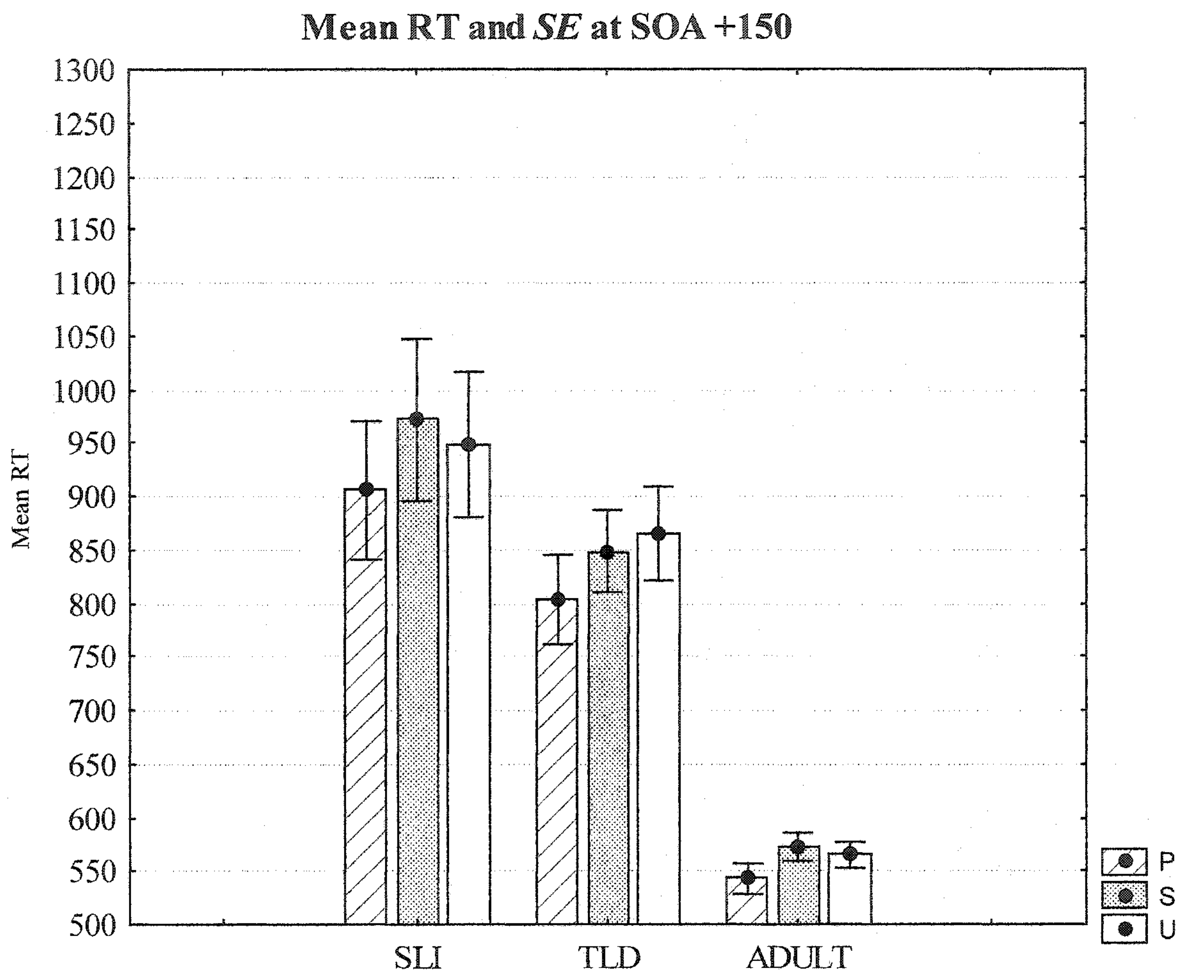


Figure 5. Mean reaction times, in milliseconds, under the phonological (P), semantic (S), and unrelated (U) IS types for each group under SA+150.

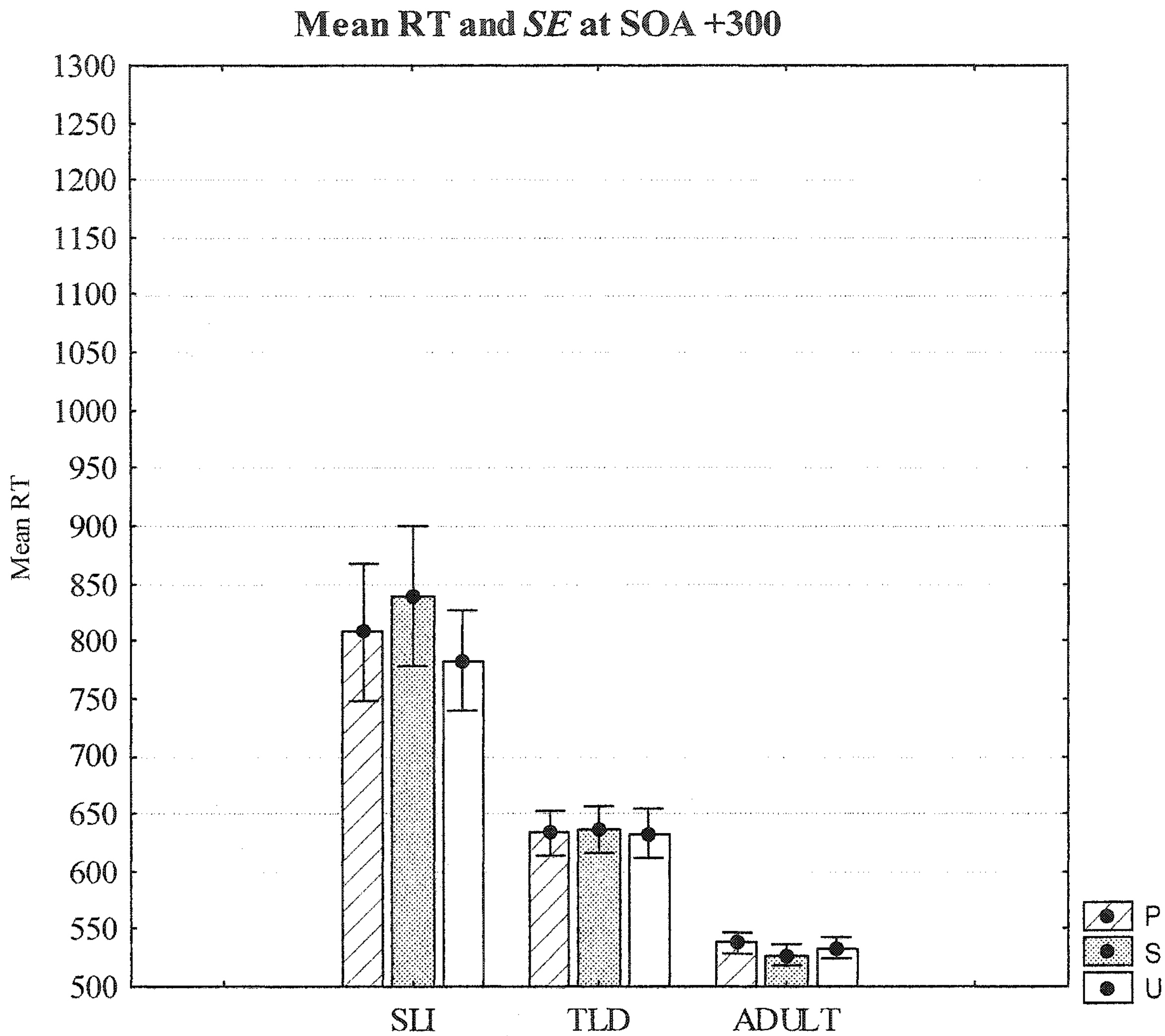


Figure 6. Mean reaction times, in milliseconds, under the phonological (P), semantic (S), and unrelated (U) IS types for each group under SA+300.

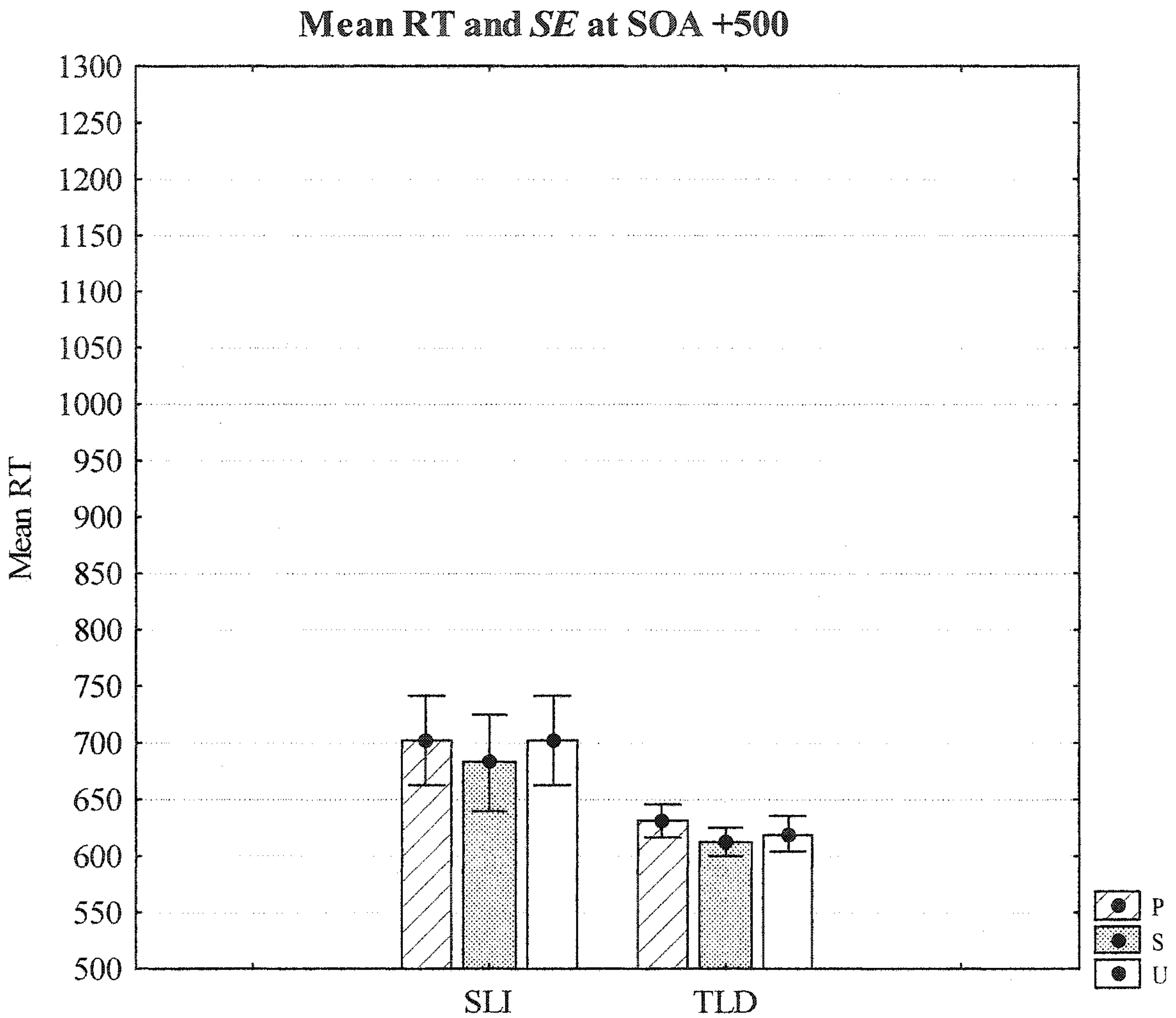
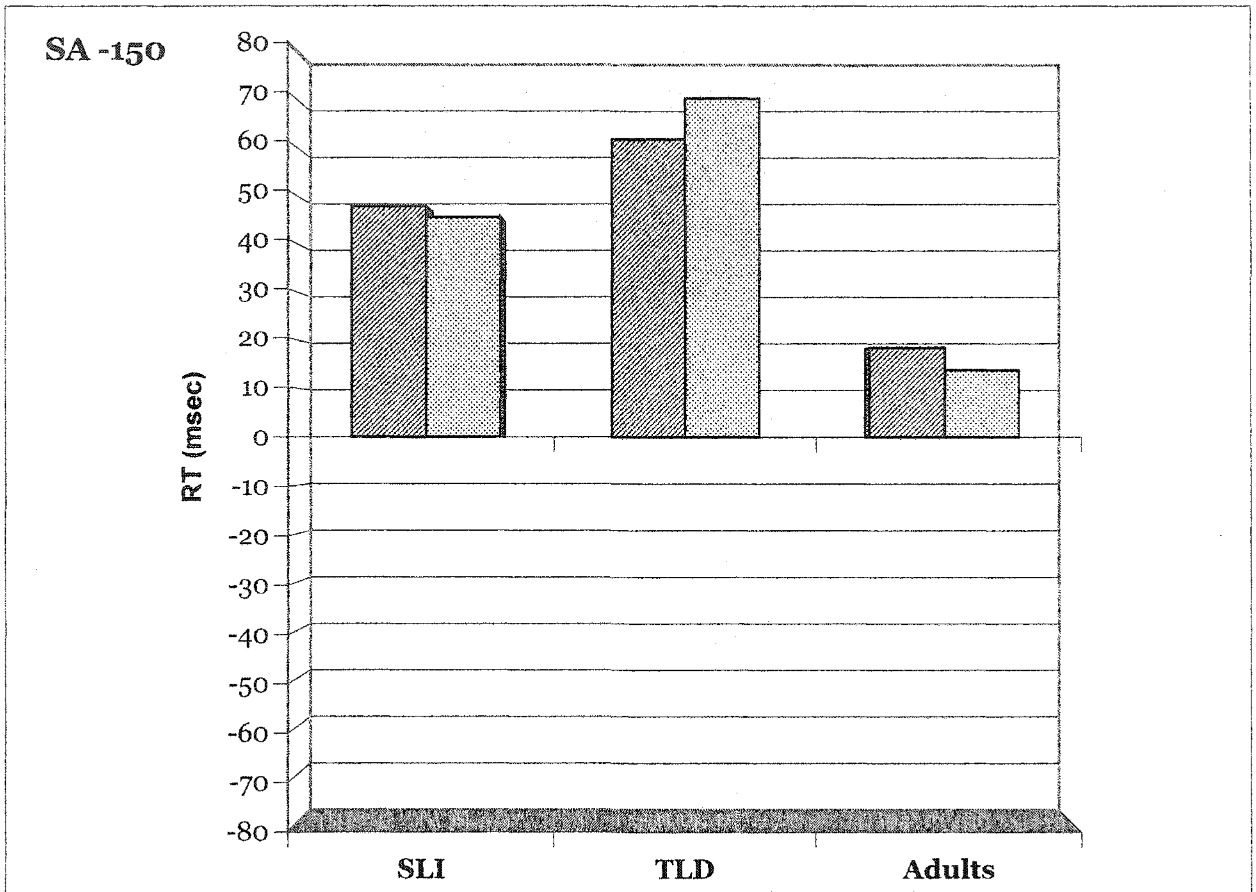
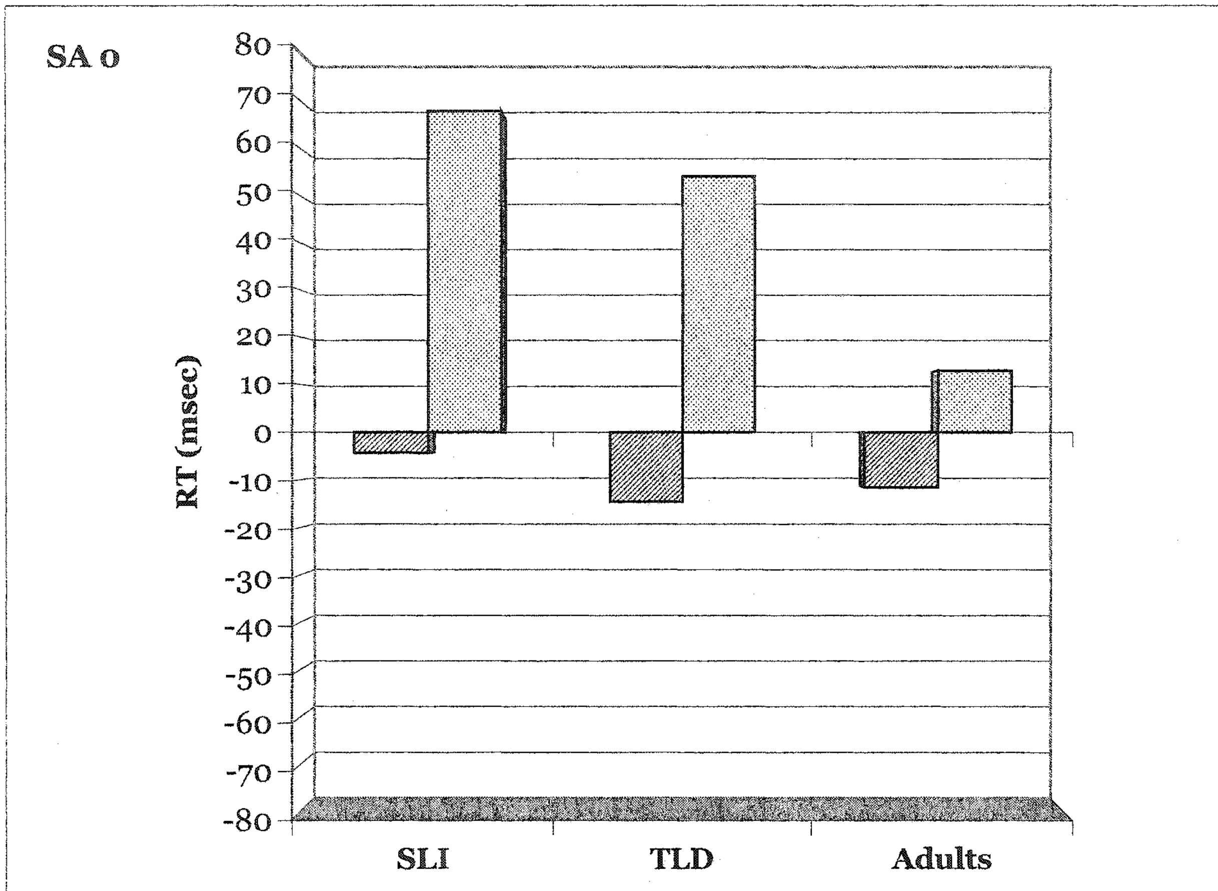


Figure 7. Mean reaction times, in milliseconds, under the phonological (P), semantic (S), and unrelated (U) IS types for each group under SA+500.



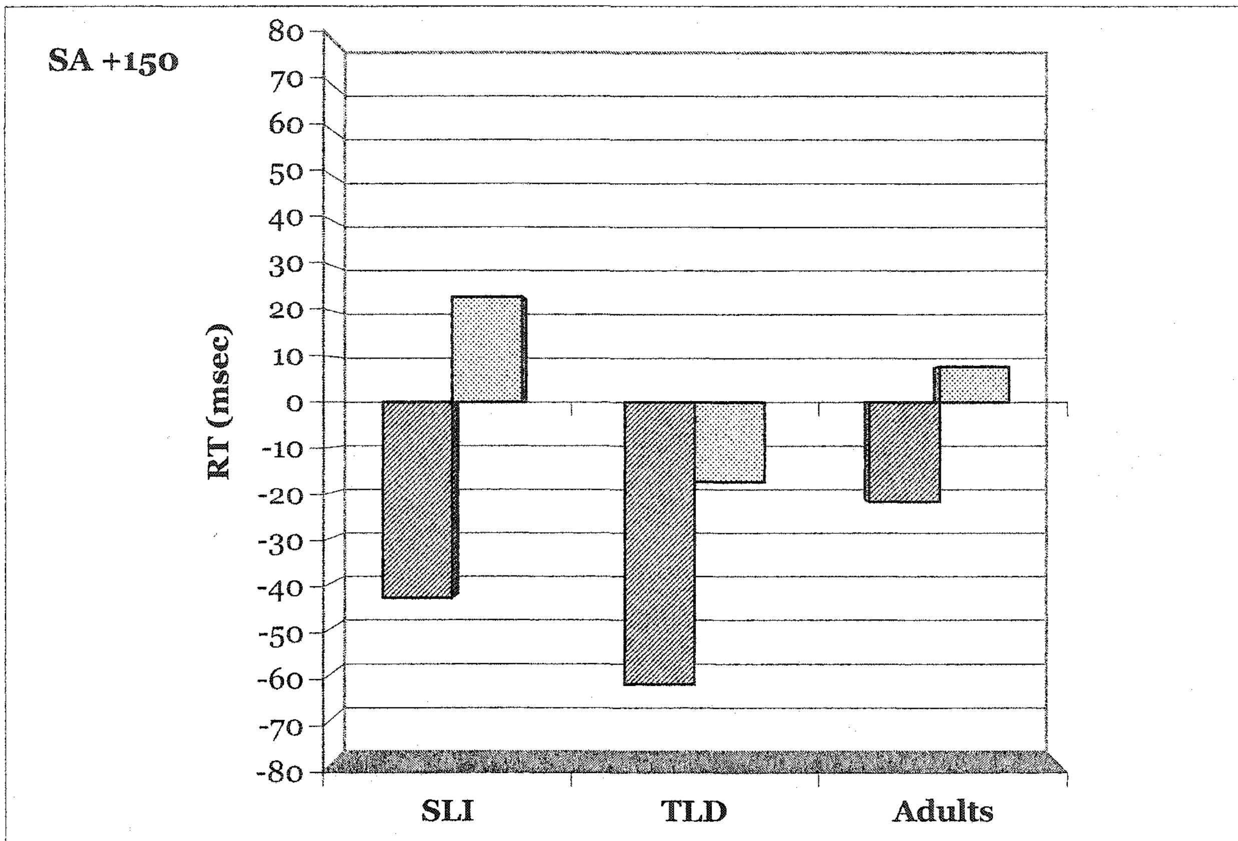
	SLI	TLD	Adults
P	48	61	18
S	45	70	14

Figure 8. Mean reaction time differences, in milliseconds, between the phonological (P) and semantic (S) IS types and the unrelated IS type, for each group under SA-150.



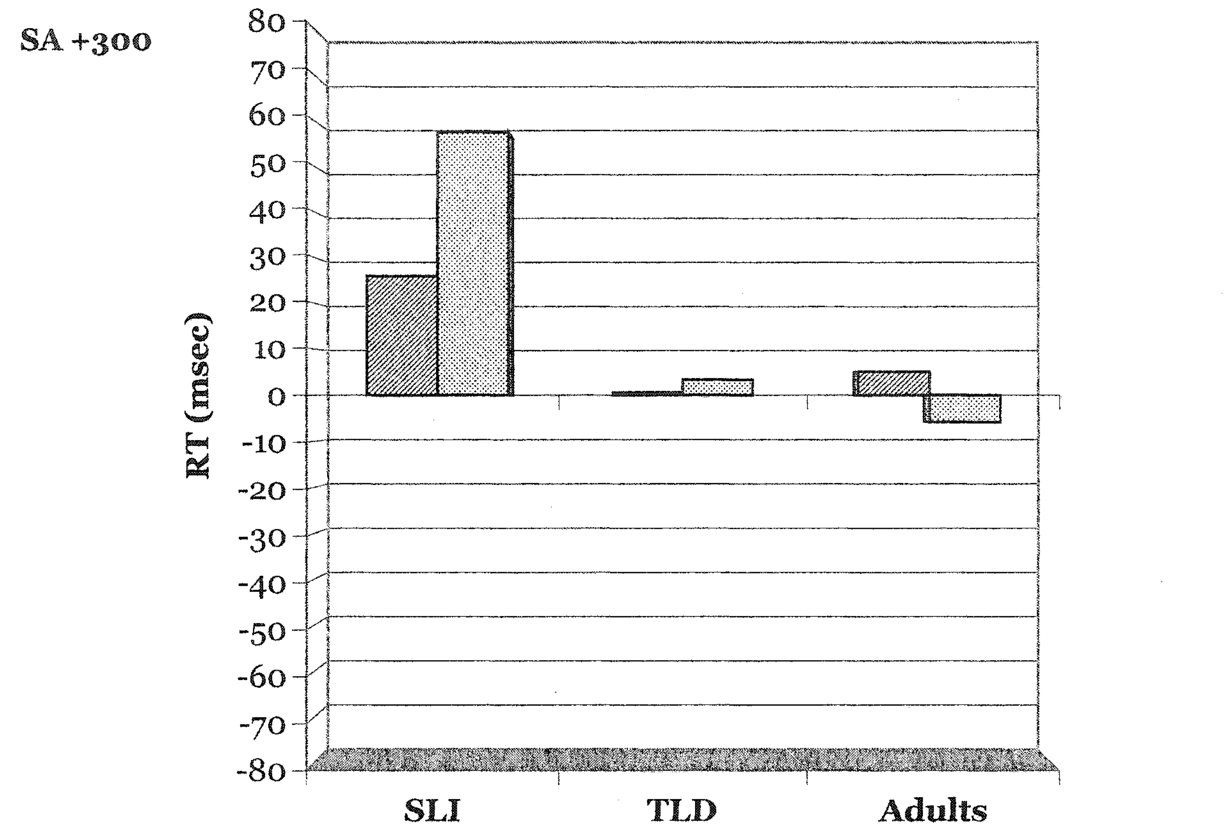
	SLI	TLD	Adults
P	-4	-15	-12
S	67	54	13

Figure 9. Mean reaction time differences, in milliseconds, between the phonological (P) and semantic (S) IS types and the unrelated IS type, for each group under and SA0.



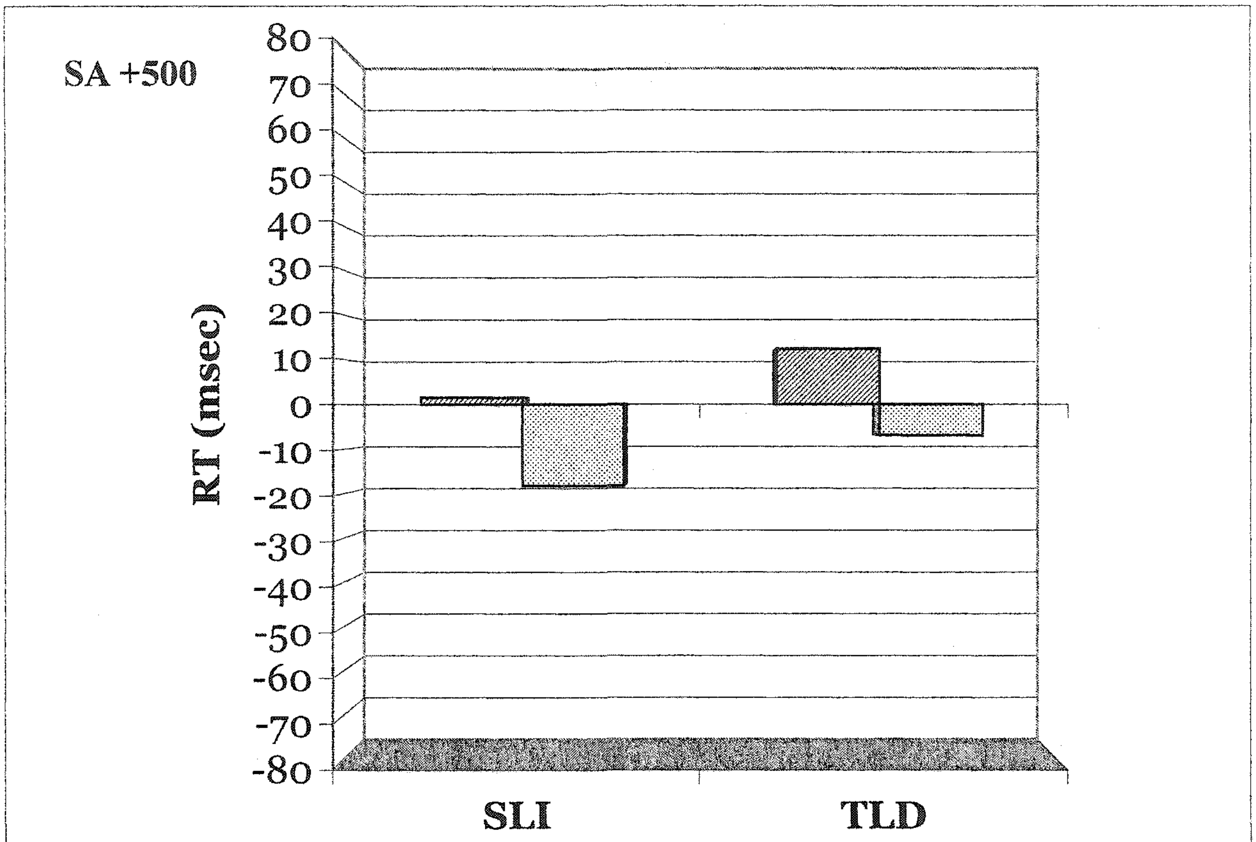
	SLI	TLD	Adults
P	-43	-62	-22
S	23	-18	8

Figure 10. Mean reaction time differences, in milliseconds, between the phonological (P) and semantic (S) IS types and the unrelated IS type, for each group under SA+150.



	SLI	TLD	Adults
P	26	1	5
S	57	3	-6

Figure 11. Mean reaction time differences, in milliseconds, between the phonological (P) and semantic (S) IS types and the unrelated IS type, for each group under SA+300.



	SLI	TLD
P	1	12
S	-18	-7

Figure 12. Mean reaction time differences, in milliseconds, between the phonological (P) and semantic (S) IS types and the unrelated IS type, for each group under SA+500.

A priori paired-sample t-tests

Subject Analysis

In the analysis of the children's and the adults' data we used one-tailed, a priori paired-sample t-tests based on our earlier predictions of early semantic inhibition and phonological inhibition effects followed by later phonological facilitation effects. The following sections present the hypotheses for each Stimulus Asynchrony (SA) condition for each group along with the statistical findings.

SA –150. Based on previous studies, we predicted that all three groups of participants would reveal early inhibition effects in the presence of semantic and phonological Interfering Stimuli (IS). As predicted, all participants, children with SLI, children with TLD, and adults, named pictures more slowly (i.e., exhibited an inhibition effect) in the presence of phonological IS ($t(1,13) = 2.37$, $p < 0.05$); $t(1,19) = 5.52$, $p < 0.001$; $t(1,19) = 3.03$, $p < 0.01$, respectively) and semantic IS ($t(1,13) = 1.82$, $p < 0.05$; $t(1,19) = 4.93$, $p < 0.001$; $t(1,19) = 3.03$, $p < 0.01$, respectively) compared to the unrelated IS. The SLI group was approximately 50ms slower in naming in the presence of semantic IS compared to unrelated IS.

SA 0. Based on previous studies of adults, we predicted that the adult group would show a facilitation effect in the presence of phonological IS and no effect in the presence of semantic IS. A one-tailed, a priori paired-sample t-tests revealed faster response times for adults (i.e., a facilitation effect) in the presence of phonological IS ($t(1,19) = -2.481$, $p < 0.01$) compared to unrelated IS. Different patterns were revealed for the two groups of children. Because children in general are slower in naming pictures compared to adults and due to the difficulty children with SLI exhibit in accessing words in their lexicon compared to children with TLD, we predicted that children with and without SLI would take longer to activate and retrieve the lemmas compared to adults and, thus, will show semantic inhibition effects at more than one SA. As predicted, children with SLI and TLD showed slower naming responses for semantic IS (t(1,13) = 1.95, $p < 0.05$; t(1,19) = 2.60, $p < 0.01$, respectively), hence, a longer period of semantic activation. The SLI group was 68ms slower naming in the presence of semantic IS compared to unrelated IS. However, neither of the groups showed facilitation or inhibition effects in the presence of phonological IS.

SA +150. Similar to the results of previous studies of adults, we predicted that all three groups of participants would show facilitation effect in the presence of phonological IS. As predicted, all three groups of participants, SLI, TLD, and adults, named pictures faster in the presence of phonological IS (t(1,13) = -2.94, $p < 0.01$; t(1,19) = -2.38, $p < 0.01$; t(1,19) = -4.17, $p < 0.001$, respectively). No semantic inhibition effects were present in any of the groups.

SA +300. Based on previous studies, we predicted no effects at the late SA for the adult group. As predicted, one-tailed, a priori paired-sample t-tests revealed no facilitation or inhibition effects in the presence of phonological or semantic IS. At this point, the process of lexical access was completed. Because we did not have a directional prediction for the response pattern in the two groups of children, two-tailed, a priori paired-sample t-tests were used in the analysis of the children's data. The children with TLD followed the same pattern observed in the adults, revealing a completion of the process of lexical access at the late SA of +300. However, in the children with SLI, the process of lexical access seemed to extend over a longer period of time, revealing a late semantic inhibition effect. Children with SLI named pictures slower in the presence of semantic IS at SA +300 (t(1,13) = 2.18, $p < 0.05$).

SA +500. Because children, in general, are slower in naming pictures compared to adults and children with SLI, specifically, exhibit difficulties in accessing words in their lexicon we predicted slower pattern of lexical access in children compared to adults. For that reason, we included a late SA of +500 to see the completion of the lexical access cycle. We predicted that no effects would be observed. As predicted, no phonological or semantic effects were found for either of the groups.

Item Analysis

SA –150. Results of item analyses were similar to the group analysis for phonological inhibition effects in the SLI and TLD groups ($t(1,19) = 1.96$, $p < 0.05$); $t(1,19) = 6.85$, $p < 0.001$, respectively) and semantic inhibition effects ($t(1,19) = 2.23$, $p < 0.05$); $t(1,19) = 3.73$, $p < 0.001$, respectively). Item analysis in the adult group revealed only phonological inhibition effects ($t2(1,19) = 2.55$, $p < 0.01$).

SA 0. Item analysis was similar to the group analysis for the SLI and TLD groups ($t(1,19) = 1.90$, $p < 0.05$; $t(1,19) = 2.30$, $p < 0.05$, respectively), revealing semantic inhibition effects. The item analysis failed to show the phonological facilitation effect seen in the adult group in the group analysis.

SA +150. Phonological facilitation effects in all three groups, SLI, TLD, and adults, were also significant in the item analysis ($t2(1,19) = -1.49$, $p < 0.1$; $t2(1,19) = -2.68$, $p < 0.01$; $t2(1,19) = -1.68$, $p < 0.05$, respectively).

SA +300. Item analysis also revealed late semantic inhibition effects in the SLI group ($t(1,19) = 1.36$, $p < 0.1$).

Silent Conditions

Adult participants were faster in naming under the Silent conditions, where there is no interfering stimulus, compared to the SLI group ($t_1(1,13) = 8.05, p < 0.001$; $t_2(1,19) = 9.41, p < 0.001$) and the TLD group ($t_1(1,19) = 6.66, p < 0.001$; $t_2(1,19) = 9.69, p < 0.001$). There was no significant difference in mean reaction time to naming under the silence conditions between the SLI and the TLD groups ($t(1,13) = -0.011, P > 0.05$). Item analysis revealed slower response times in the SLI group compared to the TLD group under the Silent 2 condition only ($t(1,19) = 4.30, p < 0.001$) (See Table 4).

A comparison of mean reaction times within groups revealed no significant difference between the Silent 1 and Silent 2 conditions for the TLD and adult groups. Thus, there was no repetitions effect for each of the stimuli. The SLI group showed an increase of 43 ms in the mean reaction times from Silent 1 to Silent 2 ($t(1,13) = -2.21, p < 0.05$).

		Silent1	**Silent 2**
SLI	**RT**	702.50	745.10
	SD	63.78	100.73
TLD	**RT**	694.57	692.70
	SD	77.50	79.29
Adult	**RT**	564.17	547.94
	SD	47.42	42.69

Table 4. Mean RTs and SDs (in milliseconds) for each group under the Silence condition.

Error Analysis

The proportions of errors were calculated as the number of errors produced by each group of participants, under each SA condition and IS type divided by the number of trials (see Table 5). The error proportions were analyzed in a mixed analysis of variance (ANOVA). No significant differences were found in the proportions of errors produced under the different SA conditions and IS types. However, there was a main effect for group ($F(2,51) = 13.64, p < 0.001, \eta = 0.35$). A post hoc Fisher LSD tests showed that the adults made significantly less errors compared to the SLI ($p = 0.001$) and the TLD groups ($p = 0.001$). No significant differences were found between the SLI and the TLD groups.

	SA-150			**SA 0**			**SA +150**			**SA +300**		
	P	**S**	**U**	**P**	**S**	**U**	**P**	**S**	**U**	**P**	**S**	**U**
SLI	0.09	0.04	0.09	0.10	0.06	0.10	0.10	0.11	0.08	0.07	0.16	0.08
TLD	0.08	0.05	0.04	0.06	0.07	0.05	0.07	0.10	0.06	0.08	0.08	0.07
Adults	0.03	0.03	0.02	0.03	0.03	0.03	0.01	0.05	0.01	0.02	0.01	0.03
Mean	0.07	0.04	0.05	0.06	0.05	0.06	0.06	0.08	0.05	0.05	0.08	0.06

Table 5. Error proportions for each group (SLI, TLD, & Adults) under each of the SA conditions and IS types (P=phonological, S=semantic, U=unrelated).

CHAPTER 4: DISCUSSION

The purpose of the current study was to investigate the language processes involved in lexical access during language production in children with and without SLI. One of the hallmarks of children with language impairment is a word-finding difficulty. The cross-modal picture-word interference paradigm was used to examine the temporal and parametrical properties of the lexical system of these children. Reaction times for naming were collected in order to trace the time course of semantic and phonological activation during lexical access. Reaction times for pictures paired with semantic and phonological IS were compared with reaction times for pictures paired with unrelated IS.

The first objective of the study was to determine whether children with and without SLI and adults have similar architectures of lexical systems and whether lexical access in children with and without SLI proceeds in a two-stage fashion as in adults, with the initial stage of lemma selection followed by a later stage of phonological encoding. Early semantic inhibition followed by a later phonological facilitation has been taken as evidence for a two-stage model of lexical access in adults (Levelt, 1992; Dell & O'Seaghdha, 1992). Previous research in children (Jaeger, 1992; Stemberger, 1989; Warren, 1986; Wijnen, 1992) postulated a parametric change rather than a structural change in the developing lexical systems of children. A parametric change refers to a quantitative change that involves the size of the storage buffers and the temporal aspects of lexical access (Levelt, 1989). Based on that and on the continuity assumption postulating similar underlying cognitive mechanisms for language processing in children and adults, I predicted that children with and without SLI would access words in their lexicon in the same manner as adults. Examination of the general pattern of lexical access revealed similar patterns of early semantic and phonological inhibition effects followed by later phonological facilitation effects, supporting a similar architecture of lexical processing. A closer investigation of the reaction time patterns revealed parametric differences between the children and the adults as well as between the SLI and the TLD groups.

Overall Naming Latencies

Previous research suggested that children process information more slowly than adults (Kail, 1991,1992; Kail & Hall, 1994). Results of the present study supported this notion revealing slower response times for naming in children with and without SLI compared to the adult participants. Naming times for both groups of children were slower than the adults under the silent condition and the experimental conditions. The slow processing characteristic of children can also be seen in the temporal patterns of the effects (i.e., semantic and phonological). Both the TLD and SLI groups took longer to retrieve the lemmas, evidenced by the longer period of semantic inhibition effects (i.e., both at SA –150 and SA 0). Both groups also lagged in activating the phonological forms of words, evidenced by the presence of phonological facilitation effects only at SA +150 compared to their presence at SA 0 as well in the adults. These patterns indicate that the process of lexical access in children is less automated and demands more resources, resulting in a slower processing time.

Earlier studies suggested a slower speed of processing in children with SLI compared to their typically developing peers on various linguistic and non-linguistic tasks (Leonard, Nippold, Kail, & Hale, 1983; Kail, 1994; Windsor & Hwang, 1999). However, results of the present study revealed no differences in naming response times between the SLI and the TLD groups under the silent condition. Similar results were evidenced in a study examining the performance of children with SLI specifically on lexical tasks (e.g., picture matching and picture naming), revealing no differences in the speed of processing between the two groups (Miller, Kail, Leonard & Tomblin, 2001). Thus, the idea that children with SLI have general cognitive slowing is not correct.

When naming latencies were examined in the present study under the experimental conditions, in the presence of interfering stimuli, children with SLI were slower in naming compared to their typically developing peers. The absence of differences in the speed of processing between the SLI and the TLD groups under the silent condition may have been due to the stimuli selected for the present study. The stimuli were highly familiar words that were well-established in young children's productive vocabulary. However, when the lexical system was put under stress by the presentation of interfering words, the children with SLI had slower response times, reflecting their fragile lexical system. The presentation of interfering words while in the process of lexical access is a laboratory-evoked interference that simulates the real life contextual interference children with SLI encounter when accessing words in their lexicon during conversations. The use of highly familiar words allowed us to distinguish between generally slow processing and slow processing due to a specific deficit in the lexical system. The fact that slower response times were apparent only under the experimental conditions suggests that the slow response times cannot be attributed to a generally slow of processing; rather, the slowness in naming response times is a by-product of the fragile, deficient lexical system of children with SLI.

Error Analysis

Previous studies suggested that children with SLI differ only quantitatively from children with TLD in the speech errors they produce. Children with SLI tended to produce more errors (German & Simon, 1991; Lahey & Edwards, 1999; McGregor, 1997). The children in the present study failed to reveal this pattern of results. The SLI and the TLD groups did not differ in the number of errors they produced. This result may be attributed to the fact that the stimuli used in the present study were of highly familiar words that are part of these children productive vocabulary. Their word-finding difficulties were reflected in the longer response time for naming rather than in the number of errors. A significant difference, however, was found between the adults and the children in the present study. The adult group produced fewer errors than the TLD and SLI groups (Stemberger, 1989; Wijnen, 1992).

Parallel versus Serial Processing

The second objective was to determine whether the time course of lexical access in children with and without SLI followed the predictions of the discrete two-stage model of two serially ordered, non-overlapping stages, or of the interactive models, indicating parallel processing of semantic and phonological information early in the process. The cascade of activation from the semantic level to the phonological level prior to lemma selection was examined. All three groups of participants (i.e., SLI, TLD, & Adult) revealed parallel processing in the early SA of -150. At SA-150, the IS are presented 150 ms prior to the presentation of the pictures to be named. The presentation of both phonologically and semantically related IS inhibited naming in comparison to the presentation of unrelated IS. The evidence of early phonological activation in all three groups of participants contradicts the predictions of the Discrete Two-Stage Model. It suggests that during lexical access, the phonological forms of multiple lexical items (i.e., semantic alternatives) are activated in the early stage of lemma access. This supports the interactive models of lexical access. Recent studies in adults indicated early activation of the phonological properties of words prior to lemma selection (Cutting & Ferreira, 1999; Griffin & Bock, 1998; Jescheniak, & Schriefers, 1997, 1998; Peterson & Savoy, 1998). Distractors phonologically related (e.g., *soda* and *count*) to target pictures and their synonyms (e.g., *sofa* and *couch*, respectively), revealed phonological facilitation effects for both distractors (e.g., *soda* and *count*) early on in the process of lexical access (Jescheniak, & Schriefers, 1997, 1998; Peterson & Savoy, 1998). Thus, the phonological forms of both target items (e.g., *sofa* and *couch*) were activated early on in the process of lemma selection, while the semantic properties of the lexical items were being specified.

Forward versus Backward Activation

The critical feature that distinguishes the interactive models reviewed in this study, the *Cascaded Processing Model* by Peterson and Savoy (1998) and the *Spreading Activation Model* by Dell (1988), is the direction of activation flow during lexical access. The cascaded processing model involves only forward activation. The spreading activation model, however, postulates that activation can also flow backward from the phonological level to the semantic level; form-related features can affect lemma selection. Malapropisms, mixed errors, and the lexical bias effect have been taken as evidence to support the presence of backward activation in lexical access. However, previous research in adults failed to reveal backward activation, which would have been indicated by late semantic inhibition. The adult and TLD groups in the present study mirrored the results of previous studies. However, the SLI group had slower response latencies in the presence of semantic IS in the late SA condition of +300, revealing a late semantic inhibition effect. This could have been seen as support for the spreading activation model. However, because this is the first evidence of a late semantic effect and it occurred only in the SLI group, explanations other than backward activation may be more viable. Two possible mechanisms that may contribute to a late semantic inhibition effect are a slow decay rate of activation of semantic alternatives, and an inadequate or inefficient suppression mechanism of semantic alternatives.

Decay rate and connection weight are two components found to play a role in models of lexical access (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Foygel & Dell, 2000). Connection weight controls how much activation spreads between the levels of representations (i.e., semantic and phonological). Strong connections between the lexical nodes and their phonological counterparts will ensure successful flow of activation and retrieval. Decay rate controls how rapidly activation decreases over time in each lexical unit. It reflects the integrity of a given representation in the lexical network. A fast decay rate will ensure that the activation of lexical items, once retrieved, quickly returns to its resting level, allowing the activation and retrieval of other lexical items to proceed with no interference.

Slower decay rate was postulated to occur in the lexical system of adults with aphasia (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Foygel & Dell, 2000) and the infantile or developing lexical system of typically developing children (Stemberger, 1989). Young children produce more perseverations than adults, suggesting that lexical items stay activated for a longer period of time and interfere with later processing. A slower decay rate in adults with aphasia was associated with high occurrence of phonological, semantic and mixed errors. Although strong activation weight ensures good transmission between the levels, a slow decay rate leaves the lexical system susceptible to interference from previously activated lexical units. One way to explain the late semantic inhibition effect observed in the present study in the SLI group is a slow decay rate of lexical units in the lexical systems of these children. Slower decay of previously activated lexical items inhibited the retrieval of the target lexical item given the extra jolt of activation they received from the semantic interfering stimuli. The only possible drawback to this explanation is the absence of a significant semantic inhibition effect at SA +150. If decay rates were slower in the lexical systems of children with SLI, leaving the system susceptible to interference, semantic inhibition effects would be expected at all SAs until the process is completed. Semantic inhibition effects were present at SAs -150, 0, and +300 but not at SA +150. However, a close examination of the lexical pattern in SLI revealed a small inhibition effect (i.e., 23msec) at SA +150, which did not reach significance possibly due to the small number of participants (i.e., n=14). In addition, examination of individual patterns revealed that 50% of the children in the SLI group showed an inhibition effect at SA +150 (ranging from 30ms to 185ms). Thus, it is highly plausible that semantically related items stay activated for a longer period of time in the lexical systems of children with SLI because they have slower decay rates.

Another possible explanation for the late semantic inhibition effect is an inefficient suppression mechanism. Once lexical items are activated, their level of activation is modulated by two mechanisms, suppression and enhancement. Suppression decreases the amount of activation of lexical items that are irrelevant or are less likely to be selected, whereas enhancement increases the activation level of the target lexical item for selection (Gernsbacher & Faust, 1991). Although these mechanisms play a vital role in language processing, they are considered to be general cognitive mechanisms that are also involved in the processing of nonlinguistic information. If children with language impairment are less efficient in suppressing semantic alternatives, access and retrieval of the target lexical items will be jeopardized. An inefficient suppression mechanism leaves the semantic alternatives activated for a longer period of time resulting in the late semantic inhibition effect. Previous studies on working memory in children with SLI (Marton & Schwartz, 2003) and on language comprehension in children with learning disabilities (Gernsbacher & Faust, 1991, Gernsbacher, 1993) have revealed inefficient suppression mechanisms in these children. The performance of children with SLI on a list recall task, a working memory task requiring participants to listen to a set of sentences and recall the last sentence's final words, suggested difficulties in simultaneous processing. These children had difficulties listening to a new sentence while rehearsing the final words of a previously presented sentence. The presence of interference errors (e.g., repeated words from previously presented sets) in the children with SLI also suggested difficulties in suppressing irrelevant information (Marton & Schwartz, 2003). Similarly, less skilled readers were less efficient in suppressing the inappropriate meanings of ambiguous words (e.g., words such as *bug*, or *bat*) and suppressing information across modalities (e.g., suppressing words while viewing pictures and vice versa) (Gernsbacher & Faust, 1991).

Attributing the late semantic inhibition effect to a slower decay rate does not preclude an inefficient suppression mechanism. The first is localized specifically to the lexical system, whereas the latter is a general mechanism involved in cognitive processing of linguistic and non-linguistic information. Both may be found impaired in children with language impairment. Further research is needed to tease apart the influence of these two mechanisms. If children with SLI have an inefficient suppression mechanism, a general cognitive mechanism underlying linguistic and non-linguistic information processing, their ability to suppress irrelevant information in non-linguistic tasks should be equally poor. However, if their deficits are localized to the lexical system, reflecting a slower decay rate, their performance on nonlinguistic tasks should not differ from that of typically developing children.

The locus of breakdown in the lexical system of children with SLI

The overall goal of the present study was finding the locus of breakdown in the lexical system of children with SLI that gives rise to word finding difficulties. The presence of a late semantic inhibition effect and a longer period of semantic activation (e.g., from SA–150ms to SA+300ms) suggest that the breakdown in their lexical system is in the semantic level. Several findings in previous research on SLI suggested the presence of a semantic deficit (McGregor & Windsor, 1996; McGregor, 1997; McGregor & Waxman, 1998; Lahey & Edwards, 1999). Children with SLI show a delay in first word acquisition and are slow in developing their vocabulary (Leonard, 1998); they tend to produce mostly semantic errors that reflect their poorly differentiated and disorganized semantic lexicon (Lahey & Edwards, 1999; McGregor, 1997); and they exhibit low scores on lexical comprehension tests (e.g., The Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1981), suggesting impoverished semantic representations of lexical items (Lahey & Edwards, 1999; McGregor, 1997).

Dell et al. (2000) associated real-word speech errors in adults with aphasia (e.g., semantic, phonological, and mixed) with a semantic deficit (corresponding to a slow decay rate) and non-word speech errors with a phonological deficit (corresponding to decreased weights on the connections between the lexical and phonological units). Even if a slow decay rate in the impaired lexical system results in the selection of the wrong lexical node, activation transmission from the lexical level to the phonological level is intact, allowing the wrong lexical item to undergo normal phonological encoding. This results in the production of real-word errors. On the contrary, if weight strength is reduced between the representation levels, the selection of the lexical nodes as well as their phonological counterparts will be random, resulting in non-word errors. Children with SLI are qualitatively very similar to their typically developing peers in the speech errors they produce (German & Simon, 1991; McGregor, 1997), most of which are semantically related to the target item. They only rarely produce non-word errors. The assumptions of the computational model (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Foygel & Dell, 2000) regarding the consequences of an impaired lexical system provide further support for the presence of a semantic deficit in children with language impairment.

The fact that the children with SLI were able to utilize the phonological primes to speed lexical retrieval at SA +150, similar to the TLD and adult groups, suggested that they had no problem accessing and retrieving the phonological forms of words during lexical access, and that the word-finding deficits apparent in these children are due to a semantic deficit. This result does not contradict the fact that some children with SLI present with phonological working memory deficits (Gathercole & Baddeley, 1990;

Montgomery, 1995). It suggests that whether or not children with SLI have phonological deficits, these deficits do not seem to underlie the word-finding deficits they exhibit.

Summary

The present study took another step forward in the investigation of the lexical limitations exhibited by children with SLI. The limited research investigating the lexical abilities of children with SLI focused on finding the loci of breakdown in their lexical system. By employing various offline techniques in their investigation, varying the elicitation context, stimuli, primes, and dependent variables (response latencies, response pattern, tip of the tongue information), previous studies were able to learn only about the end-products of lexical processing, rather than about the lexicalization process as it occurs. This is the first study that employed an online task to investigate the time course of lexical access in children with SLI. The temporal picture of lexical access in children with SLI, tracking moment-by-moment the processes involved in lexicalization, serves as a better measurement to deduce the locus of breakdown in their lexical system. The present study supports the presence of a specific deficit in the lexical system of children with SLI that is not attributed to a general slowness of processing. It suggests a deficit in the semantic level of processing as the locus of breakdown in the lexical system that gives rise to their word-finding deficits.

One of the contributions of the present study is localizing these children's deficit to a specific level of processing. Increased decay rate or inefficient suppression mechanisms were offered as possible explanations for the longer period of semantic activation apparent in these children. The temporal information provided in this study does not provide specific information regarding the semantic representations of the lexical items. Previous research in SLI suggested that these children's semantic representations are not well-established, or elaborated in their lexicon (Lahey & Edwards, 1999; McGregor, 1997). The present study used highly familiar words in the investigation of lexical access; Future research should explore the use of different stimuli, varying in semantic dimensions (e.g., high versus low frequency words, associates versus coordinates, etc.), which would provide more detailed information regarding the semantic representations of lexical items.

The present study has significant implications for intervention. The premise behind previous research in word-finding deficit in SLI was locating the locus of breakdown in their lexical system that gives rise to the word-finding difficulties. Remedial programs could then be developed to target the specific locus of breakdown. The results of the present study support a deficit localized in the semantic level of processing. Focusing intervention on the semantic properties of lexical items and practicing their production, which was proven to be effective by increasing their activation strength (Dell, Burger, & Svec, 1997), can be the first step in helping these children in their everyday struggle to find words to communicate. Further research applying online tasks, manipulating stimuli, and broadening the scope of the context, moving to the sentence or conversational levels, would provide more information for the construction of focused remedial programs.

Overall, the present study supports the notion of similar underlying mechanisms for lexical access in children and adults. All groups revealed similar temporal pictures of lexicalization. Finally, by utilizing the same methodology used in adult studies, data collected in the present study can be used as additional evidence to validate the cascaded processing model of lexical access.

APPENDICES

Appendix A: Adult Language Background Questionnaire

Name of Experiment: ____

Date: ____________________

Name: ___________________ Date of Birth: ______________ Gender: ________

Address: ____

Telephone Numbers: (Home) ________________ (Work) _____________________

Birthplace: _________________________ _____________________________

Town/City State/Country

Father's Birthplace: ____

Languages your father speaks fluently: _______________________________

Mother's Birthplace: ____

Languages your mother speaks fluently: ______________________________

Places in which you have lived for more than 1 year:

City/State/Country Years

_____________________________ from ______________ to ______________

_____________________________ from ______________ to ______________

_____________________________ from ______________ to ______________

_____________________________ from ______________ to ______________

If you have lived in more places please check here _____ and continue on the back.

As a child, what languages were spoken in your home? (for example, by parents, guardians, grandparents, or relatives) _____________________________________

Name ________________ Date ______________

What languages other than English do you speak fluently? (if none check here ________)

1. ____________________ 2. ____________________ 3. ____________________

Was English the first language you learned? (circle the right answer) YES / NO

If NO, which language (s) was/were? 1. __________________ 2. __________________

Have you ever studied Phonetics (the scientific study of speech sounds) at high school, or college level in either a linguistics, speech science, or foreign language class? YES / NO

If YES, have you ever done phonetic transcription? YES / NO

If YES, how much? ________________________________

Do you have normal hearing? YES / NO

- -

What do you consider your racial/ethnic background to be? Check all that apply

(voluntary: you need not answer)

Caucasian ____________ Native American ____________

African American ____________ Pacific Islander ____________

Hispanic ____________ Asian American ____________

Other- please specify ____

Appendix B: Adult Consent Form

Consent Form
Lexical Access in School-Aged Children with and without Specific Language Impairment

My name is Liat Seiger and I am a doctoral student in the Speech and Hearing Program at the Graduate Center, the City University of New York (CUNY), and the Principal Investigator of this project.

The purpose of this project is to study how children and adults access words in their vocabulary, while naming pictures. The experiment will involve one session lasting about an hour. The sessions will be conducted at the City University of New York, Graduate Center. Your participation will contribute greatly to the understanding of typical and atypical language processing. A copy of the completed study will be available to you upon request. Should you request them, I will need your home address.

During each session you will be presented with some pictures and will listen to some words through headphones. You will be asked to name the pictures as quickly as possible, while ignoring the words.

There are no known or expected risks or hazards in this research. Information collected during this project may be presented at a conference or published in a peer-reviewed journal. Your name and all other identifying information will be confidential.

You are free to withdraw at any time, without penalty. At the end of each session, you will be paid $10 per hour for your participation.

If you have any questions you may contact me at (212) 817-8812, lseiger@gc.cuny.edu, or my advisor, Dr. Richard G. Schwartz, at (212) 817-8804, rschwartz@gc.cuny.edu. If you have any questions about your child's rights as a participants in this study, you may contact Hilry Fisher, Sponsored Research, CUNY-Graduate Center at (212) 817-7523, hfisher@gc.cuny.edu.

The study described has been explained and I voluntarily consent to participate in the study. I have been informed of the details of the experiment. I understand that I can stop at any time without penalty. I have had the chance to ask questions and they have been answered.

I agree / don't agree (circle the correct one) to be contacted in the future to participate in other similar studies.

____________________ ____________________

Participant's Signature   Date

____

Investigator's Signature

Copies to: Participant
Investigator's File

Appendix C: Parent Questionnaire

PARENT/GUARDIAN QUESTIONNAIRE

Child's Name:____
Age:________________**Date of Birth:** ________________**Today's Date:**____________
Your Name: __________________________________
Your Relationship to the Child: __________________
Names of Parents/ Guardians: ____
Child's Address: ____

____
Home Phone Number: _________________ **Work:**_________________________
School:________________________________**Town:**___________________________
Grade: ________________ **Teacher's Name:** ________________________________
Mother's highest education level:__________________________
Mother's profession:____________________________________
Father's highest education level:___________________________
Father's profession:_____________________________________
Who lives at home with the child?

Name	Age	Relationship
__________________________	_______	________________________
__________________________	_______	________________________
__________________________	_______	________________________
__________________________	_______	________________________

What language(s) are spoken at home? (check all that apply)
English______ Spanish_______ Italian_______ Other (please specify) ____
What is the child's primary language? ___________________________
Who are the people the child frequently interacts with?

____
What is the approximate time spent in social interaction on a typical day?

____
What are the activities associated with the child's social interactions?

____
Does the child exhibit any antisocial or socially inappropriate behaviors (avoiding interactions, consistently playing alone, etc…)? No_____ Yes (explain)

____
Does the child exhibit any self-stimulating behaviors (rocking or arm flapping, etc…)? No_____ Yes (explain) ____

____
Does the child exhibit any repetitive behaviors for no apparent reason? No_____ Yes (explain) ____

____

____
Does the child maintain eye contact? No (explain) ________________________________

____
Yes_____

Does the child demonstrate outbursts of unprovoked laughter, crying, or aggression?
No_____ Yes (explain) ____
____
____

Does the child have quick and drastic mood changes? No_____ Yes (explain) ________
____

Does the child often seem nervous, tense, frightened or anxious? No_____ Yes (explain)
____

Does the child evidence any motor ability difficulties (writing, feeding themselves, etc…)? No_____ Yes (explain)_______________________________________
____
____

Is the child's speech difficult to understand? No_____ Yes (explain) ______________
____
____

Do you think the child exhibits a language delay? If so, when did you first notice the language delay? No_____ Yes (explain) __________________________________
____

Is there any history of the following in the family (check all that apply) :
Speech/ language disorders_____ Hearing impairments_____ Learning disorders_____
Please explain:____
____

Has the child been evaluated by or worked with any of the following? (check all that apply and please explain)
Ear Nose and Throat (ENT) Doctor_____ Neurologist_____ Psychologist_____
Audiologist_____ Reading Specialist_____ Speech Language Pathologist_____
Other____
Explain: ____
____

Do you think the child hears well? No (explain) ______________________________
____
Yes_____

Has the child ever had a hearing test in a facility other than school? No_____ Yes (please provide results)____
____

Does the child wear glasses? No_____ Yes_____
Which hand does the child use most? Left hand_____ Right hand_____ Both equally_____
Please state the age at which the child reached each developmental milestone:
Sat up__________ Walked__________ Spoke first word__________

Medical History:
Did the child's mother have any health problems during pregnancy? No_____ Yes (explain)____
Was the child: Full term_____ Premature_____ Child's birth weight _________
Has the child ever been hospitalized? No_____ Yes (explain) ____________________

____

Does the child have any of the following? (check all that apply)
Asthma_____ Allergies_____ Frequent ear infections_____
Is the child taking any medication? No_____ Yes (explain)____________________

____

____

Has the child ever been treated for cleft palate? No______ Yes (explain) _________

____

Is there any information you would like to share with us to help us understand your child better?

____

____

____

____

____

____

Appendix D: Parent Consent Form

Parent Consent Form

Lexical Access in School-Aged Children with and without Specific Language Impairment

My name is Liat Seiger and I am a doctoral student in the Speech and Hearing Program at the Graduate Center, the City University of New York (CUNY), and the Principal Investigator of this project.

The purpose of this project is to study how children (8-10 years old) access words in their vocabulary, while naming pictures. The experiment will involve three sessions, each lasting about 1 hour. We will conduct speech/language screenings of your child using standard clinical tools. The sessions will be conducted at the City University of New York, Graduate Center, at your child's school, clinical facility or other convenient location. Your child's participation will contribute to the understanding of typical and atypical language development. A copy of the completed study, and the language assessment results will be available to you upon request. Should you request them, I will need your home address. When necessary, referrals for further language evaluations will be provided.

Your child will be asked to agree to participate. He/She will be presented with some pictures and will listen to some words through headphones. He/she will be asked to name the pictures as quickly as possible, while ignoring the words.

There are no known or expected risks or hazards in this research. Information collected during this project may be presented at a conference or published in a peer-reviewed journal. Your child's name and all other identifying information will be confidential.

You are free to withdraw your child at any time, without penalty. Your child may also choose to stop at any time. At the end of each session, your child will be paid $10 per hour for his/her participation.

If you have any questions you may contact me at (212) 817-8812, lseiger@gc.cuny.edu, or my advisor, Dr. Richard G. Schwartz, at (212) 817-8804, rschwartz@gc.cuny.edu. If you have any questions about your child's rights as a participant in this study, you may contact Hilry Fisher, Sponsored Research, CUNY-Graduate Center at (212) 817-7523, hfisher@gc.cuny.edu.

The study described has been explained and I voluntarily consent to my child's participation. I have been informed of the details of the experiment. I understand that my child can stop at any time without penalty. I have had the chance to ask questions and they have been answered.

I agree / don't agree (circle the correct one) to be contacted in the future to participate in other similar studies.

____________________ ____________________

Parent's Signature Date

____________________ ____________________

Child's name Investigator's Signature

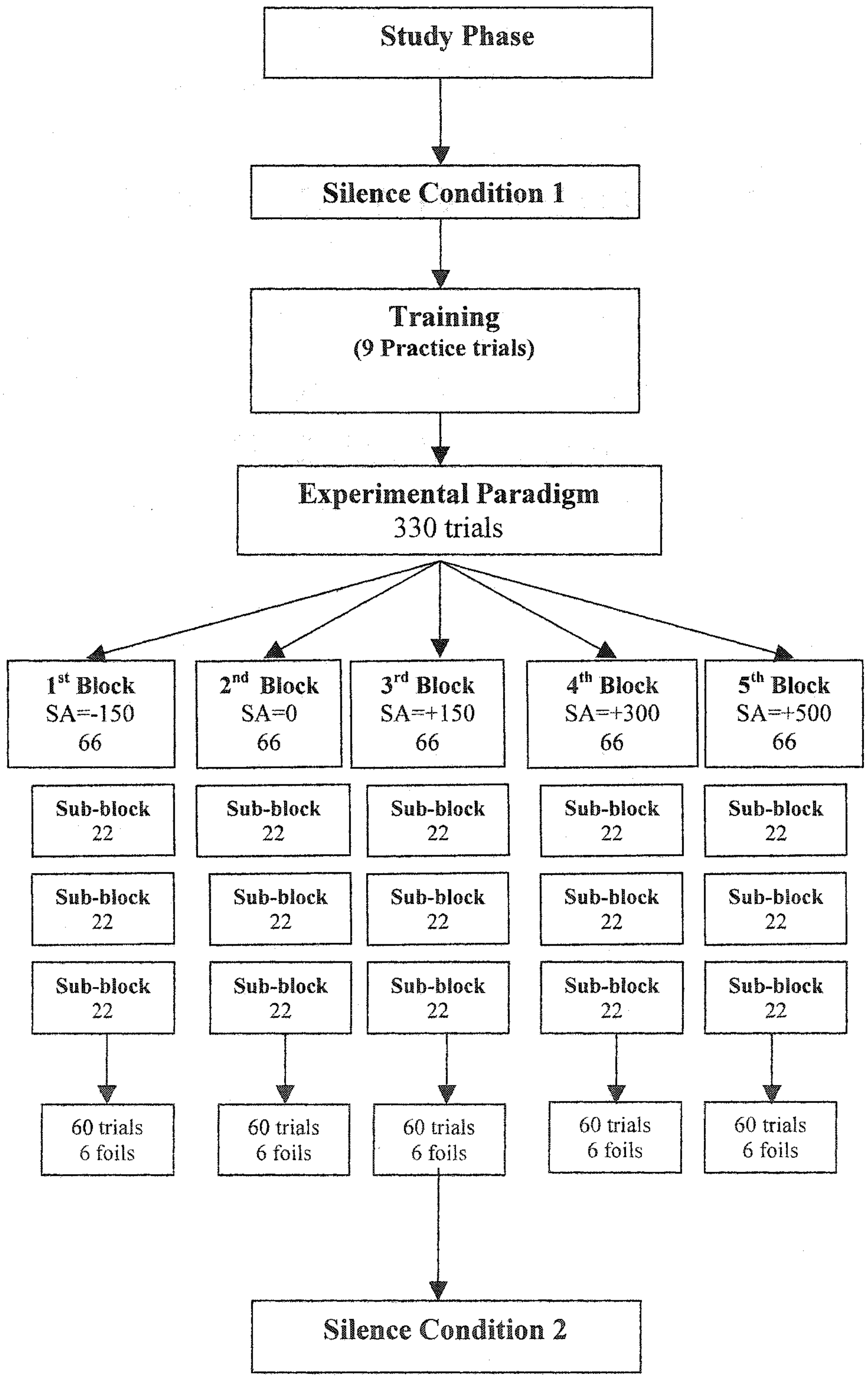
Copies to:
Parent(s)
Investigator's
File

Appendix E: Experimental Stimuli Material

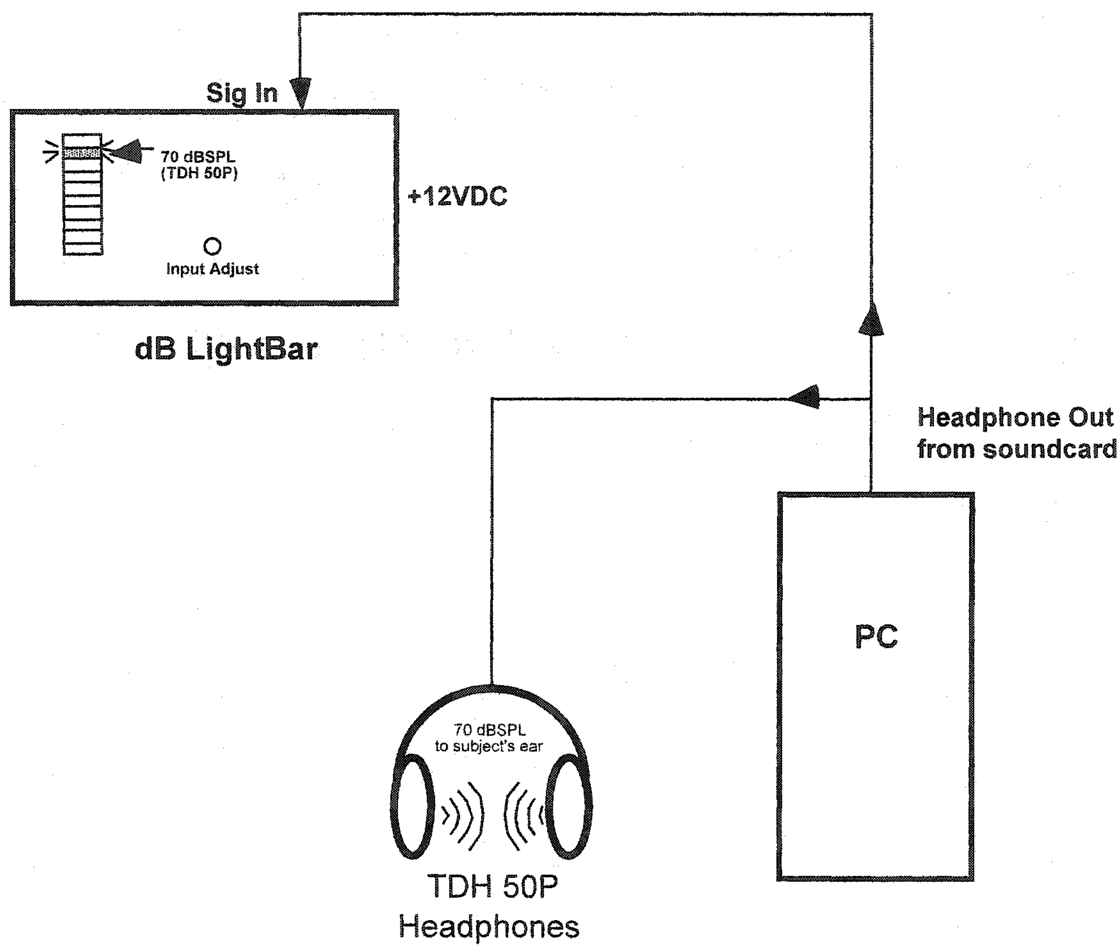
	Target	Semantic	Phonological	Unrelated
1	Belt	Tie	Boat	House
2	Bike	Plane	Bed	Plant
3	Bird	Duck	Boots	Plate
4	Bread	Cake	Brush	Comb
5	Car	Truck	Cow	Mouth
6	Cat	Sheep	Cake	Boot
7	Couch	Chair	Coat	Bear
8	Cup	Spoon	Kite	Zebra
9	Desk	Bed	Duck	Spoon
10	Fish	Shark	Foot	Hat
11	Fork	Plate	Fox	Arm
12	Hand	Arm	House	Chair
13	Horse	Zebra	Hat	Plane
14	Lion	Pig	Lips	Boat
15	Nose	Mouth	Knife	Brush
16	Pants	Boots	Pig	Fox
17	Shirt	Coat	Shark	Knife
18	Shoe	Boot	Sheep	Cow
19	Tongue*	Lips	Tie	Kite
20	Tree	Plant	Truck	Foot

* Picture not taken from Snodgrass & Vanderwart (1980).

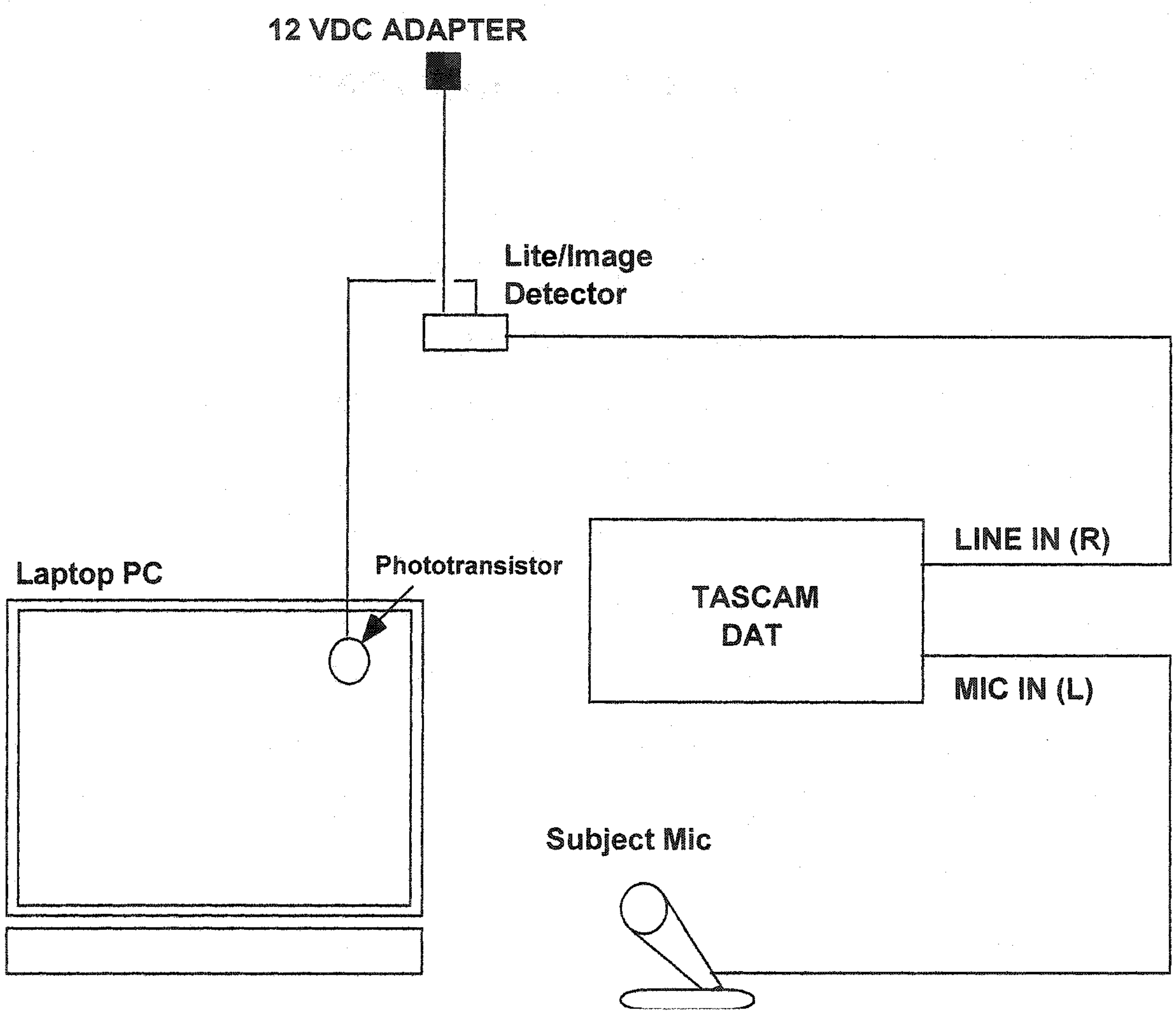
Appendix F: Experiment Design



Appendix G: Diagram of volume controller



Appendix H: Diagram of light detector



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