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Effectiveness of a Computer-Based Syntax Program in Improving the Morphosyntax of Students Who are Deaf/Hard of Hearing

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ACCEPTANCE

This dissertation, EFFECTIVENESS OF A COMPUTER-BASED SYNTAX PROGRAM IN IMPROVING THE MORPHOSYNTAX OF STUDENTS WHO ARE DEAF/HARD OF HEARING, by JOANNA E. CANNON, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

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ABSTRACT

EFFECTIVENESS OF A COMPUTER-BASED SYNTAX PROGRAM IN IMPROVING THE MORPHOSYNTAX OF STUDENTS WHO ARE DEAF/HARD OF HEARING

by

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The purpose of this study was to determine if the frequent use of LanguageLinks: Syntax Assessment and Intervention (LL), produced by Laureate Learning Systems, Inc., as a supplemental classroom activity, affected morphosyntax structures (determiners, tense, and complementizers) in participants who are Deaf/Hard of Hearing (DHH) and use American Sign Language (ASL). Twenty-six students from an urban day school for the Deaf participated in this study. Two hierarchical linear modeling (HLM) growth curve analyses were used to examine the influence of LL on the comprehension of morphosyntax based on two dependent variables: 1) the scores from LL's Optimized Intervention (OI; Wilson, 2003) reports; and 2) the scores from a subset of the Comprehension of Written Grammar (CWG; Easterbrooks, 2010) test. The results of the HLM analyses revealed that time was a statistically significant indicator of progress on both dependent variables: 1) LL, $t(25) = 4.510$, $p < .001$, and 2) CWG, $t(25) = 4.750$, $p < .001$. Two independent variables served as predictors of where the participants started on the level-1 intercept of the growth curve: 1) Degree of Hearing Loss; and 2) Age. The results indicated that Age, $t(23) = 2.182$, $p = .039$, was a statistically significant predictor of the level-1 intercept. A second set of independent variables served as predictors of change over time on the growth curve: 1) Diagnostic Evaluation of Language Variation

Norm-Referenced (DELV-NR; Seymour, Roeper, & de Villiers, 2005) pretest scores on the syntax and semantic subtest; and 2) the *Basic Reading Inventory* (BRI; Johns, 2008) scores. The results indicated that the BRI scores, $t(22) = 3.522$, $p = .002$, were statistically significant predictors of change over time on the LL program. A dependent *t*-test was used to examine the comprehension of morphosyntax based on the third dependent variable of the DELV-NR assessment, and revealed statistically significant results on the syntax subtest, $t(25) = -2.394$, $p = .024$. The daily use of LL affected the morphosyntax of the participants in this study and may be an evidence-based practice for students who are DHH and use ASL.

EFFECTIVENESS OF A COMPUTER-BASED SYNTAX PROGRAM IN IMPROVING THE MORPHOSYNTAX OF STUDENTS WHO ARE DEAF/HARD OF HEARING

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ABBREVIATIONS

ASL	American Sign Language
BRI	Basic Reading Inventory
CASL	Comprehensive Assessment of Spoken Language
CC	Core Composite
CWG	Comprehension of Written Grammar
DHH	Deaf/Hard of Hearing
DELV-NR	Diagnostic Evaluation of Language Variation –Norm Referenced
EOWPVT	Expressive One-Word Picture Vocabulary Test
HLM	Hierarchical Linear Modeling
IEP	Individualized Education Plan
LL	LanguageLinks: Syntax Assessment and Intervention
MAE	Mainstream American English
NCLB	No Child Left Behind
OI	Optimized Intervention
TGG	Transformational Generative Grammar
TOD	Teachers of the Deaf

CHAPTER 1

THE PROBLEM

Introduction and Statement of the Problem

Language delays in students who are Deaf/Hard of Hearing (DHH) are often due to their difficulty with the acquisition of morphosyntax, or the functional rules that govern linguistic units in English (Ewoldt, 1990; Quigley & Power, 1972; Quigley, Wilbur, & Montanelli, 1976). Morphosyntax is an essential building block in the language and reading development for this low-incidence population. Delays in reading comprehension are often a result of delays in language development for students who are DHH (Kelly, 1996). Reading skills are crucial for students who are DHH to become productive citizens, yet the median reading level of an 18 year old adult who is DHH has remained around a 3.9 grade equivalent for the past thirty years (Babbidge, 1965; Commission On the Education for the Deaf, 1988; Holt, Traxler, & Allen, 1997; National Agenda, 2005).

Approximately 96% of students who are DHH are born to families where both parents have normal hearing (Mitchell & Karchmer, 2004). About 49% of these students utilize some form of sign language as their primary mode of communication (Gallaudet Research Institute, 2008). Students who communicate through sign language typically experience restricted access to auditory input even with the use of assistive technology devices (Berent, Kelly, Porter, & Fonzi, 2008; Carney & Moeller, 1998; Spencer &

Meadow-Orlans, 1996). These factors may result in a restricted linguistic environment causing delays in language development (Coryell & Holcomb, 1997; Kelly, 1996; Yoshinaga-Itano, 1986; Yoshinaga-Itano, & Apuzzo, 1998).

When a parent has normal hearing and his or her child is DHH and uses sign language, the parent must first learn a second language, American Sign Language (ASL), before fully communicating with the child. This language barrier often results in children who are DHH lacking quality adult models of communication at very early ages (Coryell & Holcomb, 1997). Research results have indicated that poor models of standard language affect a child's acquisition of morphosyntax; these deficits are a problem for students who are DHH because limited syntactic ability influences reading comprehension (Kelly 1996; Power, & Quigley, 1973; Quigley & King, 1980; Quigley, Wilbur, Montanelli, Power, & Steinkamp, 1976). Therefore, intervention research is needed to address the deficits in morphosyntax and enhance language development of students who are DHH.

This low-incidence population experiences many challenges while learning to read. Acquiring a basic foundation of English is fundamental to the task of successfully reading and comprehending text in the classroom. Understanding the components of language (e.g., syntax, semantics, and pragmatics) is the basic foundation for learning how to read. When compared to hearing students, students who are DHH and use ASL may acquire language and reading differently due to the bilingual nature of the process (Brown & Brewer, 1996; McNally, Rose & Quigley, 2007).

Lack of motivation caused by repeatedly failed attempts at language tasks is another factor contributing to the academic deficits students who are DHH experience (Pipp-

Siegel, Sedey, VanLeeuwen, & Yoshinaga-Itano, 2003). Those students who struggle with learning grammatical structures of English often become apathetic about language instruction because they may lack the basic skills necessary to be successful at higher-level activities. This may cause a learned helplessness among students with special needs because teachers, parents, or peers step in and complete tasks for them with the intention of relieving the student's frustration (Marks, 1998). If students who are DHH experience frustration in language acquisition, then this might decrease their motivation to complete language tasks and increase the need for a socially valid intervention in the classroom setting (Pipp-Siegel et al.).

Theoretical Basis

One previous method for instructing students who are DHH in the acquisition of morphosyntax was based on Chomsky's Transformational Generative Grammar (TGG) theory. This theory was developed through Chomsky's observations and studies of how people acquire language and morphosyntax (Chomsky, 1957). TGG theory proposed that humans have the potential for an innate, Universal Grammar (Chomsky, 1965). Chomsky posited that the human brain is prewired to receive linguistic input and extract grammatical principles that allow us to generate an infinite number of sentences based on linguistic rules. Chomsky further proposed that there is a deep structure and a surface structure to human language. The deep structure represents the underlying meaning of information. The surface structure is how we express that information. Chomsky stated that we use grammatical parameters and linguistic rules to transform the deep structure to surface structure. For example, the deep structure "The dog chased the cat" is the underlying meaning of the surface structure "The cat was chased by the dog." Deep

structure of information can be presented through multiple surface structures (Chomsky, 1965).

Prior to the 1960's students who are DHH were taught to model a teacher's surface structure. Modeling and Self-Correction is one approach to teaching language to students who are DHH (Easterbrooks & Baker, 2002). This practice is based on the Natural Approach to learning language (Groht, 1955) and motherese (Bellugi & Klima, 1976; Meadow, 1981; Reilly & Bellugi, 1996; Snow, 1972). The Natural Approach to learning language is based on students' cognitive and developmental growth (Gleitman, 1981). Chomsky's perspective that one should learn the deep structure that supports the surface structure revolutionized Deaf education in the 1970s, resulting in the development of grammar-based curricula at most schools for the Deaf in the nation (Blackwell, Engen, Fischgrund, & Zarcadoolas, 1978; Bunch, 1979). When the promised results were not forthcoming (Commission on the Education of the Deaf, 1988) and with the advent of the Bilingual-Bicultural Approach in Deaf education (Nelson, 1998; Prinz, & Strong, 1998), many schools and programs stopped teaching grammar intensively. This resulted in the sobering fact that language skills of students who are DHH are not much better off today than they were 30 years ago (Nelson; Prinz, & Strong).

Recent advances in Chomsky's theory provide the field of Deaf education with a new way of looking at English grammar instruction. Chomsky's theory evolved through the years from TGG to the Minimalist Program as he further examined the grammatical components of English and attempted to simplify the explanatory nature of his language model (Chomsky, 1995; Chomsky, 2005; Fitch, Hauser, & Chomsky, 2005). The Minimalist Program reduces the complexity of his previous linguistic theory by removing

the numerous and complex generative rules of grammar and simplifying the explanation of how grammatical structures work in the English language. Previous phrase structure rules and transformational rules of generative grammar were eliminated because Chomsky realized they were not necessary in order to teach students how to master the English language. The concepts of deep structure and surface structure were also eliminated because Chomsky believed they could be replaced with categories of language. Chomsky proposed that language can be divided into two categories: the lexical category and the functional category. The lexical category includes nouns, verbs, adjectives, adverbs, and prepositions and develops across one's lifespan. For example, one might never learn what 'apogee' means but still be considered well-educated because the lexical category is seen as an open category that grows throughout one's lifetime. Examples of the functional category include determiners, tense, and complementizers and this category contains a finite set of word types (see Appendix A). This is considered to be a closed set because one can never add to it. For example, it is highly unlikely that the English language will ever acquire a new verb tense. Chomsky proposed that if language learners could master the components of the functional category, then they would master the syntax of language (Chomsky, 2005). Therefore instructional strategies that focus on the development of the functional category in students who are DHH may be a promising practice for the field of Deaf education.

Line of Inquiry

There are several factors that influence the language development of students who are DHH and use ASL as their primary mode of communication. Some of these factors may influence the speed of acquisition of both English and ASL. Predictors of success in

language development for students who are DHH include age of onset of the hearing loss, degree of hearing loss, age of amplification, age of intervention, parental involvement, parental hearing status, and reading level (Stinson & Kluwin, 2003).

The field of Deaf education has struggled with determining effective strategies for teaching English language skills to all students who are DHH, taking into account their predictors of success. Research regarding instructional strategies to increase language acquisition in the field of Deaf education is scarce (Easterbrooks, 1999; Schimmel & Edwards, 2003). However, there are a few best practices supported by research in Deaf education that could be used to address the problem. One widespread best practice in the 1960's and 1970's was teaching language through visual representation (Easterbrooks & Baker, 2002), a structured approach based on Chomsky's theory of TGG (Chomsky, 1957; Fitch et al., 2005). A line of research followed that led to the instructional practice of scaffolding instruction of grammatical structures (Quigley & King, 1980). Scaffolding instruction included teaching grammatical structures in a developmental order so that new knowledge could be built upon prior knowledge to create a higher level understanding of complex sentence structures (Blackwell et al., 1978).

In recent decades, political and administrative efforts have caused all educators to move away from instruction of skills that are based on individual needs to instruction of required state standards. Teachers of the Deaf (TODs) were required to follow suit, thus ignoring the individualized instruction necessary to increase language skills of students who are DHH. Unfortunately, language and literacy problems are still pervasive for most of this population (Gallaudet Research Institute, 2008). As a result of the push to cover state standards as a requirement of the No Child Left Behind Act (NCLB; 2002;

Cawthon, 2007) TODs may be prevented from addressing language needs due to time constraints, and may require a language intervention that is a supplemental classroom activity for this population. In order to scaffold language instruction, basic grammatical skills must first be mastered before students who are DHH are able to tackle curriculum that follows the state standards and consequently, to pass state mandated testing under NCLB (Cawthon). There is often a lack of time in the school day to cover both mandated curriculum and supplemental curriculum that will assist students with language delays. Therefore an independent, supplemental classroom activity that requires minimal time away from the curriculum could be beneficial to decrease language deficits for students who are DHH.

One research-based instructional strategy that can be used as a supplemental classroom activity with these students is the use of multimedia tools because they can increase motivation to complete academic tasks (Cannon, Fredrick, & Easterbrooks, 2010; Dangsaart, Naruedomkul, Cercone, & Sirinaovakul, 2008; Massaro & Light, 2004). Motivation is an important component of any language intervention program that aims to increase student achievement and be a socially valid intervention in the classroom (National Reading Panel, 2000). Increased achievement in the classroom leads to increased motivation (Pipp-Siegel et al., 2003).

Overview of the Study

These two strategies, scaffolding language instruction and the use of multimedia tools, are combined in a software program developed for students with special needs entitled, *LanguageLinks: Syntax Assessment and Intervention* (LL), produced by Laureate Learning Systems, Inc. This software program is based on Chomsky's Minimalist

Program (Wilson, 2007; Wilson, Fox, & Pascoe, 2003; 2008). To increase language acquisition, LL is designed to teach students grammatical forms such as determiners, tense, and complementizers from Chomsky's functional category in developmental order (Wilson; Wilson et al., 2003; 2008). Determiners are the head of the sentence and dictate the grammar that follows in the sentence. Determiners modify nouns and cannot exist outside of a noun phrase (Moats, 2000; Wilson et al., 2003; 2008). For example, when starting a sentence with "the", the next word can be "boy" but it can never be "he." Tense is associated with verbs and also dictates the grammar of the entire sentence (Moats; Wilson). For example, when using the phrase "jumped", the next word can be "high" or "over the fence" but it can never be "will". Complementizers introduce and characterize complement clauses, which tell the audience more information about the proposition expressed in a clause (Adger, 2003; Wilson). For example, the complementizers "if" and "whether" can be used in both, "We asked whether the dinner was ready" and "We wondered if the dinner was ready" to let the audience know that both clauses are interrogative. The LL software program attempts to combine these forms of morphosyntax (determiners, tense, and complementizers) into a self-paced, supplemental classroom activity that scaffolds instruction (Finn, Futernick, & MacEachern, 2005; Wilson; Wilson et al., 2003).

The LL software displays various components of morphosyntax embedded within printed sentences on the computer screen. The software then allows the user to choose one of the two objects viewed on the computer screen, which are alternately outlined in red for a visual cue. The correct answer matches the printed sentence on the bottom of the screen. Each of the six modules in each of the six levels of the program review different

functional categories, allowing the participant to practice the rules of morphosyntax and increase his or her skills through a scaffolded lesson (Finn et al., 2005; Wilson, 2007; Wilson et al., 2003; 2008).

Prior research using the LL software program was conducted with preschoolers who had Language Impairments. The use of the program demonstrated a significant increase in the participants' expressive language after using the software (Finn et al., 2005). The results of this research were extended when Merchant, deVilliers, and Smith (2008) conducted a study with kindergarten and first graders who were Hard of Hearing, used the auditory/oral method of communication and who had cochlear implants. The auditory/oral method uses a combination of assistive technology, auditory training, and speech therapy so that students are able to communicate through listening and speech (Ling, 1986). The participants significantly increased their expressive skills and morphosyntax after using the LL program.

The current study extends the previous research through the inclusion of participants who use ASL as their method of communication and represent a broader age range. Older participants may benefit from the intervention because their language abilities fall below their chronological age. The present study investigated whether or not the frequent use of the LL software program, as a supplemental classroom activity, affected the morphosyntax in students who are DHH.

CHAPTER 2

REVIEW OF THE LITERATURE

The current language abilities of students who are DHH reflect the lack of effective strategies and best practices available for use in Deaf education classrooms (Easterbrooks, 1999; Schimmel & Edwards, 2003) and in general education classrooms (Fuchs & Fuchs, 1995). Students who are DHH may experience language delays of up to five years below their current grade level in school (Holt et al., 1997). As previously discussed this is due to a lack of available proficient language models in the home, but can also be attributed to a lack of proficient language models in the school setting (Moats, 1994). General and special education teachers often lack training and/or skills in the English language sufficient to teach English grammar to their students (Moats). Additionally, TODs may lack the necessary ASL skills because few states enforce standards in ASL proficiency among TODs. A review of state teacher standards for certification and the National Association for the Deaf website reveal that only three states, New Jersey, Texas, and Minnesota, require a standard of ASL proficiency in their TODs (National Association for the Deaf, 2009).

The lack of effective strategies and best practices for TODs can also be attributed to the scarce research in these areas with students who utilize ASL as their primary mode of communication (Easterbrooks & Stephenson, 2006; Luckner & Handley, 2008). The bifurcation of Deaf education (auditory/oral vs. ASL) contributes to the lack of intervention research with students who use ASL. The majority of the research conducted

in the last 20 years has focused on students who use the auditory/oral method, due in part to the invention, widespread use of, and fascination with cochlear implants and advancements in hearing aid technology (Luckner & Handley). Programs that focus on spoken language development tend to address the surface structure of sentences and utilize a modeling and expansion approach (Easterbrooks & Baker, 2002). In modeling and expansion, a teacher will say a sentence in the manner expected, the child will repeat, and the teacher will expand what the child has said (Easterbrooks & Baker). This does not necessarily allow for a focus on specific elements of the functional category of English.

Although advances in the field of assistive technology devices for the Deaf have significantly increased during this time period, not all students who are DHH benefit academically from these devices (Geers, Moog, Biedenstein, Brenner, & Hayes, 2009; Wang, Trezek, Luckner, & Paul, 2008). Those students who are DHH and who use ASL as their primary mode of communication continue to experience English language deficits. Research to develop intervention strategies that increase their English language skills is needed (Wang et al.).

During the 1970s, Quigley and colleagues performed a series of studies with both hearing students and students who are DHH to determine the hierarchy of syntactic structure development, how syntactic rules are established, and the stages of acquisition pertaining to syntax (Brasel & Quigley, 1977; Power & Quigley, 1973; Quigley, Montanelli, & Wilbur, 1976; Quigley & Power, 1972; Quigley, Smith, & Wilbur, 1974; Quigley, Wilbur, & Montanelli, 1974, 1976; Wilbur, Montanelli, & Quigley, 1976; Wilbur, Quigley, & Montanelli, 1975). The findings of the 8 year study indicated that 50

participants who were DHH between the ages of 10 and 19 years old experienced significant delays in vocabulary development, comprehension of complex syntax patterns, and comprehension of the morphological rules of English when compared to 60 hearing students (Russell, Quigley, & Power, 1976). The comprehension of the hierarchy of morphosyntax influences students who are DHH's expressive language abilities and reading comprehension (Hargis, 1976).

These findings are supported by later research (Allen, 1986; Ewoldt, 1990; Kelly, 1996; Schirmer & McGough, 2005). Kelly extended the research regarding the relationship between morphosyntax and reading when he studied 325 participants who were DHH. Kelly found that vocabulary and syntactic knowledge were related because the participants with more complex morphosyntax were more successful at applying their vocabulary knowledge while reading. Further research and expansion of the hierarchies support their significance in the language and reading developmental process (Easterbrooks & Baker, 2002).

Deficits in language skills cause language delays for students who are DHH and often result in academic deficits for school age students (Holt et al., 1997). Specifically, students who are DHH have problems learning English pronominalization because there are only two variations in ASL (Peyton, 2009). They also struggle with determiners because in ASL definite and indefinite determiners are signed with the same handshape, and location and proximity are the nonmanual markers that characterize this functional category (Neidle, Kegl, MacLaughlin, Bahan, & Lee, 2000). ASL provides visual detail to represent the morphosyntax that is either implied or embedded in main clauses (i.e., gender-specific pronouns, verb tenses, affixes, and articles; Aarons, Bahan, Kegl, &

Neidle, 1992; Neidle et al.). This results in restricted models of English syntax for students who are DHH. Therefore, intervention research is needed to address these deficits and enhance language development for this population.

Similarities and differences in morphosyntax deficits for ASL users versus hearing second language learners are apparent when comparing the two populations (Paul, 2003). Both populations must be able to take information in linguistic units (phrases, sentences, and paragraphs) and combine the units with their prior knowledge of textual demands (vocabulary, syntax, and concepts). These processes must take place in the working memory model and place high-level demands on two of its' components, the phonological loop and the visual-spatial sketchpad (Baddeley & Hitch, 1974). The phonological loop is responsible for vocabulary acquisition (Baddeley, Gathercole, & Papagno, 1998) and may be a barrier to textual demands of a task for students who are DHH. The visual-spatial sketchpad is responsible for processing and linking visual stimuli in the short-term memory (Baddeley & Hitch). Second language learners face the possible barrier of the episodic buffer (Baddeley & Hitch, 2000), which links information for comprehension of experiential concepts. Both of these unique groups of students have similar difficulties with the linguistic units and textual demands involved in the comprehension of morphosyntax in written and/or spoken language (Paul).

As previously stated using a socially valid intervention is a key factor in increasing language achievement in students who are DHH and multimedia formats show promise as a motivating teaching strategy (Akbulut, 2007; Blom-Hoffman, O'Neil-Pirozzi, Volpe, Cutting, & Bissinger, 2006; Chambers, Abrami, McWhaw, & Therrien, 2001; Chambers, Slavin, Madden, Cheung, & Gifford, 2005; Dubois & Vial, 2000;

Massaro & Light, 2004; Verhallen, Bus, & de Jong, 2006). The non-stimulating rote memorization of syntactic patterns used in the scaffolded instruction of English is typically not motivating for students because of the tedious nature of the task (Harper & de Jong, 2004). In order to make language learning more motivating to struggling learners, Laureate Learning Systems, Inc. developed the LL software program. By combining the scaffolded instruction of the functional categories of English in a multimedia format, LL attempts to gain student's interest and maintain it throughout the six modules in each of the six levels of the software program (Wilson, 2007; Wilson et al., 2003; 2008)..

Finn et al. (2005) used the LL software program with 22 preschool students with Language Impairments between the ages of 3 and 4 for 12 weeks as a supplemental classroom activity. All participants were assessed prior to intervention using the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999). Participants were matched by age and by their Core Composite (CC) on the CASL and then randomly assigned to the experimental or control groups. Three teachers supervised the intervention, the LL software program, for 10 to 15 minutes, up to three times per week for the experimental group. The control group used a different Laureate Learning Systems, Inc. software program that focused on vocabulary and categorization concepts for the same amount of time as the experimental group. Overall gains on the CC scores on the CASL were significant for the experimental group. Finn et al. noted the enhanced social validity of the study that resulted from implementation of the intervention by the teacher in a typical classroom environment.

Merchant et al. (2008) used the LL software program with students who were Hard of Hearing, used cochlear implants, and utilized spoken English as their primary language and mode of communication. This study was conducted with 5 participants from kindergarten and 5 participants from first grade at a school for the Deaf that promoted spoken language development over signed language development. The researchers pretested (time 1) the participants on vocabulary using the Expressive One-Word Picture Vocabulary Test (EOWPVT) and on morphosyntax using the *Diagnostic Evaluation of Language Variation – Norm Referenced* (DELV-NR; Seymour, Roeper & de Villiers, 2005). The experimental and control groups were matched according to pretest scores and randomly assigned to either group. The experimental group used the LL software program. The control group used a different Laureate Learning Systems, Inc. software program that focused on vocabulary and categorization concepts. Both groups used the software programs for 20 minutes three times per week for 10 weeks. At the midpoint in the study the participants were evaluated using the EOWPVT and the DELV-NR (Seymour et al.; time 2) and then the groups switched programs so that each group received the LL software program. At the conclusion of the study the participants were evaluated using the EOWPVT and the DELV-NR (Seymour et al.) assessments (time 3) as posttest data. The results of the paired *t*-test on time 3 data (end of the training) versus time 1 (beginning of the training) revealed significant improvement of the morphosyntax of the participants in the study. Merchant et al. noted that the participants' expressive language scores increased even though LL provided instruction in receptive language. The researchers also noted that the software is self-paced, which allowed teachers to address underlying skills while continuing to teach required standards. However, the

software has not been examined with students who are DHH and receive instruction in environments where ASL and other forms of sign language are the preferred mode of communication.

Merchant et al. (2008) made accommodations so that the participants in their study could utilize the LL software program. This was necessary because some of the directions and feedback in the software program are auditory, although the training and assessment items are presented in print accompanied by verbally recited phrases. The 8 participants who had cochlear implants listened to the program using headphones that were adjusted to their various head shapes and placement of implants. This accommodation was accomplished using foam pieces that were attached to the underside of the headphone strap. For the 2 participants who used hearing aids, direct audio input was used so they could receive the recording on the software directly into their hearing aids. Accommodations to the settings of the LL program are reviewed in the *Materials* section for the current study.

The current study extended the research to participants who utilize ASL as their primary mode of communication. The present study determined if the frequent use of the LL software program, as a supplemental classroom activity, affected the morphosyntax in students who are DHH. The research question was: Does daily use of the LL software program, as a supplemental classroom activity, affect morphosyntax in students who are DHH, as measured by HLM growth curve analyses?

CHAPTER 3

METHODOLOGY

The setting for this study was an urban day school for students who are DHH located in a major metropolitan Southeastern area. The school enrolls students from preschool through 12th grade who are from 28 counties in and around a major metropolitan area. At the inception of the study there were approximately 200 students enrolled in the school ranging from 3 to 21 years old. Each classroom consisted of small group instruction with class sizes ranging from 4 to 8 students and was equipped with up to five computers. This setting provided a homogenous sample of students who are DHH in that all the students in this setting use some form of sign language, as opposed to spoken English, as their mode of communication and all school personnel are proficient in ASL.

Participants

This study included 26 participants. Parent permission forms were sent home to all kindergarten through fifth grade students (n = 45). Thirty-eight forms were returned and of those 27 students met the inclusion criteria and one participant dropped out of the study after two weeks when they were transferred to another school. The inclusion criteria were: 1) students between 5 and 12 years of age who are DHH at an urban day school for the Deaf; 2) degree of hearing loss of at least 40dB aided pure-tone average of the better ear average; 3) scores at or above the instructional reading rating at the preprimer level based on teacher report of the child's most recent *Basic Reading*

Inventory (BRI; Johns, 2008). Exclusion criteria included: 1) any students with documented additional disabilities; and 2) scores below an instructional reading rating at the preprimer level based on teacher report of the child's most recent BRI (Johns) assessment. The preprimer level was selected because the participants had developed some word recognition skills at this rating and this skill was necessary to participate in the intervention.

A total of 8 teachers were included in the study, 2 from kindergarten classes, 1 from a combined first/second grade class, 1 from third grade, 2 from fourth grade classes, and 2 from fifth grade classes. These 8 teachers were recruited as facilitators of the intervention for this study. Inclusion criteria included: 1) current certification in Deaf education; 2) classroom teachers of the current grade level of the participants of the study; and 3) proficiency in ASL as determined by the school's evaluation of their skills prior to employment. Exclusion criteria included: 1) teachers without certification in Deaf education; 2) school personnel who were not the classroom teacher of the participants in the study; and 3) teachers who were not proficient in ASL.

Independent Variables

The independent variables in this study served as predictors of where the participants started on two hierarchical linear modeling (HLM) growth curve analyses. These included: 1) Degree of Hearing Loss; and 2) Age at the time of this research study. A second set of independent variables served as predictors of change over time on two HLM growth curve analyses and included: 1) DELV-NR (Seymour et al., 2005) pretest scores on the syntax and semantic subtests; and 2) the BRI (Johns, 2008) scores from the participants' records.

Dependent Variables

Two HLM growth curve analyses were used to examine the influence of LL on the comprehension of morphosyntax components (determiners, tense, and complementizers), based on two dependent variables: 1) the software program's *Optimized Intervention* (OI; Wilson et al., 2003) report data; and 2) data from a subset of the *Comprehension of Written Grammar* (CWG; Easterbrooks, 2010). A dependent *t*-test was used to examine the comprehension of morphosyntax components (determiners, tense, and complementizers), based on the third dependent variable of the DELV-NR (Seymour et al., 2005) assessment. Computer-administered language assessment was used to track individual performance for each session and the participants' overall results (Brandone, Golinkoff, & Hirsh-Pasek, 2008).

Research Design

Two HLM growth curve analyses were used to examine the influence of the intervention (LL software program) on the morphosyntax of participants who are DHH. Both HLM growth curve analyses were used to measure the same outcome variable at multiple times in order to investigate a pattern of change over time. Measuring each participant multiple times created nested data structures; the measurement occasions were nested within the participants.

The independent variables were used as predictors of the initial LL software score and the initial subset of the CWG (Easterbrooks, 2010) score. Other predictors of how the participants' scores changed over time included the DELV-NR (Seymour et al., 2005) pretest raw scores on the semantic and syntactic subtests, and the BRI (Johns, 2008) scores. The BRI (Johns) scores were obtained from the participants' records via

the classroom teacher because it is a required assessment at the beginning of every year in the participating school. Both scores assisted in predicting whether or not these pretest scores influenced the participants' advancement through the levels of the software program and the subset of the CWG (Easterbrooks), and/or whether or not reading scores influenced the participants' language abilities.

HLM growth curve analyses allowed for the inclusion of a larger sample size than single subject design typically involves, while utilizing a similar design concept of allowing participants to act as their own controls. This is important because DHH is a low-incidence disability area with scarce research of effective, evidence-based classroom strategies that increase language acquisition. The need for additional research to increase the below average language scores is vital for this diverse population (Easterbrooks, 1999; Schimmel & Edwards, 2003). Yet funding for research from a federal level is difficult to acquire without group design research studies (Cawthon, 2007). HLM growth curve analysis has not been used in research with participants who are DHH and this new avenue to incorporate group design may be beneficial not only for funding of research but for a larger sample size of students who are DHH to determine evidence-based strategies.

HLM growth curve analysis allows the sample size to be small, (n = 20-30) participants, in comparison to some group design analyses. But the amount of measurement occasions for these individuals is large, (n = 20-50), and makes up for the small sample size in the statistical analysis of the data. HLM growth curve is especially useful with the DHH population because it allows for individual differences among the participants and examines these differences using statistical analysis. For example, in

some single-subject research participants must have matched characteristics, such as age range, teacher/classroom placement, IQ, etc. But as is evident in the current study, HLM growth curve participants can range in age (5-12 years old), disability characteristics (degree of hearing loss), classroom placement (kindergarten through fifth, and 8 different teachers), pretest scores (DELV-NR; Seymour et al., 2005), and inclusionary criteria scores (BRI; Johns, 2008). The reason these areas can vary is because HLM growth curve uses these independent variables to explain which ones are significant predictors of where the participants begin on the initial intercept of the growth curve (Age and Degree of Hearing Loss) and which ones are significant predictors of where participants will fall on the slope of the growth curve (DELV-NR [Seymour et al.] pretest scores and BRI [Johns] scores). This research design allowed analysis of whether or not the dependent variables (LL scores and CWG [Easterbrooks, 2010] scores) influence morphosyntax acquisition, as determined by whether or not the outcome variables showed significant growth over time. The overall concept of HLM growth curve analysis is similar to running multiple regression analyses, but has the added benefit of incorporating individualized variables to explain significant predictors of individual performance and therefore influence future research regarding significant variables.

Assessment Procedures

Language status was assessed using the DELV-NR (Seymour et al., 2005). This assessment was chosen over the CASL (Carrow-Woolfolk, 1999), used in previous studies, for pre- and postassessment because the CASL assesses spoken language and the participants in this study utilized ASL as their primary mode of communication. The DELV-NR (Seymour et al.) is a diagnostic test that assesses aspects of language that are

critical to the development of language competence. The assessment can be used to evaluate students who have linguistic backgrounds that are not Mainstream American English (MAE; Seymour, et al). St5tudents who are DHH and use ASL are at risk for expressing non-standard MAE because ASL is not considered MAE because the grammatical structures of the language conflict with English word order (Lane, Hoffmeister, & Behan, 1996). Although ASL is similar to English in how it represents the lexical category, it organizes the functional category very differently. For example, ASL functional categories, such as determiners and wh-questions, are represented through nonmanual markers, such as proximity and location (Neidle et al., 2000). The variations between MAE and ASL may cause confusion between the functional categories of English and ASL because English is not the students' native language (Bishop, 1983). Therefore this assessment is appropriate for students who are DHH and use ASL as their primary mode of communication because their native language may not be MAE.

The DELV-NR (Seymour et al., 2005) is based on the theories of Chomsky (1973, 1977, 1986), Brown (1973), Labov (1969, 1972), and Bruner (1986). This assessment was formed from recommendations by the American Speech-Language-Hearing Association that students who do not speak MAE should not be diagnosed as having language disorders (ASHA, 1983; 2003). The DELV-NR (Seymour et al.) was used as pre- and posttest to measure morphosyntax.

Administration of the assessment was conducted by researchers and graduate students who had a background in Deaf education and were proficient in ASL. The assessment was administered to each participant individually. The researcher and

participant left the classroom setting and went to an unoccupied office for each assessment. The assessor signed all questions to the participant in English word order.

Assessors administered the semantic subtest and syntactic subtest of the DELV-NR (Seymour et al., 2005). The syntax subtest consists of three subdomains, 'wh-questions', 'passives', and 'articles' to measure the participants' comprehension of wh-movement in sentences, passive sentences, and use of articles (Seymour et al.). Articles are a component of the demonstrative domain and therefore are a measure of the corresponding concept of determiners in the LL program. Passive sentences are a measure of the corresponding concept of complementizers in the LL program. The semantic subtest has four subdomains, the 'verb contrast', 'preposition contrast', 'quantifiers', and 'fast mapping'. These subdomains measure the participants' ability to organize vocabulary, contrast verbs and prepositions, comprehend quantifiers, and retain new meanings from the context of a sentence (Seymour et al.). 'Verb contrasts' are a measure of the corresponding concept of tense in the LL program. The syntax and semantic subtests were chosen because they most closely represent the concepts in the LL software program that is the intervention in this study. The DELV-NR (Seymour et al.) was chosen as an independent measure of the skills addressed in the computer program and was previously used as an assessment of morphosyntax in the Merchant, deVilliers, and Smith (2008) study. Overlapping functional categories between the intervention and assessment (see Appendices A and B; Wilson et al., 2003) in the current study included determiners (i.e., articles and quantifiers), tense (i.e., negation, aspect and agreement), and complementizers (i.e., wh-questions).

Assessment was also conducted using the OI system during intervention. The OI tracked individual participant progress. Weekly student reports were downloaded and printed for data analysis and were maintained using the LL software program. The OI was also used to track the participants' performance for each session and overall results on a weekly basis by the researcher. Up to 45 data points were collected using the OI system for each participant in the study because the intervention took place five times per week for 9 weeks. The data obtained through the student reports were entered onto a data collection spreadsheet (see Figure 1).

A subset of the CWG (Easterbrooks, 2010) was also used as an informal assessment of written grammar. The subset of CWG (Easterbrooks) was administered by showing the participant an English sentence with three pictures from which to choose. The pictures contained characteristics that require comprehension of the morphosyntax in the sentence. Fifteen key grammatical structures were selected that had overlapping

	Session Scores									
Participant	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Figure 1. Student Report Data Collection Spreadsheet

morphosyntax between the LL software program and the CWG (Easterbrooks). The subset of the CWG (Easterbrooks) was administered by the researcher and three graduate students in Deaf Education with ASL proficiency. Four baseline probes were administered in randomized order over the course of 2 weeks to establish the participants' level of English grammar present prior to the intervention and classroom curriculum. Weekly probes were administered during intervention to serve as an ongoing assessment of fidelity of the LL software program's OI system. Each participant's baseline and weekly probes were graphed to establish whether or not there was a pattern of consistency of the fifteen sentences on the CWG (Easterbrooks) graph (see Figure 2).

Intervention Procedures

A total of 8 teachers administered the software intervention in their classrooms every day for 9 weeks. The period of intervention was selected based on the fact that students are expected to make progress on their Individualized Education Plan objectives and academic grades which are distributed via report cards every 9 weeks in the elementary school. The examiner conducted three teacher workshops to demonstrate the procedures of the study and how to administer the intervention software program. All 8 teachers attended the first workshop, which lasted 1 hour. The teachers were given an overview of the study and received detailed information on the expectations of their role in the study. The teachers were asked to sign the informed consent if they chose to participate in the study. After receiving informed consent from all the teachers the researcher conducted two individual 30 minute training sessions in the teachers' classrooms on their computers. The teachers received the teacher script (see Appendix C), problem sheet (see Appendix D), and weekly checklists (see Appendix E), on

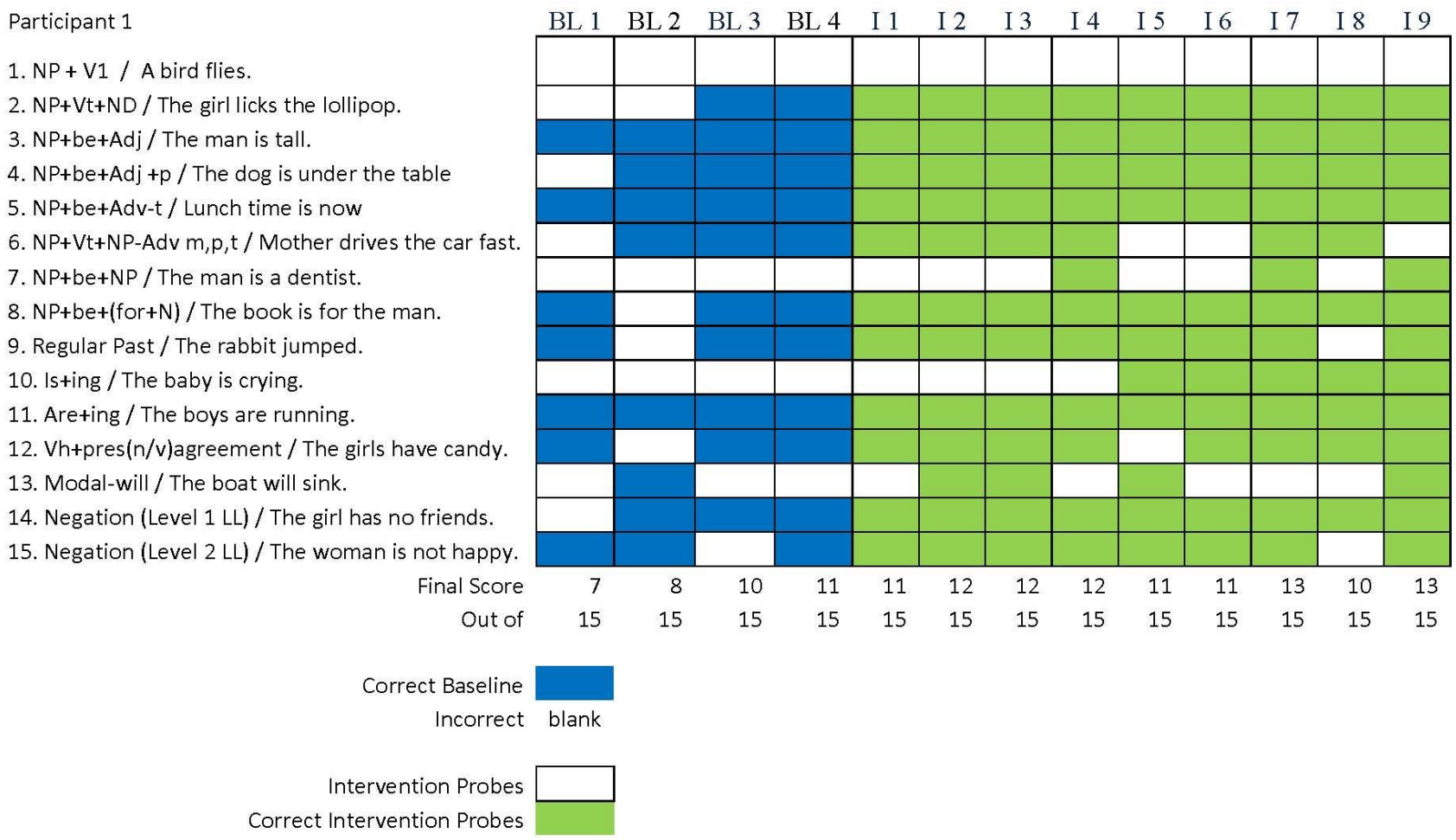

Figure 2. CWG Participant Graph

clipboards, along with timers. The researcher reviewed the procedures for intervention. The teachers were given directions that the teacher script (Appendix C) should be read to the participants using ASL. During the second session the researcher reviewed the schedule of intervention with the teachers, discussed implementation issues with teachers who did not have all students in the class participating in the current study, and had the teachers log in to the software program to practice the intervention before training the participants. During the third training session the researcher explained that fidelity checks of their implementation of the intervention sessions would be conducted by the researcher during 20% of the intervention period (approximately nine times during the 9 week period). The teachers were asked to train the participants as a group on how to use the software program for the first intervention session. For each of the up to 45 intervention sessions the participants worked on the computers as a group, or individually, depending upon the classroom teacher's preference and number of computers per classroom during the 10-minute sessions as a supplemental classroom activity.

During the intervention procedure the participants logged in to the LL program by choosing his or her name from the drop-down list on the login screen choosing the level that was indicated on the weekly checklist (Appendix E). Weekly checklists were utilized because the software program only moved participants through the individual modules of each level. When the participant had mastered module six and was ready to move to the next level of the program the teacher could refer to the weekly checklist for confirmation that the participant was allowed to advance to the next level. The checklists were updated daily after inspection of the OI student reports by the researcher. The software was self-paced so that each participant worked individually through each module (1-6) of each

level (1-6) (see Appendix B) that matched his or her current ability level. All participants began with module one, level one and the OI system advanced the participants to the next module after mastery of each skill. As previously stated, teacher monitoring of participant logins was necessary when advancing to a new level. Timers were also used to ensure fidelity of implementation because the software timers were individually set for each 10-minute session, but the software would stop prior to 10 minutes if the participant advanced to the next level. After mastery of all six modules the participant was allowed to advance to the next level by selecting the appropriate level from the login screen. If this occurred prior to the end of a 10-minute session the teachers were instructed during the teacher training sessions on how to check the student report for mastery of a level and instructed the participants how to choose the next level from the drop down menu and continue working until the 10-minute session was complete, as noted by the timers. The participants were instructed on the procedures of how to log off the computer when the software program stopped after 10 minutes and/or when the 10-minute timer stopped. Three out of 26 participants completed all the modules and levels in the program before the completion of the study and their teachers allowed them to work on a math website during the intervention sessions. The OI system generated student reports that recorded the amount of time each participant spent on each session. The researcher monitored these reports to assure the fidelity of time that each participant spent on the computers daily and provided feedback to the teacher if proper timing was not followed.

Materials

Materials necessary for the implementation of the intervention included: 1) a site license for 22 computers to use the LL software program simultaneously, which was

obtained gratis from the publisher, Laureate Learning Systems, Inc.; 2) 22 computers equipped with keyboard and mouse controls; 3) participant records of degree of hearing loss, age at the time of this research study, and his or her most recent BRI (Johns, 2008) scores; 4) the examiner manual, stimulus manual and record forms for each participant from the DELV-NR (Seymour et al., 2005); 5) stimulus manual for the subset of the CWG (Easterbrooks, 2010) and participant scoresheets (see Appendix F) and 6) teacher clipboards that included teacher scripts (Appendix C), problem sheets (Appendix D), weekly checklists (Appendix E), and digital timers.

Specific settings in the LL software program are important for replication purposes and fidelity of intervention with participants who are DHH who utilize ASL as their primary mode of communication. Four important program settings (see Appendix G) in the LL software were used with the participants in this study. First, the 'interface' option in the program settings was set to 'scanning'(see Appendix G). The sentences voiced on the software program were printed on the screen so no captioning of the software was necessary. Directional words were voiced but not printed on the computer screen. The 'scanning' accommodation gave visual cues in place of the directional words. Second, the 'duration of session' option was set to 10 minutes (see Appendix G). After 10 minutes the software stopped and asked the participant to log off the program. To assist with fidelity and ease of implementation for the teacher a timer was provided to control for interruption of the intervention when participants advanced to a new level or for when technical difficulties occurred. For example, one classroom experienced a computer that 'crashed' during the middle of a session and the participant was able to move to another computer, log on to the system again and continue with his session

because the timer let the teacher know how much longer he needed to work on the intervention during that session. The third accommodation was the ‘scans per item’ setting option which was set at ‘infinite’ so that the participants had extended time to read the sentence and match it to the correct object on the screen (see Appendix G). This was consistent with the program’s intent to provide self-paced instruction. The fourth accommodation was that the scan delay setting was set to 5 seconds for the participants 5 to 9 years of age and 3e seconds for the participants 10 to 12 years of age (see Appendix G). The rationale for the difference in scan delay was that the researcher noted some of the older participants in the study responded faster to the questions than the younger participants. The older participants’ attention to the computer screen also began to decrease, as noted by the researcher during the initial training/intervention session and during the first week of the intervention. Therefore, the scan delay setting was changed after the first week for participants 10 to 12 years of age, to enhance attention to the computer screen and decrease lapses in attention by the older participants in the study.

Additional accommodations were made to the computers and tables in the classrooms to give participants visual aids while completing the daily intervention. Index cards with the username and password for the school’s computer login screens were taped to the computer tables beside each computer to aid with ease of implementation. This login was separate from the login in LL and the procedure was noted on the teacher scripts (Appendix C). Red circle stickers were added to the space bars of all 22 computers as an additional visual aid. These stickers gave participants a visual cue to press the space bar for selection of the picture on the computer screen that was surrounded by a red circle. The stickers were added to divert the participants from using the computer mouse

for selection because if they selected a picture with the mouse and the red circle was around the other picture on the screen, then the picture with the red circle would be counted as their answer.

Data Collection

The timeline for executing the research plan was 9 weeks, every school day for 10 minutes per session. The scores for each participant from the OI student reports were compiled on the student report data collection spreadsheet (Figure 1). Instrumentation to account for validity and reliability included a procedural fidelity checklist (Appendix H) for 20% of the intervention sessions which consisted of nine observations, or once a week for the entire study. The researcher assessed treatment fidelity of the intervention by the teachers by comparing teacher weekly checklists (Appendix E) to the student reports from the OI system to monitor how many times participants logged onto the system per week and the duration of their sessions. The researcher also requested a general schedule of when teachers were using the software program in their classrooms and conducted spontaneous treatment fidelity checks to ensure teacher compliance with the script and procedures explained during the training session.

Interobserver reliability (IOR) of the pre- and postassessments of the syntax and semantic subtests of the DELV-NR (Seymour et al., 2005) were completed. IOR was conducted by four graduate researchers with majors in Deaf education, with Collaborative Internal Review Board Training Initiative certification, and who were all proficient in ASL. During these assessment fidelity checks, the second researcher observed during the administration of the assessment by sitting next to the researcher and used an identical DELV-NR (Seymour et al.) protocol record form to mark the answers

expressed by the participant. IOR was conducted for 20% of the fidelity assessments and calculated using point-by-point agreement on both the DELV-NR (Seymour et al.) pretests and posttests.

Social validity was assessed using a short answer teacher questionnaire (Appendix I) that was distributed a week after the intervention was completed. The social validity of the intervention was enhanced since the intervention was administered by a teacher in a typical classroom environment, and not by the researcher. In addition, a 5-point Likert scale questionnaire (Appendix J) was distributed to the students who served as participants in the study 1 week after the intervention was complete during posttesting. The researcher read the questions on the questionnaire to the participants in ASL. These questionnaires served as an informal and subjective evaluation (Wolf, 1978) to examine the social validity of using the intervention in the classroom setting.

Data Analysis

Two HLM growth curve analyses, one on the LL scores and one on the CWG (Easterbrooks, 2010) scores, were used to examine the same outcome variable at multiple times in order to investigate a pattern of change over time as evidenced by a change in level and slope. Each participant was measured multiple times in order to create a nested data structure. The data points from the OI reports of the LL scores and the data points from the subset of the CWG (Easterbrooks) were nested within the participants. Time was used as a level-1 predictor of the outcome of the dependent variable of the LL and CWG (Easterbrooks) scores over time on the slope of the growth curve.

The level-2 predictor variables were the Age of the participant at the time of the study and Degree of Hearing Loss. These variables were used as predictors of the level-1

intercept. Other level-2 predictor variables included the DELV-NR (Seymour et al., 2005) pretest scores on the semantic and syntax subtests and the BRI (Johns, 2008) scores. These scores served as predictors of change over time because they examined the influence of language and reading scores on the level-2 slope. The level-1 equation was

$$Y_{ti} = \pi_{0i} + \pi_{1i}Time_t + e_{ti} \quad (1)$$

The level-2 equation was

$$\pi_{0i} = b_{00} + b_{01}Age_{1i} + b_{02}Hearing\ Loss_{2i} + r_{0i}, \text{ and } \pi_{1i} = b_{10} + b_{11}BRI_{1i} + b_{12}DELV\text{-}NR_{2i} + r_{1i} \quad (2)$$

The combined equation was

$$Y_{ti} = b_{00} + b_{01}Age_{1i} + b_{02}Hearing\ Loss_2 + b_{10}Time_t + b_{11}BRI_{1i}Time_t + b_{12}DELV\text{-}NR_{2i}Time_t + r_{0i} + Time_t \cdot r_{1i} + e_{ti} \quad (3)$$

The researcher analyzed the data using these equations and the HLM 6 (Raudenbush, Bryk, Cheong, & Congdon, 2008) and SPSS (2008) software programs. The same equation was used to run both HLM growth curve analyses on the LL software program data and the subset of the CWG (Easterbrooks, 2010) data.

The DELV-NR (Seymour et al., 2005) pre- and posttest scores on the syntax and semantic subtests were analyzed using two separate dependent *t*-tests. SPSS (2008) software was used to compare the whole sample of participants' scores before and after the intervention. The results of both HLM growth curve analyses and the DELV-NR (Seymour et al.) assessment dependent *t*-test scores were compared to analyze the validity of the OI system's self-assessment of the LL software program. These results were examined to enhance the explanatory nature of the study and answer the research question. The two HLM growth curve analyses were compared to examine whether the results were due to the intervention or classroom instruction.

CHAPTER 4

RESULTS

The purpose of this study was to determine if the frequent use of the LL software program as a supplemental classroom activity affected morphosyntax in participants who are DHH. Two HLM growth curve analyses were used to examine the influence of LL on the comprehension of three components of morphosyntax (determiners, tense, and complementizers) based on two dependent variables: 1) the software program's OI (Wilson, 2003) report data; and 2) data from a subset of the CWG (Easterbrooks, 2010). In addition, a dependent *t*-test was used to examine the comprehension of morphosyntax based on the third dependent variable of the DELV-NR (Seymour et al., 2005) assessment. Fidelity and social validity were also assessed using observations and questionnaires.

LanguageLinks HLM Growth Curve

Time spent per module was a statistically significant predictor of progress, $t(25) = 4.510$, $p < .001$, with participants averaging an increase of 0.4 modules per time period, or approximately half of a module per session. The level-2 predictor variables, Age, $t(23) = 1.867$, $p = .074$, and Degree of Hearing Loss, $t(23) = -0.102$, $p = .920$, were not statistically significant predictors of where participants began on the level-1 intercept. The DELV-NR (Seymour et al., 2005) pre-syntax, $t(22) = -0.713$, $p = .483$ and pre-semantic, $t(22) = 1.722$, $p = .099$, subtest scores were not statistically significant predictors of change over time for the participants in this study. Examining the influence

of language and reading scores on the level-2 slope, the results indicated that the participants' BRI (Johns, 2008) scores, $t(22) = 3.522$, $p = .002$, were statistically significant predictors of change over time on the LL software program modules.

Comprehension of Written Grammar HLM Growth Curve

Time was a statistically significant predictor of progress, $t(25) = 4.750$, $p < .001$, on the scores from the subset of the CWG (Easterbrooks, 2010), averaging .148 sentence structures per weekly assessment. The level-2 predictor variable Degree of Hearing Loss, $t(23) = -0.964$, $p = .346$, was not a statistically significant predictor of the beginning score. Age was a statistically significant predictor of the beginning score, $t(23) = 2.182$, $p = .039$. The DELV-NR (Seymour et al., 2005) pretest syntax subtest, $t(22) = -0.234$, $p = .817$, and pretest semantic subtest, $t(22) = 1.830$, $p = .080$, scores were not statistically significant predictors of change over time on the subset of the CWG (Easterbrooks). The BRI (Johns, 2008) scores, $t(22) = -0.037$, $p = .971$, were not statistically significant predictors of change over time on the weekly CWG (Easterbrooks) scores.

Diagnostic Evaluation of Language Variation Results

Pre- and post- syntax subtests. A dependent *t*-test was conducted to compare the pretest scores of the syntax subtest of the DELV-NR (Seymour et al., 2005) assessment and the posttest scores of the syntax subtest of the DELV-NR (Seymour et al.) assessment with alpha set at .05. There was a statistically significant difference between the scores on the pretest syntax subtest ($M = 10.884$, $SD = 5.778$) and the posttest syntax subtest ($M = 12.769$, $SD = 4.966$), $t(25) = -2.394$, $p = .024$. A summary of the results is presented in Table 1.

Pre- and post- semantic subtests. A dependent *t*-test was conducted to compare the pretest scores of the semantics subtest of the DELV-NR (Seymour et al., 2005) assessment and the posttest scores of the semantics subtest of the DELV-NR (Seymour et al.) assessment with alpha set at .05. There was not a statistically significant difference between the scores on the pretest semantic subtest (M = 20.384, SD = 7.228) and the posttest semantic subtest (M = 22.153, SD = 5.661), $t(25) = -2.004$, $p = .056$. A summary of the results is presented in Table 1.

Table 1

Results of DELV-NR Subtests

	M	*N*	*SD*
Pre-syntax subtest	10.884	26	5.778
Post-syntax subtest	12.769	26	4.966
Pre-semantic subtest	20.384	26	7.228
Post-semantic subtest	22.153	26	5.661
	T	Df	Sig (2-tailed)
Syntax subtest	-2.394	25	.024
Semantic subtest	-2.004	25	.056

Inter-Observer Reliability and Procedural Fidelity

IOR was calculated using point-by-point agreement. The total number of agreements was divided by the total number of agreements plus disagreements and multiplied by 100. The researcher conducted both the DELV-NR (Seymour et al., 2005) pretest subtests and posttest subtests while recording the participant responses on the DELV-NR (Seymour et al.) protocol record sheet. The graduate research assistants

recorded the participant responses on a separate, identical protocol record sheet. The data on both protocols were compared for agreements and disagreements for 20% of the pretest and posttest sessions (5 participants for the pretest and 5 participants for the posttest). The DELV-NR (Seymour et al.) pretest point-by-point agreement was 98% and the DELV-NR (Seymour et al.) posttest point-by-point agreement was 94%.

Weekly procedural fidelity checklists (Appendix H) were completed for 20% of the intervention sessions for 9 weeks. Nine fidelity checks were conducted, one per week for 20% of the 45 intervention sessions. The results of the procedural fidelity checklists indicated that the teachers complied with the scripts during intervention for 100% of the observed sessions. The researcher observed that the teachers followed the teacher script (Appendix C) to ensure that the participants logged onto the system correctly.

Social Validity

Teacher social validity questionnaires (Appendix I) were completed by 5 out of 8 teachers who participated in the study. These consisted of five questions that were qualitative in nature. The responses varied among the teachers and results were mixed regarding the motivational nature of the multimedia software format. For the responses to the question regarding motivation (question 4) the teachers were asked to circle “Better”, “Same”, or “Worse” regarding whether or not they believed this task was more or less motivating than other direct instruction of language skills they previously used in their classroom and explain their answer. Three teachers answered “Worse” and 2 teachers answered “Better”. For the responses to the question regarding student perception of the program (question 2) the teachers were asked to circle “Positively”, “Neutral”, or

"Negatively" and explain their answer. Two teachers answered "Positively", 1 teacher answered "Neutral", and 2 teachers answered "Negatively".

Participant social validity questionnaires (Appendix J) were completed during posttesting and all questions were read to the participants in ASL. There were six questions in the survey. A Likert scale from 1-5 measured participant responses, where 1 indicated "strongly agree", 2 indicated "agree", 3 indicated "unsure", 4 indicated "disagree", and 5 indicated "strongly disagree". Results are presented in Table 2.

Table 2

Social Validity Questionnaire Results

Questionnaire Item	strongly agree	agree	unsure	Disagree	strongly disagree
1. I enjoyed using *LanguageLinks.*	22	2	2	0	0
2. I learned a lot using *LanguageLinks.*	18	1	6	0	1
3. *LanguageLinks* was fun.	18	0	8	0	0
4. I make fewer mistakes writing now.	11	2	5	1	7
5. I would use *LanguageLinks* at home.	12	1	2	1	10
6. I would recommend *LanguageLinks* to a friend.	14	1	5	0	6

CHAPTER 5

DISCUSSION

The present study determined if the frequent use of the LL software program as a supplemental classroom activity affected the morphosyntax of participants who are DHH. The research question was: Does daily use of the LL software program as a supplemental classroom activity affect morphosyntax in participants who are DHH as measured by HLM growth curve analyses? The results indicated that LL did affect the morphosyntax in participants who are DHH and use ASL, as measured by the HLM growth curve analysis of the OI scores. These results were supported by the statistically significant HLM growth curve analysis of the subset of the CWG (Easterbrooks, 2010) scores. The subset of the CWG (Easterbrooks) was administered as an additional measure of whether the results of the OI scores were due to the LL software program or language instruction in the classroom setting during the course of this research study. The corroboration of these statistically significant results indicated that the software program was partially responsible for the increase in morphosyntax of the participants in this research study. These results were also supported by the statistically significant results of the dependent *t*-test on the DELV-NR (Seymour et al., 2005) pre- and post- syntax subtest scores of the participants in the current study. Examination of all three statistically significant results supports the claim that participants in the study increased their morphosyntax due to the LL software program.

LanguageLinks Results

The results of the HLM growth curve analysis of the scores on the LL software program showed that participants in the study progressed through the program's six levels and six modules at an average increase of 0.4 modules per time period. This is equivalent to completing half of a module per session, per day. Each module allowed for practice and assessment of one of three concepts of morphosyntax (determiners, tense, and/or complementizers). Therefore participants either reviewed, or initially practiced, approximately half of a lesson on one of these concepts of morphosyntax within a 10-minute session on a daily basis. The speed of acquisition and/or reinforcement of these morphosyntax concepts suggest that this program may be a promising evidence-based, supplemental classroom strategy for participants who are DHH and use ASL.

Prior research on learning outcomes in general education has identified that the amount of time a student is actively engaged in learning (time on task) is an important factor for teachers to consider when planning instruction (Anderson, 1984; Morgan, 2006). The LL software program encourages students to spend time on the task of learning language. The multimedia component of the program also allows students an alternate language learning format to classroom instruction. Ramsey, Jolivette, Patterson, and Kennedy (2010) found that students who were given a choice of a task spent more time on task. The LL software provides students with a different option to learning language and may have accounted for the pace at which they went through the program. Given the fact that most students who are DHH plateau in language at a very early age (Holt et al., 1997), the result that they were continuing to advance through the program at a statistically significant rate indicates that the LL software may be an important option in

supporting time on task. Davey, LaSasso, and MacReady (1983) found that TODs spent very little time on task in reading instruction and so one might speculate that teachers also spend little time on the task of language instruction. Perhaps the LL software program is an option that would increase the amount of time students could spend on direct instruction of morphosyntax if they were given a choice between the software program and typical paper and pencil tasks.

The participants' scores on the BRI (Johns, 2008) were statistically significant predictors of their ability to progress through the modules and levels of the LL software program. In previous studies of this software the participants were able to listen to the prompt and could have ignored the printed sentence (Finn et al., 2005). In this study the participants did not have access to the voiced prompts so they tended to pay more attention to the printed sentences, which may account for why the BRI (Johns) scores were so predictive of progress. Therefore, the participants used their reading ability to comprehend the printed sentences and the directions in the software program on the screen. Prior research (Allen, 1986; Ewoldt, 1990; Kelly, 1996; Schirmer & McGough, 2005) supports the finding that participants with more complex vocabulary knowledge were more successful at applying the rules of morphosyntax when reading sentence prompts.

Comprehension of Written Grammar Results

The results of the subset of the CWG (Easterbrooks, 2010) showed that participants were able to add an average of .148 sentence structures per week to their knowledge pool of morphosyntax. Fifteen identical sentence structures were assessed weekly. These findings indicated that the participants were able to transfer their

knowledge of morphosyntax from the intervention to this assessment. Although the actual acquisition of structures appeared small (i.e., 1.5 sentence structures during the course of the study), this acquisition was statistically significant. This is important because there are no other research studies available that document rate of access of morphosyntax in children who are DHH. While this may appear on the surface to be minimal progress, it is consistent with what we know about the rate of progress in the literacy of students who are DHH (Marschark & Wauters, 2008).

Age was the only statistically significant predictor variable for this HLM growth curve analysis and therefore appears to have influenced the ability of the participants to transfer their knowledge from the intervention to the assessment. The selection of which subset of sentences was used in the CWG (Easterbrooks) may have influenced the results of this HLM analysis as they were chosen to match the structures from the LL software program. The high level of vocabulary in the sentences may have influenced the results. This is consistent with research showing that grammar ability correlates highly with reading ability (Macaluso, 2007; Verhoeven &Van Leeuwe, 2008).

Diagnostic Evaluation of Language Variation Results

The statistically significant results of the DELV-NR (Seymour et al., 2005) pre- and post- syntax subtest scores indicated that the LL software program may be a useful supplemental classroom activity for students who are DHH in the age ranges of 5 to 12 years old. Additionally the DELV-NR (Seymour et al.) syntax subtest may be a useful tool in assessing students' who are DHH knowledge of morphosyntax. Presently no published research exists on using the DELV-NR (Seymour et al.) with students who are DHH and use ASL as their primary mode of communication. The reason this assessment

may be useful with students who are DHH and utilize ASL is that their first language is not MAE and the morphosyntax of ASL does not follow MAE (Lane et al., 1996). Few assessments are available in Deaf education because a majority of the previous research has focused on the oral/manual controversy. The assessment of MAE may prove to be a mutually beneficial tool for both hearing students and students who are DHH.

The DELV-NR (Seymour et al., 2005) pre- and post- semantic subtest scores were not statistically significant. This may indicate that the four subdomains of the assessment did not overlap to the extent originally estimated when constructing the research design of this study. The 'verb contrasts' present in the DELV-NR (Seymour et al.) assessment were a measure of the corresponding concept of tense in the LL software program. The subdomains of 'preposition contrast', 'quantifiers', and 'fast mapping' were not overtly taught in the LL software program (see Appendices A and B). These subdomains measure the participants' ability to organize vocabulary, contrast prepositions, comprehend quantifiers, and retain new meanings from the context of a sentence (Seymour et al.). Although some of these concepts are necessary for comprehension of the sentence structures throughout the modules and levels of the program, the lack of direct instruction in particular modules may account for the lack of gain between pre- and posttest scores in this study. Including all four subdomains of the semantics subtest in this study may have washed out the effects of the one subdomain that overlapped with the LL software.

Social Validity

Upon completion of the intervention, teachers filled out a questionnaire to assess the social validity of using this intervention in a classroom setting as a supplemental

activity. The teachers' responses were mixed and appeared to be dependent upon the grade level of the students participating in the study. Although not all grade level teachers completed a questionnaire, which restricts the interpretation of the results, it appeared that the fifth grade classroom teachers felt the program was not motivating for their students. This may be due to their students' age and may be an indication that some of the programs' activities, pacing, and feedback are better designed for younger students.

The 2 kindergarten teachers reported that the program was too difficult for their students without direct teacher instruction of the concepts and suggested that the intervention might work better as a supplemental activity after direct instruction. Additionally, both kindergarten teachers felt that their students' limited skills in reading and vocabulary knowledge may have impeded their ability to comprehend all the sentences presented in print on the computer screen. They also commented that if they used the software in the future they would prefer to read the sentences to the students using ASL. Had this been done, it would have added a confounding factor to the study as the grammars of English and ASL differ greatly.

The second, third, and fourth grade teachers who responded to the questionnaires, and gave verbal feedback to the researcher, expressed positive comments regarding motivation and ease of implementation of the intervention. They also commented that using this software program in tandem with classroom instruction of the morphosyntax concepts might have been more beneficial to the students. All teachers expressed frustration that they were not able to read the sentences to the students using ASL or explain the morphosyntax concepts to the students while they were completing the

research study. However, the point of the study was to determine whether the LL software product in and of itself was of benefit to the participants studied.

Participant Questionnaire Results

The student questionnaires were designed to assess the social validity of the intervention because previous research found that multimedia tools could be a best practice for students (Cannon et al., 2010; Dangsaart et al., 2008; Massaro & Light, 2004). Socially valid interventions may be key factors to academic success for direct instruction of morphosyntax (Pipp-Siegal et al., 2003) and investigating this aspect of the intervention was an additional, informal component of the current research study. Based on positive responses to 50% of the questionnaires it appears that the up to half of the participants enjoyed using the LL software program and viewed it as a fun activity. Although responses to the remaining questions on the questionnaire were not as positive. Less than half of the participants felt that their writing skills had increased. This is not surprising because the program did not target writing instruction. Further, the students indicated that they would not use the software at home nor would they recommend it to a friend. Therefore, the results of the questionnaires were mixed and may not be an accurate indicator of whether or not the LL software program was actually a socially valid activity for the majority of the participants in this study.

Conclusions

LanguageLinks software program. The LL software program appears to be an effective supplemental classroom activity to increase morphosyntax for students who are DHH and use ASL. The reading level of the students utilizing the software program appears to be a significant predictor of their ability to progress through the modules and

levels of the program. Optimal age range for this population appears to be first through fourth grade. This conclusion is derived from the statistical analyses, as well as the examination of the informal social validity information gathered from the participants and teachers. The question of whether or not the LL software program is a socially valid classroom activity was not fully answered in the current study. The intervention appears socially valid to certain participants, but further study of the link between student participation and the multimedia format of this software is needed before this conclusion could be asserted.

Comprehension of Written Grammar. The 15 question subset of the CWG (Easterbrooks, 2010) appears to be an emerging yet valid assessment tool of overlapping morphosyntax structures that are addressed in the LL software program. Age of the participants was a significant predictor of their ability to progress through the subset of the assessment. This may be due to the participants' age influencing their ability to match printed sentences to pictures with similar characteristics yet subtle differences that are only detectable by the morphosyntax changes in the sentence.

HLM research design. The current study's use of HLM growth curve analysis as a research design with the low incidence population of students who are DHH and utilize ASL is promising for the field of Deaf education. This design allowed the researcher to examine the ongoing progress of the participants in the study and make the above conclusions based on examination of multiple variables that in the past have shown to be influential in the language acquisition for this population (Stinson & Kluwin, 2003). A more intricate examination of these variables was possible with this research design

because it allowed the inclusion of a broader range and number of participants than another design would, such as single subject research.

Implications

There are numerous implications for the outcomes of the predictor variable results of this study. First, the fact that Age was not a significant predictor variable on the LL scores but was on the CWG (Easterbrooks, 2010) scores may be attributed to aspects of the level of abstract criteria-based decision making that is necessary to select an answer for the subset of the CWG (Easterbrooks). In the subset of the CWG (Easterbrooks), there were three pictures in the stimulus array from which the participant could choose their answer. The answer was dependent upon comprehension of a complete sentence unlike the sentence parts primarily presented in the LL software. Further, in the LL software the children had only two options from which to choose. This may have presented a more abstract task to the participants.

Another factor may have been the vocabulary necessary for comprehension of the sentences in the subtest of the CWG (Easterbrooks, 2010). Whereas all vocabulary was explained during the training phases of the LL, no pretesting of prior knowledge of vocabulary used in the CWG (Easterbrooks) was conducted. Therefore, lack of prior experience with the vocabulary in the CWG (Easterbrooks) may have influenced the results, and a lack of morphosyntax skills may have affected participants' comprehension of the lexicon (Miller, 2006).

Finally, a puzzling result of the data was that the BRI (Johns, 2008) scores were not significant predictor variables for the CWG (Easterbrooks, 2010) even though they were on the LL software. This is puzzling because of the intentional use of overlapping

morphosyntax. One explanation might be that the BRI scores did not predict grammar within separate sentences but they did predict phrase and grammar results embedded within a high visual context. This explanation may cause one to conjecture about the importance of visual support in grammar acquisition in students who are DHH.

Limitations and Suggestions for Future Research

The results of the present study add to the minimal literature base on the effectiveness of using a software program to increase the morphosyntax of students who are DHH and use ASL. However, limitations of the current study were found during the course of the research process. These limitations will be reviewed along with suggestions for further research to enhance the methodology of future studies.

LanguageLinks software program. Limitations in the current study included components of the LL software program. The first limitation of the software was the timing component because it constricted the ease of implementation of the intervention. Timers had to be used to monitor the length of the sessions because the LL software would exit the participant and the timer would turn off if they completed the sixth module of a level. Future research may use the new web-based version of the LL program that will automatically move participants between modules *and* levels. This new component would make the limitation of the software's timing problems obsolete and would increase ease of implementation for classroom teachers.

The second limitation of the LL software was that it did not restrict which level the participants could log on to during each session. The teachers became frustrated when the participants could log on to any level accidentally. The teacher scripts (Appendix C) and the weekly checklists (Appendix E) were used to minimize this issue during the

course of the study, but occasionally participants were still logging on to the wrong level. To prevent this from occurring in future studies the web-based LL program that would move participants between modules and levels should be used. Future studies should add more emphasis during teacher training sessions on the importance of monitoring participants' log on procedures.

The teachers participating did not fully comprehend why they could not teach in tandem with the LL concepts or assist the participants when they were "stuck" on a concept. Trying to measure whether this was truly a supplemental activity may not have been accomplished in this study because the teachers could not "supplement" the concepts with direct teacher instruction. An example of this during the current study was when many participants were "stuck" on module two, level one. This module reviewed regular singular and plural nouns. The teachers reported that some participants do not hear the 's' at the end position of words in an everyday auditory environment and unless the teacher could point out that the 's' was the only difference between the text on the screen the participants would not be able to master this module.

The LL software program should be investigated to determine its effectiveness as a classroom activity that supplements teacher instruction of morphosyntax concepts of determiners, tense, and complementizers. Participants who receive classroom instruction from a teacher on the concept prior to utilizing the software program may increase their average progress through the modules beyond 0.4 per session. This is especially true for students who are in the lower grade levels (kindergarten, first, or second), or score in the first two levels of the BRI (Johns, 2008) inclusionary assessment, due to the abstract nature of the concepts of morphosyntax and the need for direct teacher instruction.

Future studies should examine the effect of the LL software program with two separate groups, one receiving the same implementation as the current study, and another group receiving direct teacher instruction in an overlapping concept with the LL software which the participants could then use after instruction. Results of these groups could be compared to analyze the effect of only using the LL program versus an approach that includes teacher instruction on the acquisition of morphosyntax concepts in combination with the LL software. Additional training for those teachers conducting the LL only group may be warranted so there is a more clear rationale for why they cannot provide assistance to participants during the course of the research study. Since time on task influences progress, one future area of research might be to investigate whether students would choose the computer-based task over a different form of language instruction.

A further limitation may be the procedural decision to begin all participants on module one, level one, regardless of their ages. This procedural decision may have influenced the results of the predictor variables of Age and Degree of Hearing Loss on the level-1 intercept. Neither Age nor Degree of Hearing Loss was a statistically significant predictor variable of where participants began on the level-1 intercept. These results indicate that these variables were not influential on which module or level each participant would first show progress in the software program. This may be due to the decision to have all participants begin on module one, level one, or it may indicate that Age and Degree of Hearing Loss were not significant indicators of the participants' knowledge of morphosyntax structures. Future research may allow participants to complete the screener in the LL software program and begin on the module and level indicated. The same predictor variables should be analyzed to ascertain whether these

were not statistically significant due to the design of the current study or whether they are indeed influential variables in the language acquisition of students who are DHH who use ASL, as previous research has indicated (Stinson & Kluwin, 2003).

Subset of the Comprehension of Written Grammar. The lack of assessment of prior knowledge of the vocabulary used in the 15 question subset of the CWG (Easterbrooks, 2010) was a limitation for the present study. Even though a score of preprimer instructional level or higher on the BRI (Johns, 2008) was an inclusionary criteria of the study, participants may have lacked comprehension of some of the vocabulary in the subset. The 15 questions were chosen based on the morphosyntax structures reviewed in the LL software and not on the vocabulary contained within the sentences. Future research should include a pretest of the main vocabulary in the CWG (Easterbrooks) in order to eliminate this as a factor. Another possible solution may be to alternate subtests with varying vocabulary for each weekly probe.

Another limitation pertaining to the CWG (Easterbrooks, 2010) may have been the use of only a subset of the entire test. The full battery of the CWG (Easterbrooks) may have given a more accurate assessment of the participants' knowledge of morphosyntax. Future studies could use the full CWG (Easterbrooks) rather than a targeted subset to gain more information regarding the participants' knowledge of morphosyntax. A valuable tool in future research may be to administer the full battery of the CWG (Easterbrooks) as a pretest and posttest and alternate subsets as weekly probes. This approach may assist with ease of implementation of the assessment because weekly probes of the full battery may prove logistically difficult due to the length of the full test.

Diagnostic Evaluation of Language Variation assessment. Another limitation of the current study was the use of the full semantic subtest of the DELV-NR (Seymour et al., 2005) because not all of the concepts overlapped with the intervention and may have influenced the results of the dependent *t*-test. For example the 'fast mapping' assessed in the DELV-NR was not a concept introduced in the LL software program. Therefore, future studies may need to administer the subdomain of 'verb contrasts' on the pre- and post- semantic DELV-NR (Seymour et al.) assessment so that only this aspect of morphosyntax is measured. Administering this subdomain of 'verb contrasts' would eliminate the other three subdomains which lack overlapping correspondence of morphosyntax between the intervention and assessment.

The lack of previous research using the DELV-NR (Seymour et al., 2005) with participants who are DHH and use ASL is a limitation of the present study. Even though the DELV-NR (Seymour et al.) was previously used with participants who are DHH and use the oral/aural method, the lack of assessment with the population used in this study was a limitation when interpreting the current results. The fact that students who are DHH and use ASL do not use MAE was the justification for using the assessment with this population. Optimism of the validity of this initial research using the DELV-NR (Seymour et al.) with these participants should be tempered until further investigation warrants the use of the subtests to measure the morphosyntax of participants who are DHH and use ASL. Future research should include using the DELV-NR (Seymour et al.) syntax and semantic subtests as assessments on a larger pool of participants who are DHH within the same age range (5 to 12 years old) and utilize ASL as their primary mode of communication.

Future research may support further use of this assessment with the specific population of students who are DHH and use ASL. If the DELV-NR (Seymour et al., 2005) is used in future research with the LL software program, then the 'verb contrast' subdomain may be the most accurate measure of the overlapping concepts with the LL. Future researchers may want to run an analysis exclusively on this subdomain of the semantic subtest. The two other DELV-NR (Seymour et al.) subtests of pragmatics and phonology could be investigated for their ability to assess the morphosyntax of students who are DHH and use ASL.

Fidelity of implementation. A limitation of the present study was the treatment fidelity of implementation of the LL intervention. During fidelity checks the teachers monitored the weekly checklists (Appendix E) for participant levels and ensured that participants worked on the computer for 10 minutes per session. However, while assessing treatment fidelity through daily checks of the OI records, the researcher found that some participants did log on to the wrong levels and some participants did not work for the entire 10 minutes of the intervention session. The issue of session timing was sometimes due to the OI system because it ended sessions prior to the indicated time of 10 minutes. The software company was contacted about this problem and reported that the software would end after 8 minutes if the participants successfully completed a level. Therefore the timers were used as a "back up" to ensure proper fidelity of timing of each session. When the researchers discussed the problem of participants spending too little or too much time on the program, the teachers reported that they sometimes forgot to turn on the timer or fully monitor the participant when on the computer because they had other students in the class that occupied their time. Consequently, although the teacher

fidelity checks were 100% for 20% of the intervention sessions, the researcher concluded that there were fidelity issues in the classroom when she was not present. The presence of the researcher may have skewed implementation procedures and could be viewed as another reason for the inconsistency between the fidelity results and teacher comments. Future research would need to address the limitation of treatment fidelity by increasing the fidelity checks of the teachers from 20% to 30% and emphasizing the importance of following the teacher script (Appendix C). Additional teacher training throughout the intervention phase of future studies may be warranted.

Social validity. Finally, the ability to measure accurately the social validity factors of the LL software program through teacher and participant questionnaires (Appendices I and J) did not yield conclusive results. Therefore, the measurement techniques used to assess the social validity of using the intervention in the classroom were a limitation of the present study. Future research should use a more in-depth and validated measure to assess whether or not the multimedia format of the LL software was indeed socially valid to students. Investigating whether or not motivation increases when this software is used as a supplemental activity to classroom instruction of the morphosyntax structures of determiners, tense, and complementizers is necessary. For participants who were unfamiliar with concepts introduced in the software and were unable to request help from the teacher, frustration may have occurred. The addition of teacher support may increase participant involvement when using this software. This same line of inquiry could examine the social validity of the intervention because teachers may give different feedback about the software program if it is used as a

supplement to their instruction. The investigation of other approaches to alleviate these limitations is important for future research.

Suggestions for future research stem from examination of the conclusions and limitations of the current study. Further research on evidence-based practices for students who are DHH are vital for the field of Deaf education and should consider the above suggestions. Innovative research designs to eliminate some of the challenges of conducting research with low-incidence disability groups should be investigated in future studies.

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APPENDIXES

APPENDIX A

LanguageLinks Functional Categories with Examples (Wilson, 2008)

Determiners	Examples
Articles	*a, the*
Prenominal Determiners	*this, that, these, those*
Locative Pronominals	*here, there*
Pronouns	
Nominative	*I, we, you, he, she, they, it*
Accusative	*me, us, you, him, them, it*
Pronominal Possessives	*my, your, our, his, her, their, its*
Independent Possessives	*mine, yours, ours, his, hers, theirs, its*
Anaphors (Reflexives)	*myself, yourself, ourselves, himself, herself, themselves*
Determiner '*no*'	He has ***no*** hair.
Genitive's Inflection	Joe'***s*** house is blue.
Nonthematic *'of'*	Have a cup ***of*** tea.
Pronominal Quantifiers	*all, many, several, each, any, none* Joe has ***none***. ***Many*** tried.

Tense	Examples
Nominative Case Checking	He (Nominative Case Subject) ***is*** setting the table.
Tense & Aspect	
Regular Past *"-ed"*	Joe fix***ed*** the house.
Future Modal "*will*"	He ***will*** set the table.
Present Progressive (Aux. "*be*"+V+"*ing*")	He ***is*** driv***ing*** the car.
Infinitival "*to*"	I want ***to*** set the table.
Auxiliary "*do/have*" (Affirmative)	She ***does, did, has, had*** set the table.
	They ***do, did, have, had*** set the table.
Modals (Affirmative)	I ***can, may, must*** set the table.
Negation	
Modal + Negative	Joe ***can't, won't, mustn't*** set the table.
Auxiliary "*do/have*" + Negative	She ***doesn't, didn't, hasn't, hadn't*** set the table.
Agreement	I/we/you/he/she/it/they…
Copula "*be*"	…***am, are, is, was, were***, hungry.
Auxiliary "*be*"	…***am, are, is, was, were***, skiing.
Third Person Singular	Joe fix***es*** the house.

Complementizers	Examples
Complementizers	We know ***if, that, whether***, you are here.
Auxiliary Inversion	***Is*** Joe __ setting the table?
	Will, Can Joe __ set the table?
Wh-movement+NP+VP	***Which*** table will Joe_ set _ ?
	Who, what, where, when, why, how is Joe __ V+ "-ing"__ ?
Indirect Question	I wonder ***what*** Joe will do __ .

APPENDIX B

LanguageLinks Modules and Levels (Wilson, 2008)

Level 1 Module	Examples
1. Gender with Genitive‘s	Girl’s Noun/Boy’s Noun
2. Regular Noun Singular/Plural	Noun/Nouns (Singular/Plural)
3. Determiner ‘No’	With/With No
4. Accusative 1st & 2nd Person Singular	Me/You
5. Noun/Verb Agreement Copular ‘Be’	Is/Are
6. Nominative 3rd Person Gender	He/She

Level 2 Module	Examples
1. Negation	Is/Is Not
2. Nominative 3rd Person Number/Gender	He/She/They
3. Accusative 3rd Person Number/Gender	Him/Her/Them
4. Locative Pronominals	Here/There
5. Auxiliary ‘Be’/Regular Past -ed	Is Verb+(-ing)/Verb+(-ed)
6. Prenominal Determiners Singular	This/That

Level 3 Module	Examples
1. Prenominal Determiners Plural	These/Those
2. Pronominal Possessive 1st & 2nd Person Singular	My/Your
3. Accusative 1st Person Singular/Plural	Me/Us
4. Nominative 1st & 2nd Person Singular	I/You
5. Noun/Verb Agreement Auxiliary ‘Be’	Is Verb+(-ing)/Are Verb+(-ing)
6. Nominative 1st Person Singular/Plural	I/We

Level 4 Module	Examples

1. Negation	Does/Does Not
2. Accusative 1st Person Plural & 2nd Person	Us/You
3. Pronominal Possessive 1st Person Singular/Plural	My/Our
4. Nominative 1st Person Plural & 2nd Person	We/You
5. Pronominal Possessive 1st Plural & 2nd Person	Our/Your
6. Noun/Verb Agreement 3rd Person Singular/Plural	Has/Have

Level 5 Module	Examples
1. Pronominal Possessive 3rd Person Number/Gender	His/Her/Their
2. Future Modal Will/Auxiliary 'Be'/Regular Past -ed	Will Verb/Is V+(-ing)/V+(-ed)
3. Independent Possessive 1st & 2nd Person Singular	Mine/Yours
4. Independent Possessive 1st Singular/Plural	Mine/Ours
5. Independent Possessive 1st & 2nd Person Plural	Ours/Yours
6. Noun/Verb Agreement 3rd Person Singular/Plural	Noun Verbs/Nouns Verb (Agr)

Level 6 Module	Examples
1. Independent Possessive 3rd Person Number/Gender	His/Hers/Theirs
2. Anaphors Singular Masculine	Himself/Other DP
3. Anaphors Singular Feminine	Herself/Other DP
4. Anaphors Plural	Themselves/Other DP
5. Genitive 's	Boy Noun/Boy's Noun
6. Present Passive	Is Verb+(-ed) By (Passive)

APPENDIX C

Teacher Script

Step 1: Make sure that the computer is at the log in screen.

Step 2: Type the following:

User Name: Laureate

Password: laureate

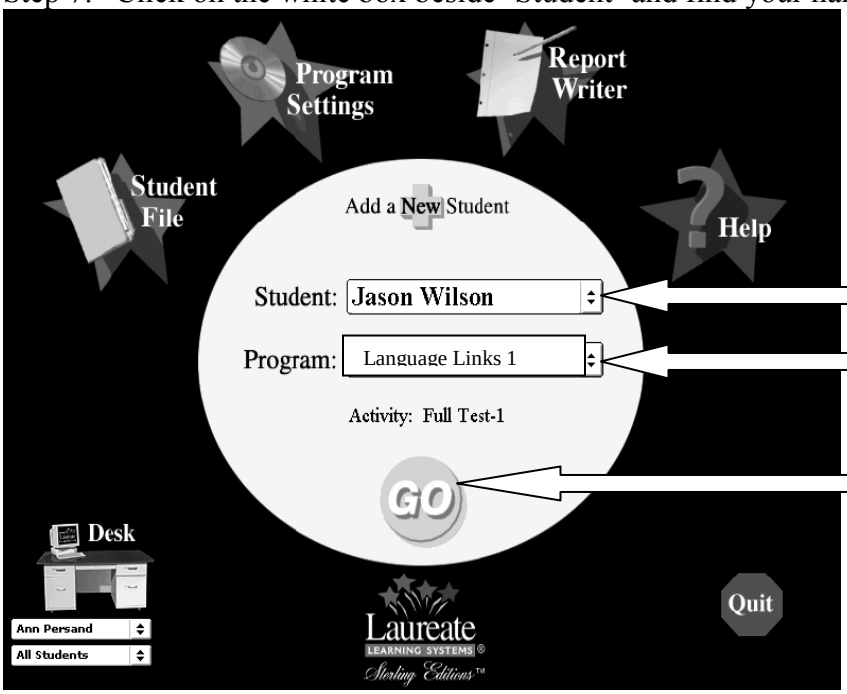
Step 3: Go to ‘Start’ in the bottom left hand corner and click on it OR click the ‘Laureate Sterling Administration System’ icon and skip to Step 5

Step 4: Go up to ‘Programs’ and choose ‘Laureate Sterling Administration System’

Step 5: When the ‘Log on Educator’ comes up make sure ‘Joanna’ is on the screen and click ‘Continue’

Step 6: Ask the student(s) to “Sit down at the computer.”

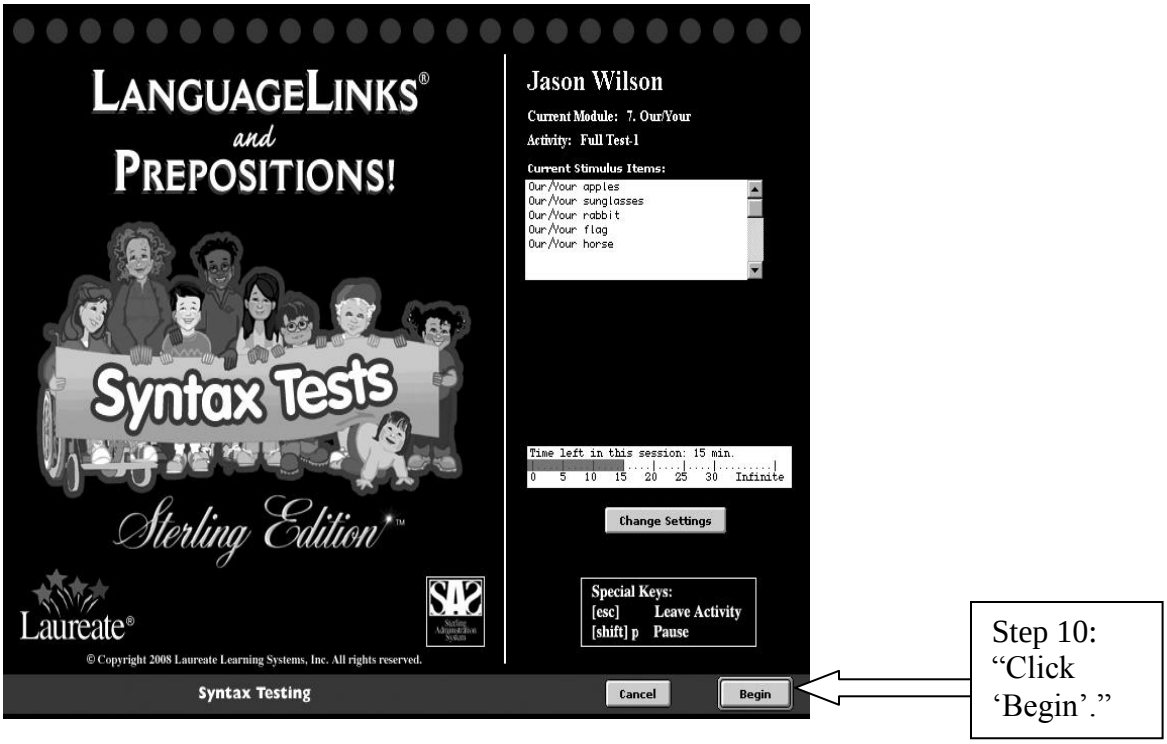
Step 7: “Click on the white box beside ‘Student’ and find your name.”



Step 8: “Click on the white box beside Program and find your level.” Levels for each day are listed on the weekly checklist attached to the teacher clipboards. These will change as the student progresses through the program.

Step 9: “Click on the green circle that says ‘GO’.”

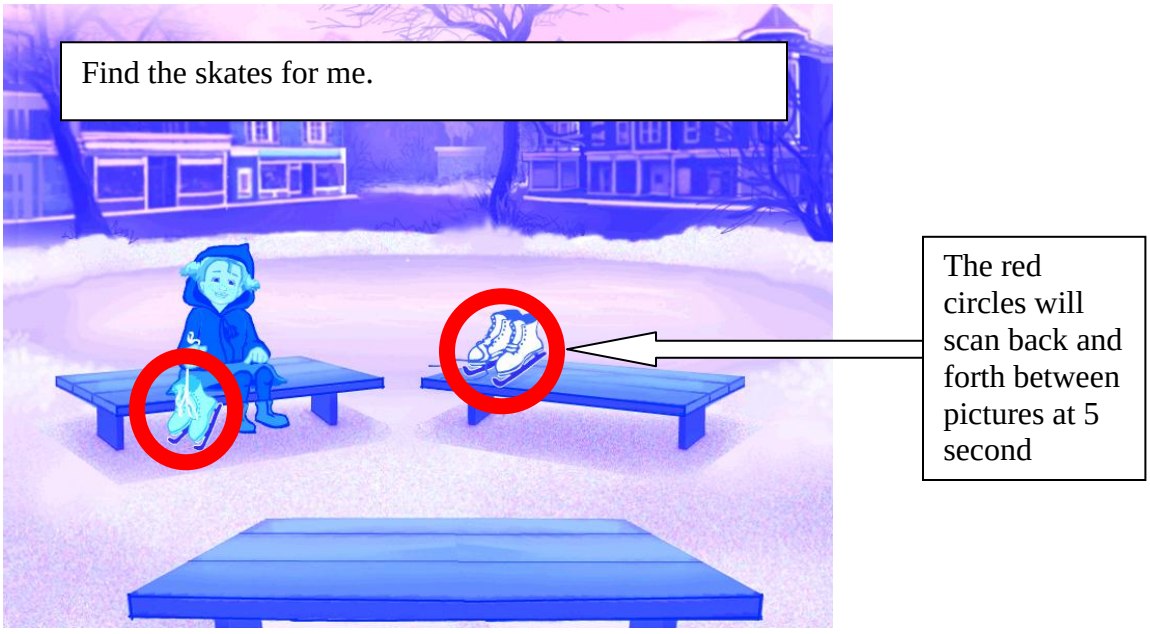
Step 10: “Click on ‘Begin’ in the bottom right hand corner.”



Step 11: At this time the teacher should set and begin the timer for 10 minutes and display it in an area that the students can see it.

Step 12: Tell the students “You will see a picture on the screen followed by a sentence. Read the sentence and look at the picture. Do not touch the keyboard.”

Step 13: “When you see the red outline on the picture that matches the sentence on the screen touch the space bar.”



Step 14: When you see a black screen with 2 pictures and a yellow arrow this means the module or level is complete. Tell the student to “Press the ‘ESC’ key and on the next screen click ‘OK’ in the bottom right hand corner of the screen. Look at the timer, if you still have time left choose the correct level and click ‘GO’ again. If the timer is finished then you will be allowed to continue where you stopped tomorrow.”

Comments:

APPENDIX D

Problem Sheet for Teachers

Please write date and any problems/concerns/comments below and I will check the list daily when I update the weekly checklists. Also please contact me at jcannon3@gsu.edu or 770-722-8632 if you have any problems that I may be able to solve by email or over the phone:

APPENDIX E

Weekly Checklists

Week 1 Teacher #__	Monday 9/21	Tuesday 9/22	Wednesday 9/23	Thursday 9/24	Friday 9/25
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___

Week 2 Teacher #__	Monday 9/28	Tuesday 9/29	Wednesday 9/30	Thursday 10/1	Friday 10/2
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___
Participant #	Level ___	Level ___	Level ___	Level ___	Level ___

- Intervention Time Daily: _____
- Please place an X beside the student's name everyday when they complete their 10 minutes on the computer.
- Please place an A beside each student's name if they are absent that day.
- I will add the level the students are supposed to work on for each day as I check them throughout the week.

APPENDIX F

CWG Scoresheet

Examiner: _____

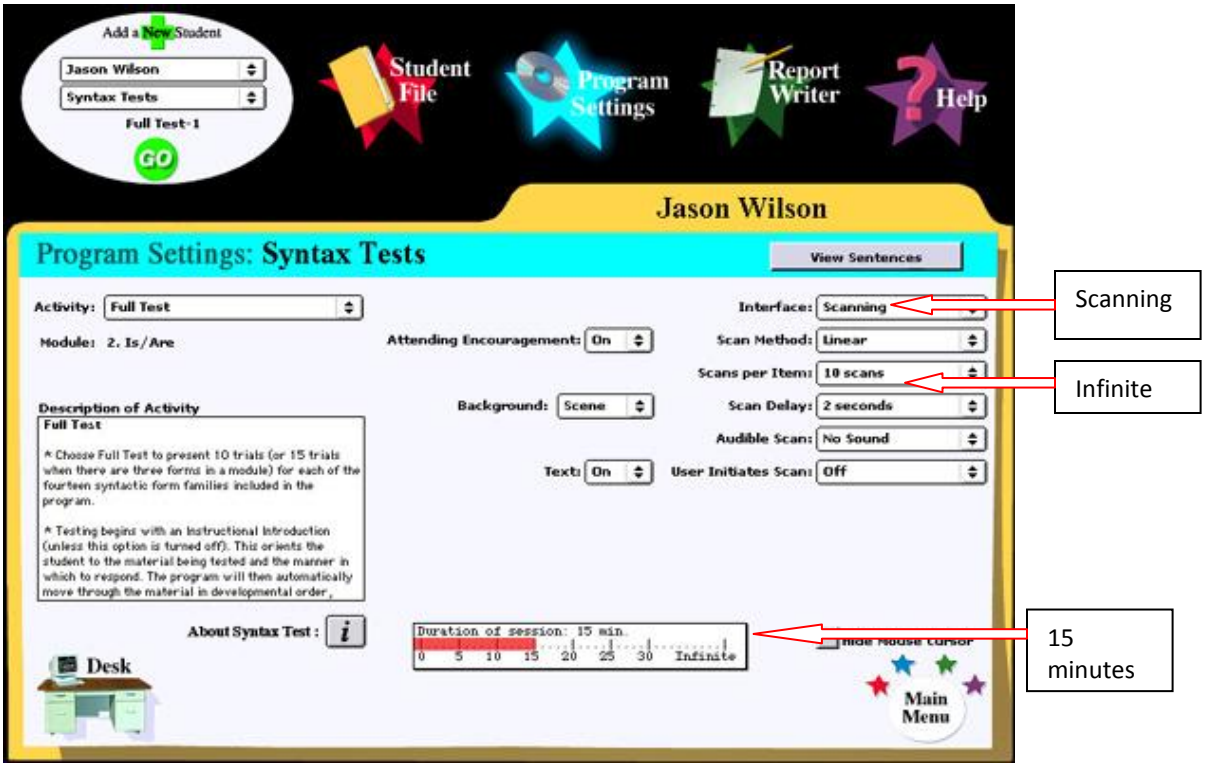
Student Name: _____ Date:_____

1	A Bird flies.	1	2	3	✓	—
2	The girl licks the lollipop.	1	2	3	✓	—
3	The man is tall.	1	2	3	✓	—
4	The dog is under the table.	1	2	3	✓	—
5	Lunch time is now.	1	2	3	✓	—
6	Mother drives the car fast.	1	2	3	✓	—
7	The man is a dentist.	1	2	3	✓	—
8	The book is for the man.	1	2	3	✓	—
9	The rabbit jumped.	1	2	3	✓	—
10	The baby is crying.	1	2	3	✓	—
11	The boys are running.	1	2	3	✓	—
12	The girls have candy.	1	2	3	✓	—
13	The boat will sink.	1	2	3	✓	—
14	The girl has no friends.	1	2	3	✓	—
15	The woman is not happy.	1	2	3	✓	—

Score /15

APPENDIX G

Program Settings Screen Shot from *LanguageLinks* Software Program



APPENDIX H

Procedural Fidelity Checklist

_____ Step 1: Make sure that the computer is at the log in screen.

_____ Step 2: Type the following:

User Name: Laureate

Password: laureate

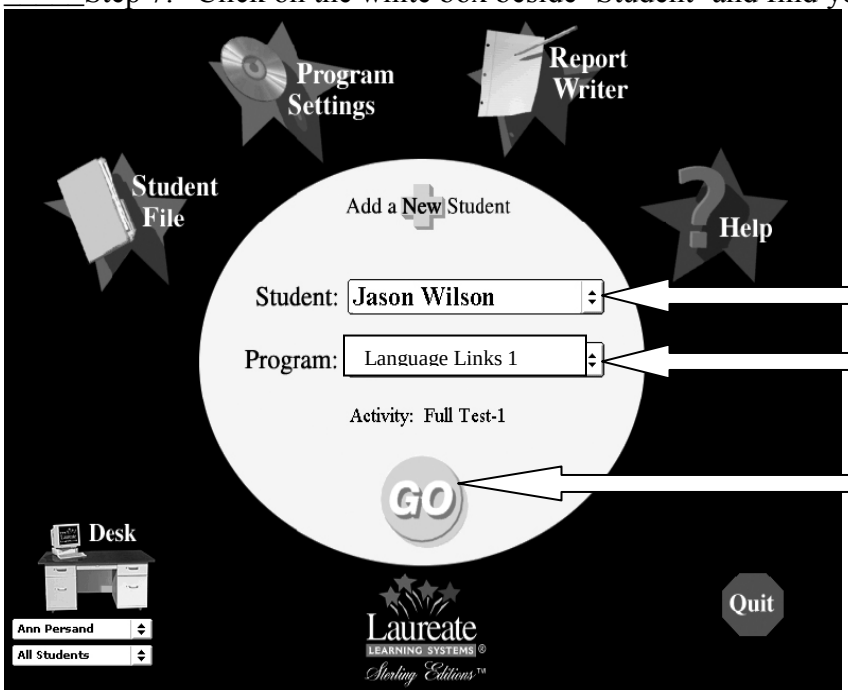
_____ Step 3: Go to ‘Start’ in the bottom left hand corner and click on it OR click the ‘Laureate Sterling Administration System’ icon and skip to Step 5

_____ Step 4: Go up to ‘Programs’ and choose ‘Laureate Sterling Administration System’

_____ Step 5: When the ‘Log on Educator’ comes up make sure ‘Joanna’ is on the screen and click ‘Continue’

_____ Step 6: Ask the student(s) to “Sit down at the computer.”

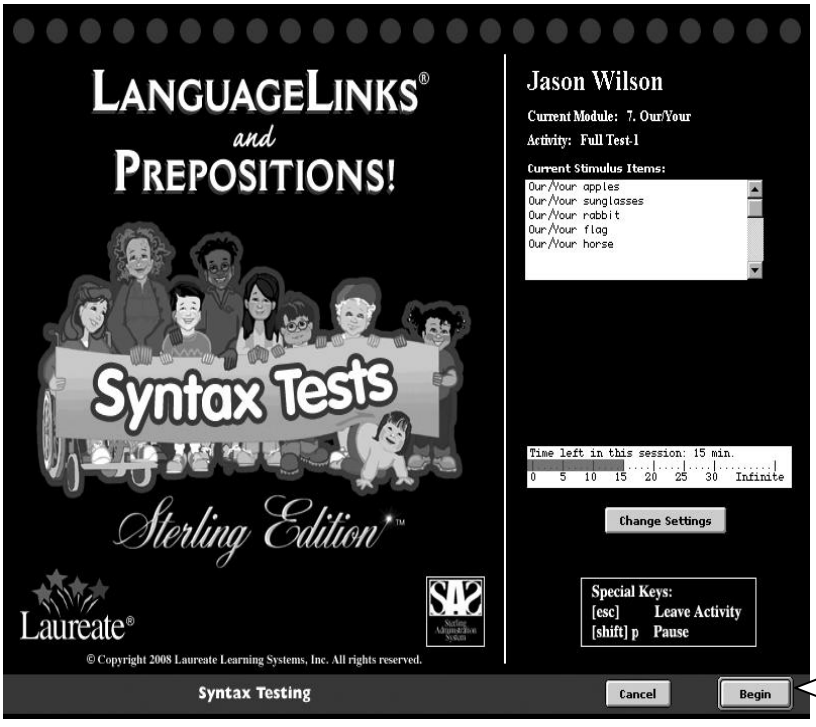
_____Step 7: “Click on the white box beside ‘Student’ and find your name.”



_____ Step 8: “Click on the white box beside Program and find your level.” Levels for each day are listed on the weekly checklist attached to the teacher clipboards. These will change as the student progresses through the program.

_____ Step 9: “Click on the green circle that says ‘GO’.”

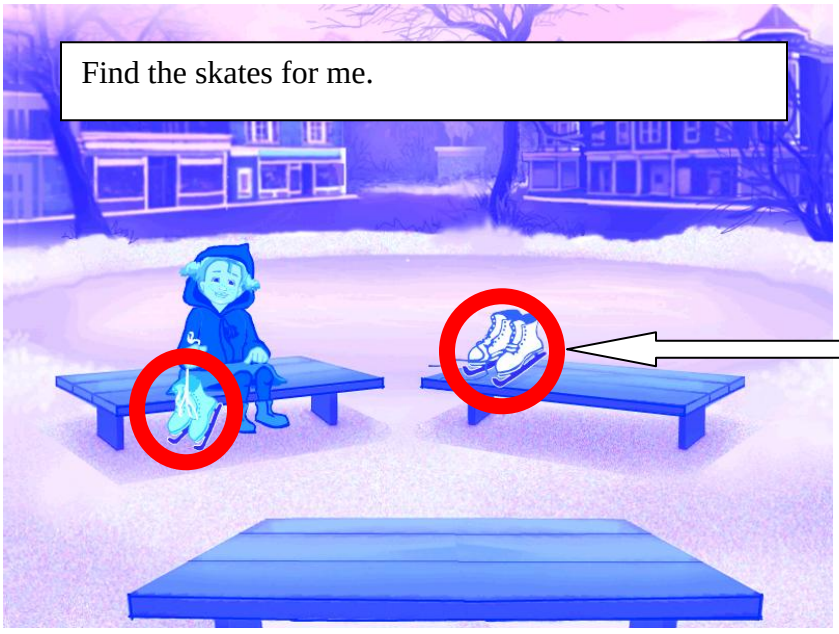
_____ Step 10: “Click on ‘Begin’ in the bottom right hand corner.”



_____ Step 11: At this time the teacher should set and begin the timer for 10 minutes and display it in an area that the students can see it.

_____ Step 12: Tell the students "You will see a picture on the screen followed by a sentence. Read the sentence and look at the picture. Do not touch the keyboard."

_____ Step 13: "When you see the red outline on the picture that matches the sentence on the screen touch the space bar."



_____ Step 14: When you see a black screen with 2 pictures and a yellow arrow this means the module or level is complete. Tell the student to “Press the ‘ESC’ key and on the next screen click ‘OK’ in the bottom right hand corner of the screen. Look at the timer, if you still have time left choose the correct level and click ‘GO’ again. If the timer is finished then you will be allowed to continue where you stopped tomorrow.”

Comments:

APPENDIX I

Teacher Social Validity Questionnaire

1. Did you find the intervention easy or hard to implement? If hard, why?

2. How did the students react to the procedure? (Circle one and explain)

Positively Neutral Negatively

3. Do you plan to use the intervention now that the study is over? If no, why not?

4. How motivating did you think this task was relative to other direct instruction of language skills you have used in the past? (Circle one and explain)

Better Same Worse

5. Do you view the results as worth replicating in other classrooms?

APPENDIX J

Participant Social Validity Questionnaire

Please read or listen to each sentence carefully. Circle the number that best fits your opinion.

1 Strongly Agree 2= Agree 3 = Unsure 4 = Disagree 5 = Strongly Disagree

					
1. I enjoyed using *LanguageLinks.*	1	2	3	4	5
2. I learned a lot using *LanguageLinks.*	1	2	3	4	5
3. *LanguageLinks* was fun.	1	2	3	4	5
4. I make fewer mistakes writing now.	1	2	3	4	5
5. I would use *LanguageLinks* at home.	1	2	3	4	5
6. I would recommend *LanguageLinks* to a friend.	1	2	3	4	5

APPENDIX K

Permission for Screen Shots

To Whom it May Concern,
Laureate Learning Systems grants permission for Joanna E. Cannon to use screen shots from its copyrighted software program *LanguageLinks®: Syntax Assessment & Intervention* in her Georgia State University dissertation.

Sincerely,

Mary Sweig Wilson, Ph.D. (CCC-SLP)
President & CEO

Special Needs Software

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