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Automated Identification of Adverbial Clauses
in Child Language Samples

Brittany Cheree Brown

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of
Master of Science

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ABSTRACT

Automated Identification of Adverbial Clauses in Child Language Samples

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Adverbial clauses are grammatical constructions that are of relevance in both typical language development and impaired language development. In recent years, computer software has been used to assist in the automated analysis of clinical language samples. This software has attempted to accurately identify adverbial clauses with limited success. The present study investigated the accuracy of software for the automated identification of adverbial clauses. Two separate collections of language samples were used. One collection included 10 children with language impairment, with ages ranging from 7;6 to 11;1 (years;months), 10 age-matched peers, and 10 language-matched peers. A second collection contained 30 children ranging from 2;6 to 7;11 in age, with none considered to have language or speech impairments.

Language sample utterances were manually coded for the presence of adverbial clauses (both finite and non-finite). Samples were then automatically tagged using the computer software. Results were tabulated and compared for accuracy. ANOVA revealed differences in frequencies of *so*-adverbial clauses whereas ANACOVA revealed differences in frequencies of both types of finite adverbial clauses. None of the structures were significantly correlated with age; however, frequencies of both types of finite adverbial clauses were correlated with mean length of utterance. Kappa levels revealed that agreement between manual and automated coding was high on both types of finite adverbial clauses.

Keywords: adverbial clauses, automated identification, language impairment, language samples

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Table of Contents

Introduction.....	1
Development of Adverbials.....	3
Adverbial Clauses in Children with Language Impairment	6
Clinical Language Samples.....	8
Language Sample Analysis Software Programs.....	8
Purpose of Study.....	9
Method	10
Participants.....	10
Procedure	11
Results.....	12
Reno Samples.....	12
Provo Sample	15
Discussion.....	20
References.....	25
Annotated Bibliography.....	30

List of Tables

Table	Page
1. Descriptive statistics for the Reno Samples.....	14
2. Summary statistics for the Reno samples	15
3. Descriptive statistics for the Provo samples	16
4. Partial correlations between grammatical structures and age.....	17
5. Partial correlations between grammatical structures and MLU.....	18
6. Kappa levels for the Reno and Provo groups.....	18
7. Sensitivity and Specificity percentage rates for the automated analysis	19

List of Appendixes

Appendix A: Annotated Bibliography 30

Description of Structure and Content

The body of this thesis is written as a manuscript suitable for submission to a peer-reviewed journal in speech-language pathology. An annotated bibliography is presented in Appendix A.

Introduction

One of the most interesting and important aspects of language acquisition is the child's development of the ability to produce and understand complex sentences of various kinds. In becoming able to convey ideas using complex sentences, the child becomes able to communicate sophisticated ideas and messages for which syntactically simple constructions may be inadequate (Limber, 1971). One grammatical construction used to accomplish this linguistic expansion is the adverbial clause. According to Wells (1985), the median age of emergence of adverbial clauses is 3;6 (years;months). Children progress from first using single word adverbials such as *I went to the movie **yesterday*** to prepositional phrase adverbials such as *I went to the movie **on Friday*** and finally to adverbial clauses, as in the clause *I went shopping **to buy groceries***.

Adverbials are a significant part of a child's language, adding variety to utterances while allowing the child to use language to describe elements of time, location, reason, and manner. Through the use of adverbial clauses, children can express these elements with even more detail, building more meaningful conversations. The use of adverbial clauses also helps children express the complex idea of cause and effect relationships. For example, in the sentence, *John came to **BYU to get a master's degree***, the adverbial clause allows the speaker to more clearly identify the nature of the events, rather than simply knowing that two events both occurred.

For many children, the acquisition of complex sentences comes naturally and effortlessly, but children with language impairment (LI) have difficulty understanding and producing complex sentences (Scott, 1988). Children with LI thus use fewer adverbial clauses than children with typical language (Marinellie, 2004). When children with LI do use adverbial clauses, they are often simple or grammatically incorrect (Diessel, 2004).

Clinical language samples are often used to assess a child's language complexity, including the use of adverbial clauses. Complex structures, however, such as adverbials, do not show up frequently in conversational child language samples, but when present, provide valuable information about the child's language abilities. Children with LI use less-extensive language and are even less likely to show their use of adverbials in clinical language samples that contain few utterances. However, many clinicians do not conduct complete analyses of language samples because of the complexity and time involved in performing language sample analysis by hand (Long, 2001). Reliable software that would allow automated identification of a child's language abilities without having to spend time analyzing and rechecking samples by hand could be of clinical value.

Grammatical constructions such as adverbial clauses are of importance both in typical language development (O'Grady, 1997) and development in children with language impairment (Diessel, 2004). However, these constructions are rather sparse even in spontaneous language samples produced by typically developing children (Diessel, 2004), and even when present are not likely to be analyzed because of the lengthy nature of language sample analysis by hand. Because of this relevance, published techniques for the clinical analysis of language samples generally include adverbial clauses, yet computer software for the automated identification of adverbial clauses in clinical language samples has had limited success. In completing these analyses, the present study aims to extend knowledge regarding the development and clinical use of adverbial clauses as well as the automated identification of these clauses.

Development of Adverbials

In order to study the identification of adverbial clauses, it is necessary to understand what adverbial clauses are. It is also necessary to understand their development in typically developing children and children with language impairment. This brief overview will focus on these issues.

Overview of adverbial clauses. Groups of words that modify a verb can be considered adverbial constructions. In an adverbial clause, the entire clause functions as an adverb (Hartmann & Stork, 1972). A clause contains a subject defining who or what is completing the action and a predicate containing the verb (Mitamura & Nyberg, 1995). The subject in an adverbial clause can either be explicit, as in the sentence *I saw my teacher when I went to school*, or implied in a sentence containing an infinitive adverbial clause such as *She yelled loudly in order to get attention*. Most adverbial clauses can be recognized by the word or phrase before them such as *when* or *so that*. These words or phrases are called subordinating conjunctions and come in a variety of forms, including *after, as, because, before, if, in order, like, since, though, unless, where, and whether* (Diessel, 2001). The most commonly used adverbial clause subordinating conjunctions in conversation are the words *after, because, before, if, when, and whenever* (Chafe, 1984). In non-finite adverbial clauses, quite often parts of the clause are elliptically removed. For example, in the utterance *He opened the chest **to look for the picture***, the portion *to look for the picture* could be interpreted as *so that he could look for the picture*.

Adverbial clauses typically occur in the initial or final position of sentences (Diessel, 2001) and can appear in both finite and non-finite forms. Finite adverbial clauses are those in which the verb phrases have tense, for example in the clause *Tom chased Jerry **so he could catch him***. The verb *chased* indicated that the event took place in the past. Finite forms of adverbial clauses contain subordinating conjunctions which indicate time, place, reason, manner,

condition, and concession (Scott, 1988). Non-finite adverbial clauses rarely contain these subordinating conjunctions and are thus more difficult to recognize. In non-finite adverbial clauses the verb phrases have no tense and can be infinitives or past or present participle phrases (Vespoor & Sauter, 2000). Participle clauses have two forms: present participle forms including those with *-ing* participles, for example, *Watching television, she heard the door open*, and those with *-ed* participles, as in *Tired from dancing, she sat on a bench* (Huddleston, 1984).

Infinitives can function as adverbials of reason or purpose, for example *She searched the house to find her earring*. Generally, sentences containing infinitive adverbial clauses will contain the word *to* or *in order to* and will answer the question *why*. A number of studies have been done about infinitive verbs; most recognized is the work done by Rice & Wexler (1995) looking at specific language impairment as a period of extended optional infinitive. Rice and Wexler's extended optional infinitive model was based on the finding that children with specific language impairment used nonfinite forms of lexical verbs or omitted *BE* and *DO* more frequently than children who were chronological age equivalent and mean length of utterance (MLU) matched groups. At the same time, when the children with specific language impairment marked finiteness, they did so appropriately. Rice and Wexler found that children with specific language impairment did not seem to know that tense-marking was obligatory in a main clause as evidenced in two ways: they produced a higher proportion of nonfinite matrix clauses than expected for their MLU levels, and they persisted in producing nonfinite matrix clauses to an older age than did typically developing children.

Age of emergence. According to experimental studies, many children six to eight years old do not fully understand certain types of adverbial clauses. However, observational studies state that children as young as 3;0 are able to use a wide variety of adverbial clauses

appropriately. Varying studies disagree on the age of emergence. Wells (1985) stated that the median age of emergence is 3;5. Similarly, Tyack and Gottslesben (1986) argued that such clauses are not typically produced until the child reaches an MLU of 4.0. Further, O'Grady (1997) stated that development of adverbial clauses continues until after age 6;0. Studies do agree that finite adverbial clauses are the first forms to appear, followed by non-finite forms. Finite adverbial clause are found more frequently in speech than writing until age 10;0 while non-finite forms occur less often overall, but are more common in writing than speech (Fletcher & Garman, 1986).

Adverbials initially appear in a child's language around 2;0. The first adverbials to typically appear are adverbs of contrast, for example, *already* and *still*. These are followed by adverbs indicating times such as *today* and *tomorrow* (Weist & Bucowska, 1987). By age 3;0, children begin using prepositional phrase adverbials such as *in a second* (Weist, 2002). The progression of adverbials thus goes in this sequence of single word adverbs, prepositional phrase adverbials, and lastly adverbial clauses.

The mastery of complex sentences marks the last stage of linguistic development (Leopold, 1939-1949). Adverbial clauses appear as complex sentences begin to develop in a child's language. During the second half of the third year, children will use a variety of adverbial conjunctions, mostly in the form of *so*, *if*, *because*, and *when* with some uses of *before* and *after*. Children use these subordinators to form adverbial clauses (Diessel, 2004). While learning to use complex language including adverbial clauses, children will first use simple sentences containing an adverb, next sentences containing a single preposition and no embedding. While other complex language forms appear such as the complement and relative clauses, children begin expanding their utterances and adverbial clauses arise through the integration of two

grammatically independent sentences (Diessel, 2004). For example, the two sentences *I want mashed potatoes* and *They are my favorite* become *I want mashed potatoes because they are my favorite*. As previously mentioned, children begin to comprehend the concepts of time, location, reason and manner before indicating them in conjunctions (Eisenberg, 1980).

Adverbial Clauses in Children with Language Impairment

In comparison to typically developing children, children with LI have difficulty comprehending and producing complex syntax (Scott, 1988). Sentence complexity is one of the key elements in determining the presence of language impairment (He, Brown, Covington, & Naci, 2004). Children with LI may have delayed appearance of complex syntactic forms, including adverbial clauses, a less frequent use of complex syntax or smaller range of forms, and may use grammatically inaccurate complex syntactic forms. According to Kent (2004), school-aged children with language disorders use shorter and simpler utterances in conversational speech to relay the same information as their typically developing peers. The utterances used by children with LI may be free of grammatical errors but will likely not contain all of the elements to link ideas. Due to this lack of complexity, children with LI often exhibit a low MLU (Eisenberg, Fersko, & Lundgren, 2001).

Marinellie (2004) stated that the language of children with LI includes fewer adverbial clauses and other elements of complex language than children with typical language. He went on to say that children with typically developing language demonstrate a quality rather than quantity advantage to children with LI and that children with LI use fewer adverbial clauses but in similar proportions by clause type. Specifically, clauses of reason were used most by both groups followed by clauses of time. Children with LI have more difficulty with temporal adverbials than

children with typical language. Adverbials of the present are more easily understood by children with LI than adverbials of past or future (Godard & Labelle, 1999).

Fletcher and Peters (1984) studied which aspects of language distinguish children diagnosed with language impairment from those with typical language. Fletcher and Peters collected 200 utterance language samples from nine children with LI with a mean age of 5;2 and 20 age matched children with typically developing language. From analysis of 65 grammatical and lexical categories, the two groups were significantly different in 23 of them, with one of the top ten being adverbial clauses. The results of this study indicated that adverbial clauses are one of the key differences between children with typical language and children with LI.

In addition to Fletcher and Peters (1984), Nippold et al. (2008) studied the differences between production of finite embedded structures between groups of children with and without LI. This study showed no differences in frequency of adverbial clauses in conversational samples of children with and without LI. This contradicted what many previous studies concluded about the production of adverbial clauses when comparing children with and without LI. Thus, further information describing frequency and production of adverbial clauses of children with and without LI would be beneficial.

It should be noted that clinical language researchers differ in regards to whether clauses starting with the conjunction *so* are coordinated or subordinated. Some approaches to language sample analysis, such as the Language Assessment, Remediation and Screening Procedure (LARSP), view *so* as a coordinating conjunction rather than a subordinating conjunction. However, *so* may also introduce clauses explaining the answer to a *why* question, thus acting as an adverbial clause. Thus to differentiate between these different classifications of *so*, the present study will separately tabulate *so*-clauses from other finite adverbial clauses.

Clinical Language Samples

Many times language samples of children are taken in a clinical setting to determine a child's grammatical repertoire and mean length of utterance. "The suggested conventional, contemporary, clinical practice is to calculate it [MLU] from a language sample of a minimum of 50 to 100 contiguous intelligible utterances" (Casby, 2011, p. 286). This often proposes a problem when looking at complex sentences in children, especially children with LI because a short sample will not indicate their full grammatical abilities. Additionally, MLU may not be the best quantitative measure. When speaking of sample size of clinical populations with substantial performance variability, including children with LI, Heilmann, Nockerts, and Miller (2010) stated, "Short language samples, however, may be particularly at risk for poor reliability because the children do not have as many opportunities to demonstrate their range of performance, and the measure will reflect either artificially high or artificially low performance" (p. 393). In regards to MLU, Casby (2011) mentioned that regardless of the sample size, MLU does not have the same informative data as some form of descriptive content analysis such as examination of verb phrases, noun phrases, subjects, predicates, inflectional morphology, pronouns, determiners, prepositions and other forms of complex grammatical structures. This information indicates that use of longer samples, as well as an alternate way of analyzing children's complex grammatical structures, particularly adverbial clauses may be needed.

Language Sample Analysis Software Programs

Several computer software programs are available for transcribing, analyzing, searching and quantifying data from language transcripts. None of these, however, have shown high accuracy in automatically identifying adverbial clauses in language samples. Long and Channell's (2001) study yielded only 15% accuracy in agreement between manual coding and

automated analysis on LARSP's subordinate clause level of analysis using CP, the level which includes adverbial clauses. Clark's (2009) study yielded 87% accuracy in agreement between manual coding and automated analysis using the CX computer program which uses probabilities extracted from other samples to grammatically code structures such as adverbial clauses.

However, this study did not include non-finite adverbial clauses in its analysis. Clearly, improvement in automated recognition of structures such as adverbial clauses is necessary for any clinical or research application.

Improvement of automated parsing might be possible by using recently developed and available tools such as the Stanford parser (Klein & Manning, 2003). The Stanford parser uses a probabilistic context-free grammar model to create an analysis of syntactic structure. This parser does not directly label constituents such as adverbial clauses, which would be useful in speech-language pathology for comparing children's utterance productions to developmental data. Therefore, if the output of the Stanford could be interpreted by another program which identified constructions such as adverbial clauses in this output, perhaps substantial improvement in accuracy could be obtained. This would also provide enhanced clinical utility of automated analysis of clinical language samples.

Purpose of Study

Adverbial clauses are important developmentally and offer insight into the language abilities of children with LI. To date, however, software has been ineffective in analyzing clinical samples of children's language for adverbial clauses. Thus software which claims to identify utterances containing adverbial clauses might be beneficial to clinicians if it can be shown to be effective. The current research project compared the use of several varieties of adverbial clauses, including finite adverbial clauses, *so*-adverbial clauses, and non-finite

infinitive adverbial clauses in samples of typically developing children and in samples of children with language impairment to determine how the structures differ among the groups and how these structures correlate with age and MLU. This study also examined the accuracy with which adverbial clause varieties could be identified in children's samples using automated computer software.

Method

Participants

Two separate collections of language samples were used in the present study. Both the Reno samples and the Provo samples were gathered for previous studies and were used in this study.

Reno samples. A total of 30 child language samples were collected by Fujiki, Brinton, and Sonnenberg (1990) for a study of conversational repairs. The samples were collected in the Reno, Nevada area. Included in the study were ten children with LI, ten children matched by chronological age (CA), and ten children matched by language age (LA). Each group contained five males and five females. None of the children had a history of hearing, cognitive, neurological, or severe articulation impairment. Children with LI were between the ages of 7;6 and 11;1 and had received language services from a speech-language pathologist since first grade. These children all scored one standard deviation or more below the mean on each of two standardized tests, demonstrating impairments in both comprehension and production. On a measure of nonverbal intelligence, however, they scored within normal limits. The tests given to the children in the group with LI included the Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981) the Test for Auditory Comprehension of Language-Revised (Carrow-Woolfolk, 1985), subtests taken from the Test of Language Development-Primary (Newcomer & Hammill,

1997), and the Clinical Evaluation of Language Functions Screening Test (Semel & Wiig, 1980). Children in the LA matched group, who ranged from 5;6 to 8;4 years, were given the Utah Test of Language Development (Mecham, Jex, & Jones, 1967) and matched by a language age score within six months of the impaired child's language performance. Children in the CA group (7;6-11;2) were within four months of age and attended the same elementary school as their LI match. With only the child and examiner present, thirty minute spontaneous child language samples ranging from 200 to 400 utterances were collected. The samples were elicited using an assortment of toys and games including Viewmaster, a *Guess Who* game, transformer toys, and a magic kit. Familiar topics such as favorite movies and vacations were also used to stimulate conversation.

Provo samples. The Provo samples were gathered by Barber (1989), Chamberlain (1989), and Taylor (1989) as part of three separate thesis studies. The children ranged from 2;6 to 7;11 in age, and none were considered to have language or speech impairments. All children lived in the Wymount student housing complex at Brigham Young University in Provo, Utah. Three children from each six month age interval were randomly selected from a pool of volunteers. Each child passed a hearing screening. A language sample of at least 200 child utterances was collected from each child participant, and generally only the child and the examiner were present during the sample collection. The first ten minutes of each sample were considered to be a warm-up period and were not transcribed.

Procedure

Manual coding. Transcripts of the child language samples were analyzed and manually coded for adverbial clauses. The Reno and Provo samples were coded for adverbial clauses by the author. Adverbial clauses were divided into three subcategories for tabulation: (a) finite

adverbial clauses, (b) finite *so* adverbial clauses (adverbial clauses starting with the word *so*), and (c) non-finite infinitive adverbial clauses (non-finite forms are those in which the verb form is not limited and not fully inflected by categories such as tense, mood, and gender, or adverbial clauses starting with *in order to*).

Interrater reliability of the manually coded files was calculated by having a second clinician independently code the structures of interest in 20% of the samples. The number of classification agreements was divided by the total number of classification judgments. Using this formula, interrater reliability was found to be 93%.

Computer analysis. Following manual analysis, each sample was prepared for automated analysis using a utility program which removed details such as speaker codes, utterances not produced by the target child, parenthetical material and manual codes. The prepared files were then grammatically analyzed by the Stanford parser (Klein & Manning, 2003). The Stanford parser is a probabilistic context-free grammar parser which uses grammatical data extracted from training corpora to isolate the grammatical constituents of sentences. The Stanford parser output was then analyzed for utterances containing targeted varieties of adverbial clauses using software which was written as part of the current study and called *cxs*. The *cxs* software finds patterns in the Stanford parser output. The output from the *cxs* program's analysis was then compared to the manual coding of the various adverbial clause varieties in each utterance of the sample.

Data analysis. The data from comparing the manual and automated analysis of each noun clause type in each child utterance were assigned four possibilities including, true positives, false rejections, correct rejections, and false positives. True positives were the number of utterances that were agreed upon as containing an adverbial clause by both the computer and

manual analysis. False rejections were the utterances which were shown to contain an adverbial clause by manual coding but were not identified (i.e., missed) by computer analysis. Correct rejections were when neither manual nor computer analysis found an adverbial clause in an utterance. False positives were when an utterance is identified by the computer as containing an adverbial clause but not by manual analysis.

Cohen's Kappa levels were calculated for each group of participants to quantify manual to computer agreement while controlling for the possibility of chance agreement. An alpha level of $p < .05$ was used for all statistical comparisons.

Results

Reno Samples

Table 1 shows the frequency of occurrence of each type of adverbial clause structure for each child in the three Reno groups. It may be seen in Table 1 that children varied greatly in terms of the number of utterances and number of occurrences of each adverbial clause structure produced. Additionally, it can be seen that finite adverbial clauses were the variety of adverbial clauses most commonly produced by these children. Most of the *so*-adverbial clauses and infinitive adverbial clauses were produced by the CA-matched children. Children in this group also produced the highest numbers (12) and (9) of *so*-adverbial and infinitive adverbial clauses, respectively.

Table 2 shows a summary of the descriptive statistics for the Reno samples, organized by the type of adverbial clause structure. It can be seen in Table 2 that the standard deviations were higher than the means in over half of the groups, suggesting that the mean was not a highly reliable indicator of group performance. In order to compare the frequencies of adverbial clause types among the three groups, a one-way ANOVA was used. This ANOVA showed that the

Table 1

Descriptive statistics for the Reno Samples, including age in months, number of utterances and number of finite adverbial clauses (FAC), so-adverbial clauses (SAC), and infinitive adverbial clauses (IAC)

Child	Age	N Utt.	FAC	SAC	IAC
RLI 1	111	188	9	0	1
RLI 2	90	376	22	1	1
RLI 3	111	123	2	0	0
RLI 4	104	251	9	4	7
RLI 5	104	392	14	0	0
RLI 6	113	301	28	2	3
RLI 7	119	533	26	3	4
RLI 8	133	401	8	4	5
RLI 9	104	198	2	0	0
RLI 10	109	190	0	0	2
RLA 1	91	269	10	0	1
RLA 2	88	180	7	1	1
RLA 3	95	261	31	3	3
RLA 4	66	261	20	1	0
RLA 5	82	219	4	2	2
RLA 6	100	425	38	8	1
RLA 7	69	274	11	4	1
RLA 8	77	259	16	0	1
RLA 9	83	446	7	1	1
RLA 10	84	318	32	3	3
RCA 1	90	375	27	8	3
RCA 2	108	321	20	9	8
RCA 3	106	360	26	0	0
RCA 4	100	404	11	6	2
RCA 5	122	264	21	9	0
RCA 6	110	423	36	12	5
RCA 7	106	307	20	0	9
RCA 8	104	370	12	1	0
RCA 9	132	262	12	6	2
RCA 10	110	288	21	4	2

Table 2

Summary Statistics for the Reno Samples, including Means and Standard deviations (in parentheses) of each group for finite adverbial clauses (FAC), so-adverbial clauses (SAC), and infinitive adverbial clauses (IAC)

Group		FAC	SAC	IAC
RLI	<i>M</i>	12.0	1.4	2.3
	<i>SD</i>	10.2	1.7	2.4
RLA	<i>M</i>	17.8	2.3	1.4
	<i>SD</i>	12.4	2.4	1.0
RCA	<i>M</i>	20.6	5.5	3.1
	<i>SD</i>	7.8	4.2	3.3

groups differed significantly on only one type of adverbial clause, the *so*-adverbial clauses.

Because of this significant difference, a posthoc Student-Newman-Keuls analysis was performed. This analysis showed that the RCA group differed from the RLI and RLA groups, which did not differ from each other.

Because the RCA had longer samples sizes in comparison to the other two groups, a larger number of adverbial clauses could be due to the larger number of utterances. Thus, an ANACOVA was performed to compare the three groups while controlling for sample size. With this analysis, the difference of finite adverbial clauses was significant between groups, $F(2, 26) = 4.314$; $p = .024$.

Provo Samples

Table 3 shows the frequency of occurrence for each adverbial clause structure for each child in the Provo group.

Table 3

Descriptive Statistics for the Provo Samples, including age in months, number of utterances and number of finite adverbial clauses (FAC), so-adverbial clauses (SAC), and infinitive adverbial clauses (IAC)

Child	Age	N Utt.	FAC	SAC	IAC
P1	30	190	1	0	0
P2	30	222	5	0	1
P3	33	193	10	0	0
P4	35	222	2	3	1
P5	37	233	3	0	0
P6	39	221	0	0	0
P7	45	238	12	2	3
P8	45	266	26	1	0
P9	46	206	6	0	0
P10	53	218	14	1	0
P11	56	214	27	3	0
P12	59	217	22	1	3
P13	59	259	7	1	0
P14	62	199	2	0	0
P15	62	216	6	3	0
P16	64	234	6	0	0
P17	65	226	11	1	0
P18	65	282	29	2	2
P19	66	230	5	2	0
P20	68	217	13	1	0
P21	69	377	16	2	7
P22	72	226	6	4	0
P23	75	249	8	4	3
P24	77	328	18	11	2
P25	79	225	5	3	3
P26	79	229	8	0	0
P27	84	258	5	0	1
P28	91	222	7	1	1
P29	94	301	41	6	3
P30	95	313	22	4	2

Children from the Provo group, presented in Table 3, varied greatly in numbers of utterances and occurrences of the various adverbial clause structures. Although the table is arranged according to ages of the children, no general pattern can be observed between child age and frequency of adverbial clause structures. Because older children generally produced longer samples, partial correlations were used to determine the relationship between age and frequency of adverbial clause structures, while controlling for the number of utterances. These correlations are presented in Table 4. It can be seen in Table 4 that none of the adverbial clause structures were correlated with age.

Table 4

Partial correlations between frequency of finite adverbial clauses (FAC), so-adverbial clauses (SAC), infinitive adverbial clauses (IAC), and age (with $df=27$; 2-tailed)

	FAC	SAC	IAC
Correlation	0.144	0.255	-0.007
Significance	0.456	0.182	0.971

Because a child's MLU may be a better indicator of syntactic complexity, the relationship between the frequency of adverbial clause structures and MLU was also assessed, while controlling for the number of utterances. Using partial correlations, the obtained values are presented in Table 5. In Table 5 it may be seen that finite adverbial clauses and so-adverbial clauses were significantly correlated with MLU.

Accuracy of Automated Analysis

The Kappa statistic, which relates the number of agreements between automated and manual analysis of both presence and absence of an item to the number of misses and false

Table 5

Partial correlations between frequency of finite adverbial clauses (FAC), so-adverbial clauses (SAC), infinitive adverbial clauses (IAC), and MLU (with $df = 27$; 2-tailed)

	FAC	SAC	IAC
Correlation	0.629	0.375	0.157
Significance	0.000*	0.045*	0.415

* $p < .05$

positives, was used to determine the level of accuracy for automated analyses of adverbial clause structures. The guidelines for Kappa interpretation published by Landis and Koch (1977) rate Kappas from .61 to .81 as *substantial* and .82 to 1.00 as *almost perfect* (Boslaugh & Watters, 2008). Kappa levels are presented in Table 6.

Table 6

Kappa levels for Reno children with language impairment (RLI), language-aged matched (RLA), chronological-aged matched (RCA), and Provo group for finite adverbial clauses (FAC), so-adverbial clauses (SAC), and infinitive adverbial clauses (IAC)

	FAC	SAC	IAC
RLI	0.865	0.814	0.152
RLA	0.868	0.698	0.314
RCA	0.877	0.822	0.247
Provo	0.868	0.716	0.351

Another indication of the accuracy of automated analyses of complex structures, such as adverbial clause, is by examining the rates of sensitivity and specificity. For the present study,

sensitivity refers to the likelihood that the software would identify the adverbial clause that had been identified through manual analysis. Specificity refers to the likelihood that the computer software would identify an adverbial clause when manual analysis had not. The percentage rates for specificity and sensitivity of the automated analysis are presented in Table 7. Sensitivity and specificity rates averaged 80%.

Table 7

Sensitivity and Specificity percentage rates for the automated analysis of finite adverbial clauses (FAC), so-adverbial clauses (SAC), and infinitive adverbial clauses (IAC) for Reno children with language impairment (RLI), language-aged matched (RLA), chronological-aged matched (RCA), and for the Provo group

	FAC	SAC	IAC
RLI			
Sensitivity	96	79	9
Specificity	99	100	100
RLA			
Sensitivity	94	61	21
Specificity	99	100	100
RCA			
Sensitivity	97	73	16
Specificity	99	99	100
Provo			
Sensitivity	96	66	28
Specificity	99	100	100

Discussion

The present study examined the frequency of three types of adverbial clauses in two sets of language samples and assessed the accuracy of computer software in identifying these structures. Frequencies of adverbial clauses were compared in samples containing children with LI and those of children who were similar either in language test scores or in chronological age. An ANCOVA controlling for sample size showed that the frequencies of finite adverbial clauses between groups differed significantly. The frequencies of the three types of adverbial clauses were correlated with the ages of children in the Provo samples, but none of these frequencies were significantly correlated with age. The frequencies of the three adverbial clause types were then correlated with the MLU levels of this second group of children: both finite and *so*-adverbial clauses were correlated with MLU. The accuracy of the automated recognition of adverbial clauses was high but imperfect both in sensitivity (identifying correctly when an adverbial clause was present in an utterance) and specificity (not falsely concluding that an adverbial clause was present).

When studying differences between children with LI and typically developing children, the findings of the present study extends the findings of Nippold et al. (2008), who found no significant differences in the frequency of adverbial clauses (as well as other finite complex structures) in conversational samples between groups with and without LI. The present study did find differences in the use of finite adverbial clauses and *so*-adverbial clauses, a structure not addressed in the Nippold et al. (2008) study. The chronological-age-matched children used both finite and *so*-adverbial clauses more frequently than did the language-similar and language impaired children. Additionally, the present study extends the findings of the Nippold et al. (2008) study because the present study looked at developmental comparisons, in addition to

group comparisons. Although none of the structures studied were correlated with age, the finding that the finite structures were correlated with MLU suggests that these structures might help distinguish children with language impairment from those without impairment.

The present study's findings that children with a larger MLU tended to use finite adverbial and *so*-adverbial clauses more frequently, even when controlling for sample length, is of interest. This confirms and extends the findings of Clark (2009), who found that the frequency of adverbial clauses was correlated with MLU, both in manually coded and computer software coded language samples. It is important to point out that Clark's (2009) study did not use non-finite forms of adverbial clauses such as the infinitive adverbial clauses and did not separate out the *so*-adverbial clauses, as did the present study. Furthermore, extending the findings as with the Nippold et al. (2008) study, the present study addressed developmental comparisons whereas the other two did not.

The findings of Lee (1974) also have relevance to the current findings. Lee presented a procedure for Developmental Sentence Scoring (DSS), which examined varieties of syntactic constructions, including both finite and non-finite forms. Although Lee presented the DSS as an assessment technique and not necessarily a study of language development and impairment, her placement of the structures used in the present study are of interest. The constructions in the DSS differentiated younger children (ages 2;6-3;0) from older children (ages 6;0-7;0) and were assigned a point value on a 1 to 8 point scale. Utterances the child used were then awarded a number of points based on the syntactic structures they contained, and the average number of points per utterance was termed the Developmental Sentence Score. In the scale Lee developed, finite adverbial clauses and *so*-adverbial clauses were both given 8 points, the highest point value. Thus the present study extends Lee's claim that these two grammatical structures were of

clinical and developmental importance. Lee gave infinitive adverbial clauses a score of 3, under the heading of "non-complementing infinitives," though these structures are rare in children's spontaneous speech and no data were presented to support this decision. Lee was one of few to mention this non-finite structure, thus the interest in the current study to extend findings on a little-studied grammatical structure.

Though the present study gathered data on infinitive adverbial clauses, the frequency of these clauses was not significantly correlated with age or MLU. In addition, the Stanford parser, which had been used as a preparatory program for the cxs software, was of little help in picking out these infinitive adverbial clauses. Perhaps this occurred because two sentences could have nearly the same sequence of grammatical tags but differing grammatical structure. For example, the sentence *I want to buy groceries* contains an infinitive noun clause, whereas the sentence *I went to buy groceries* contains an infinitive adverbial clause. The only difference guiding the computer tagging of these sentences is in the specific verbs present, and this grammatical information is not used by the program. This could be one reason that the sensitivity (identifying correctly when an adverbial clause was present in an utterance) of infinitive adverbial clauses was low. Because the software could not be confident that the sentence contained an infinitive adverbial or an infinitive noun clause, it was conservative in identifying infinitive adverbial clauses. Instead, the software relied on indicators such as a comma or a sentence with the infinitive at the beginning, for example, *To buy groceries, I went to the store.*

Another point of interest is that the constructions studied were all quite sparse and infrequent, even though the developmental language samples all exceeded 190 child utterances. This brings up two issues: (a) whether conversational language samples yield the best data, and (b) whether the use of frequency of structures to separate groups and show age-related trends is

best. Nippold et al. (2008) suggested that expository samples may provide a better profile of a child's language. Infinitive adverbial clauses were especially sparse. Perhaps a situation in which the clinician probed for these structures in order to see if the children could produce them would yield a superior description of language abilities. Setting up an appropriate context might elicit these structures for which spontaneous speech samples, such as the ones used in the present study, did not. A future study might focus on using expository samples or probing for these structures to study the emergence of non-finite and finite grammatical constructions. The second question as to whether raw frequency data yields the best results was studied by Bloom and Lahey (1978). Bloom and Lahey looked at patterns of language development and language impairment and proposed the use of criteria of productivity and emergence, rather than frequency, to understand language development. Bloom and Lahey suggested that if a child used a construction 2 or 3 times in a sample, that the structure was emerging, and if the child used it 4 or more times, the construction was judged as productive. Thus, once the child had used the construction 4 or more times, whether or not they used it more depended on context, relevance, or stylistic choices rather than linguistic development. Future research may focus on re-analyzing the data based on a productivity criterion rather than on frequency counts.

Finally, in relation to the accuracy of automated identification of adverbial clauses in children's conversational language samples, only Clark (2009) specifically gave data on the accuracy of automated analysis. Although the accuracy of that study was quite high, the study used less advanced computer software to analyze its data and did not include non-finite structures in its analysis. Additionally, the findings of high levels of specificity on all three of the structures and the high levels of sensitivity on finite adverbial clauses and *so*-adverbial clauses for identification of adverbial clause varieties in utterances in children's clinical language

samples suggests the further enhancement of the computer software for automated analysis used in the present study. The low levels of sensitivity for infinitive adverbial clauses suggest that further improvement in the automated identification of non-finite structures is necessary. The fluctuation in the Kappa levels for the analysis of the three varieties of adverbial clauses (ranging from .15 to .88 with a mean of .63) also suggests further improvement in the automated identification of adverbial clause structures is necessary before clinical or research use of the software.

Nevertheless, the present study contributes new information regarding differences in the production of adverbial clauses between typically developing children and children with LI. This study also provides information regarding age and MLU-related frequencies of adverbial clauses between these two groups of children. Finally, the present study illustrates the currently obtainable levels of accuracy for the automated identification of adverbial clauses.

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Appendix A: Annotated Bibliography

Bloom, L., & Lahey, M. (1978). *Language development and language disorders*. New York: Wiley.

Purpose: Book which overviews both child language development and child language impairment.

Relevance to current work: Particularly areas in the book that outline a discussion as to what clinical frequency data from language samples means in terms of drawing conclusions regarding a child's abilities for grammatical and semantic constructions. It suggests a criterion for emergence and for the productive use of a grammatical construction which pose implications for the current study.

Casby, W. M. (2011). An examination of the relationship of sample size and mean length of utterance for children with developmental language impairment. *Child Language and Teaching Therapy* 27(3), 286-293.

Purpose: To investigate the relationship between language sample size and resultant MLU with a sample of children with developmental language impairment.

Design: Language samples collected from 10 children with developmental language impairment were gathered from a Child Language Data Exchange System. The language samples consisted of conversational discourse between an adult and a child. Language samples consisting of 100 to 150 total utterances across the children were used. For each sample the MLU was calculated for 10 different sample sizes. These samples consisted of: the total sample, the first 10, first 20, middle 10, middle 20, last 10, last 20 and three quasi-random language samples gathered from the total sample. Prior to the examination and calculation of MLU for the various language samples, interjudge reliability for the calculation of MLU was established between the investigator and two research assistants.

Results: In summary, the results showed no significant differences, as well as strong and statistically significant correlations between MLUs calculated on smaller language samples, and larger language samples for this group of young children with developmental language impairment. This was particularly so for the quasi-random utterance samples.

Conclusions: The results of this research indicate that busy practicing speech-language pathologists and other professionals may well be able to effectively and efficiently obtain an accurate, reliable MLU based on expressive language sample sizes smaller than the traditional and conventional suggestion of 50-100 utterances.

Relevance to current work: This article is relevant to the current work because it illustrates that conventional language sample analysis is a lengthy process for SLPs and suggests alternative, faster methods of language sample analysis as will also be employed in the current study.

Channell, R. W. & Johnson, B. W. (1999) Automated grammatical tagging of child

language samples. *Journal of Speech, Language and Hearing Research*. 42, 727-734.

Purpose: To examine the accuracy with which methods of automated grammatical categorization (tagging) could tag transcribed naturalistic conversational samples of children's spontaneous language.

Design: 30 previously collected conversational language samples of normally developing children interacting with graduate students were used for grammatical tagging using a computer software called GramCats. The language samples were of children ages 2;6 to 7;11 (years;months). Each sample consisted of approximately 200 intelligible utterances. Using a dictionary and probability matrix, GramCats scanned and tagged words in a language sample one utterance at a time. The language samples were manually tagged by the first author. 6 separate probability matrices were generated including frequency data extracted from 25 of the manually tagged samples within the set of 30 samples. One dictionary was created using the words and associated relative tag probabilities derived from adult and child language samples other than the ones used in this study. A utility program carried out a word-by-word comparison of the manually tagged and computer-tagged version of each language sample. The comparison was used to calculate accuracy of computer tagging on a word-by-word basis, on a whole-utterance basis and also to compute an overall percentage of agreement.

Results: Automated grammatical tagging yielded a word-by-word accuracy rates ranging from 92.9% to 94.7%. The obtained levels of computer-tagging accuracy when two or more tag options existed ranged from 84% to 92%.

Conclusions: The quantification of the accuracy of automated language sample analysis programs is a necessary step in the development and evaluation of such software for use by

language researchers. Improvement of automated analyses offer increased potential for clinical use of software to enhance the assessment and treatment process.

Relevance to current work: This article is relevant to the current study because it illustrates earlier use of automated language sample analysis as will be used in the current study.

Clark, C. J. (2009). *Automated identification of adverbial clauses in child language samples*. (Master's thesis). Retrieved from Brigham Young University Electronic Theses & Dissertations Collection.

Purpose: To examine the accuracy of computerized software in automatically identifying finite adverbial clauses.

Design: Two separate collections of language samples were used. One collection included 10 children with language impairment, 10 age-matched peers, and 10 language-matched peers. A second collection contained language from 174 students in first, third, fifth grade and junior college. These language samples were manually coded for finite adverbial clauses by the author. Reliability was found by having a second observer independently code 25% of samples. Both samples were analyzed by the software which used probabilities extracted from other samples to grammatically code structures such as adverbial clauses. Accuracy of the automated analysis was calculated.

Results: There was a high total agreement between manual and software analysis in locating adverbial clauses. Total point-by-point agreement for the first collection of language samples was .987 and for the second collection .985. Analysis of both sets of samples yielded high Kappa values, with an overall Kappa values of .895.

Conclusions: The findings of this study suggested that the computer software used has potential to assist and improve the quality of clinical language assessment. Future computer software capable of quickly and accurately locating complex grammatical structures could aid clinicians in understanding a child's abilities while easing or eliminating some of the costs associated with manual analysis.

Relevance to current work: This master's thesis is relevant to the current study because it suggests implications for developing more precise computer software for automated language sample analysis, as does the current study. It also outlines recent work done with adverbial clauses.

Diessel, H. (2001). The ordering distribution of main and adverbial clauses: A typological study. *Language*, 77, 433-455.

Purpose: To study the ordering distribution of main and adverbial clauses in crosslinguistic perspective.

Design: Analysis was based on a sample of forty languages, which were selected on the basis of two criteria: genetic diversity and geographical distance. These samples were divided into six large areas: (1) North America, (2) South America, (3) Asia, (4) Europe, (5) Africa, and (6) Oceanic, Australia and New Guinea. Samples were analyzed based on an operational criteria developed to decide whether a certain construction qualified as an adverbial clause.

Results: The ordering of main and adverbial clauses correlates with the position of the subordinator in the subordinate clause. In languages in which adverbial clauses have a final subordinator, adverbial clauses tend to precede the main clause, whereas languages in which adverbial clause are marked by an initial subordinator, adverbial clauses commonly occur in both sentence-initial and sentence-final position. In the latter language type, the position of an adverbial clause varies with its meaning or function: conditional clauses precede the main clause more often than temporal clauses, which in turn are more often preposed than causal, result, and purpose clauses.

Conclusions: It is suggested that the distributional patterns arise from the interaction between structural and discourse-pragmatic factors.

Relevance to current work: This study is relevant to the current work because it is one of the few previous studies focused solely on understanding adverbial clauses. It explains the reasoning for placement of various types of adverbial clauses in speaking. It also gives a thorough background of the development and types of adverbials which was necessary to understand for the current study.

Diessel, H. (2004). *The acquisition of complex sentences*. Cambridge, UK: Cambridge University Press.

Purpose: To examine the development of complex sentences in early child speech based on the hypothesis that the development of complex sentences progresses gradually from simple nonembedded sentences to multiple clause constructions.

Design: The hypotheses were tested using data from 5 English-speaking children ranging in ages from 1;8 to 5;1, taken from the CHILDES database. Multiple-clause utterances were identified and analyzed.

Results: Particularly of interest in the current study are the results in chapter 7 on adverbial clauses. Adverbial clauses were found to occur in asymmetrical constructions in which one of the two clauses asserts new and unfamiliar information whose interpretation is supported by the associated clause. Finally, children begin to use adverbial clauses that precede the matrix clause. Initial adverbial clauses serve particular discourse-pragmatic functions: they lay the foundation for the interpretation of subsequent clauses enhancing discourse coherence.

Conclusions: The development of conjoined clauses (co-ordinate and adverbial) contrasts sharply with the development of other complex sentence constructions. While complement and relative clauses can be seen as a process via clause expansion, the development of conjoined clauses can be seen as a process of clause integration.

Relevance to current work: This is relevant to the current study particularly due to the background information Diessel presents on the development adverbial clauses which was used to support the current study. Additionally, his research shows that the development of adverbial clauses may be a key factor in understanding differences in language development.

Heilmann, J., Nockerts, A., & Miller, J. F. (2010). Language sampling: Does the length of the transcript matter? *Language, Speech, and Hearing Services in Schools, 41*, 393-404.

Purpose: To determine if stable language sample measures could be generated using relatively short language samples.

Design: 231 typically developing monolingual English-speaking children ages 2;8 (years: months) to 13;3 provided language samples. All samples were collected by school SLPs. Each child produced two language samples in two different contexts: conversation and student-selected narrative. The language samples were recorded and transcribed using the Systematic Analysis of Language Transcripts (SALT). Examiners gathered 11 minute samples from each child. A 7-minute sample was used as the reference sample, and two other samples were analyzed as the experimental short samples (1 and 3 minute samples). Sample length comparisons were further broken down into two age groups: the younger group included 98

children who were between ages 2:8 and 5:11, and the older group included 133 children who were between ages 6:0 and 13:3. Sample length comparisons were also conducted for sampling context (conversation vs. narrative).

Results: Overall, the language sample measures were consistent across transcript cuts. Measures of productivity, lexical diversity, and utterance length were the most reliable when short sample were used.

Conclusions: The findings of this study indicate that there are a variety of factors that affect shift in reliability when using short language samples, including the type of sample collected, measures of interest, child's age and child's diagnosis. The analyses from this study did not prescribe definitive doses of language sampling that are required for each clinical situation, but provided some evidence of the reliability of short language samples, which are more clinically feasible than recommended procedures that can consume hours in analysis.

Relevance to current work: This article is relevant to the current study because it suggests that language sample analysis has limitations in the time required for collection and transcription of language samples. This article cites new methods being used in place of lengthy language sample analysis just as the current study will provide another method.

Lee, L. (1974). *Developmental sentence analysis*. Evanston: Northwestern University.

Purpose: This book presents a technique for evaluating children's syntactic development called Developmental Sentence Analysis.

Design: Developmental Sentence Analysis makes a detailed, readily quantified and scored evaluation of a child's use of Standard English grammatical rules from a tape-recorded sample of his spontaneous speech in conversation with an adult. It provides a way of measuring a child's growth and progress throughout the period of clinical teaching.

Relevance to current work: Of particular importance to the current work is chapter 4 in the book which talks about Developmental Sentence Scoring (DSS). The DSS scores a corpus of fifty sentences based on eight categories of grammatical forms: (1) indefinite pronoun or noun modifier, (2) personal pronoun, (3) main verb, (4) secondary verb, (5) negative, (6) conjunction, (7) interrogative reversal in questions and (8) wh-question. The corpus of sentences is entered corresponding to the eight categories. Each utterance is then given a score ranging from 1 to 8 points based on the syntactic structures they contained. The average number of points is termed

the DSS. This is of relevance to the current study because of the points which were awarded for the various forms of adverbial clauses. The DSS was used in the current study to display the importance of research on adverbial clause types.

Limber, J. (1973). The genesis of complex sentences. In T. E. Moore (ed.) *Cognitive development and the acquisition of language*. Retrieved April 9, 2012, from http://pubpages.unh.edu/~jel/JLimber/Genesis_complex_sentences.pdf

Purpose: This chapter in the book deals with the development of complex sentences in a number of English-speaking children before their third birthday.

Design: The subjects were a number of children in the Boston area between the ages 1:6 to 3:0 who for a year and a half had participated in a longitudinal development study of early language acquisition. The focus of which was early segmentation, morpheme structure and phonological development. The child and parent visited the laboratory monthly for recording sessions in which 30 minutes of spontaneous speech between the parent and child alone was obtained and up to 30 minutes of experimenter-elicited speech, generally naming objects or describing toy situations was obtained. Additionally, the children were administered the Bayley Scales of Infant Development approximately at their second birthdays.

Results: The author describes the stages of syntax acquisition in terms of precomplex constructions, and complex constructions. Precomplex constructions included simple names and predicates, referential pronouns, and wh-questions. Complex constructions included complements (the earliest complex constructions were object complements (or nominals), Wh-Clause Constructions, and conjunctions.

Conclusions: By age 3, the children were able to (a) generate syntactically complex names and descriptions: complements and relatives. This enables them to individuate linguistically a wide variety of abstract and concrete entities. (b) Their utterances display the basic structural features of English with the major exceptions to that is those aspects of English syntax not present in the child's production during this developmental period. (c) The major developments involving complex sentences during the third year are: simple N-V-N sequences, expansions or substitutions of N-V-N sequence for noun phrases, and finally the conjoining of sentences.

Relevance to current work: This study is relevant to the current study because it outlines the acquisition of complex constructions, including adverbials, for children under 3 years of age.

Some children around this age were included in the language samples in the current study. This study also illustrates the importance of further research in the acquisition of complex structures, as the current study attempts to illustrate using various forms of adverbial clauses.

Long, S. H. (2001). About time: A comparison of computerised and manual procedures for grammatical and phonological analysis. *Clinical Linguistics and Phonetics*, 15, 399-426.

Purpose: To study the time efficiency of procedures for phonological and grammatical analysis, comparing manual and computerized methods.

Design: Analyses was done on three phonological and three grammatical samples, varying in size and complexity/severity. Analyses were done by 256 students and practicing clinicians. Phonological analyses included evaluation of variability, homonymy, word shapes, phonetic inventory, accuracy of production and correspondence between target and production forms. Grammatical analyses included MLU, number of syntactic types, LARSP, DSS and IPSyn. Manual and computer analyses were both on all at sets of samples.

Results: Although the research question involved the time efficiency of manual versus computerized methods of analysis, accuracy was also reported. For phonological analysis of 10 possible accuracy points, the computerized procedure received 8.8. For grammatical analysis, 4.7 out of 5 accuracy points were given. In no instances was the analysis done by hand more accurate than the computer. Without exception, computerized procedures were completed faster. The smallest ratio of manual to computerized performance times for any of the samples was still 11:1. The averaged advantage for computerized analysis ranged from 17 to nearly 35 times faster.

Conclusions: Clinicians will reap the reward of comprehensive grammatical analysis in the long-term efficiency of therapy especially, as demonstrated, the time needed is markedly reduced, the level of accuracy remains the same or better and the analytical power of the procedure is extended.

Relevance to current work: This study is relevant to the current study because it outlines some of the benefits of using computerized procedures to complete language sample analyses, as done in the current study. It also suggests using computers for additional forms of sample analysis than those they used, as the current study employed.

Long, S. H., & Channell, R. W. (2001). Accuracy of four language analysis procedures performed automatically. *American Journal of Speech-Language Pathology, 10*, 180-188.

Purpose: To explain the Computerized Profiling automated language analysis program. A program which combines a probabilistic parser with modules customized to produce four clinical grammatical analyses: MLU, LARSP, IPSyn, and DSS.

Design: 69 conversational language samples drawn from four different sources were used to carry out analyses. Samples included typically developing, speech-impaired, and language-impaired children ranging in ages from 2 years 6 months to 7 years 10 months. The four language analyses were performed using the relevant modules of computerized profiling which is designed to produce linguistic analyses symbiotically by automatically generating a file of codes that can then be reviewed and edited by the user before final results are tabulated. Analyses were performed under two conditions: Condition 1, all coding and tabulation was done by CP. In Condition 2, the codes generated by CP for every file under each analysis procedure were reviewed by two judges, the author and one other analyst. Coding errors in the computer-generated files were correct independently by the two judges and CP was used to identify all discrepancies between judges. The accuracy of all automatic language analyses was then calculated comparing Condition 1 and Condition 2 results.

Results: The range for this study's automatic MLU calculations was 95.5-100%. For IPSyn, the minimum agreement between automatic and corrected analyses was 81.7% and the mean was 91.4%. For DSS, the range was 81.8-94.5% with a mean of 90.0%. LARSP yielded 94.3% accuracy at word level, 90.9% accuracy at phrase level, and 83.7% accuracy at clause level.

Conclusions: Speech-language pathologists are still learning when and how to apply computer technology in the clinical evaluation of language disorders. However, based on the findings of this study, at least for certain procedures, software can produce analysis results that rival those achieved by hand. This shows that now and in the future, the burden of generating an analysis will become lighter.

Relevance to current work: This research is relevant to the current study because it explains some the research that has been done in the past 10 years on automatic language sample analysis. It shows that progress has been made, but poses implications for further development in this area, hence the need for the current study.

Marinellie, S. A. (2004). Complex syntax used by school-age children with specific language impairment (SLI) in child-adult conversation. *Journal of Communication Disorders*, 37, 517-533.

Purpose: To investigate the complex sentence structures used by children with typically developing language (TL) and specific language impairment (SLI) in conversations with an adult.

Design: Participants were 30 children from grades 3-5, 15 of which were diagnosed with SLI and 15 with TL. Initially the investigator met with each child for a brief time in order to establish rapport. Within one week, the research was audio recorded. Each conversation ranged in duration from 15 to 25 minutes, depending on the willingness to talk of the child. Conversations consisted of open-ended questions and included topics such as school-related activities, hobbies, pets and sports. Each sample was transcribed using SALT. For each child, a language sample of 100 utterances was analyzed for complex sentence structures. The categories included adverbial clauses, relative clauses, coordinate clauses, full propositional clauses, infinitive clauses, ing/ed clauses, catenative clauses and wh- clauses. Reliability was established and was no lower than 82% for any of the given syntactic structures.

Results: Results showed that a 100-utterance conversation sample yielded at least one example of the complex syntactic structures, adverbial, relative, full propositional, coordinate and infinitive clauses. Results also indicated that children with TL used complex structures significantly more than did children with SLI.

Conclusions: One of the most interesting findings with regards to the use of adverbial clauses was that children with TL and children with SLI used adverbial clauses in similar proportions by clause type. Clauses of reason or cause were used most frequently followed by clauses of time. This study also suggests in implications for further research that it takes a great amount of time to collect and transcribe language samples and that more research will be needed to better characterize syntactic differences.

Relevance to current work: This study is relevant to the current study because it outlines differences between children with TL and SLI in their use of complex structures, particularly adverbial clauses, as will the current study. The current study also embraces the implications for further research that this study put forth in trying to find a method to save time in language

sample analysis and trying to explain some of the syntactic differences in children with LI and TL, specifically with adverbial clauses.

Nippold, M. A., Mansfield, T. C., Billow, J. L., & Tomblin, J. B. (2008). Expository discourse in adolescents with language impairments: Examining syntactic development [Electronic Version]. *American Journal of Speech Language Pathology*, 17, 356-366.

Purpose: This study examined syntactic development among adolescents who had been identified as having specific language impairment (SLI), nonspecific language impairment (NLI), or typical language development (TLD) in kindergarten.

Design: Participants ranged in ages from 12;10-15;5 with a mean of 13;11. Language samples were elicited in two genres, conversational and expository. They were then transcribed and analyzed for mean length of T-unit, subordinate clause production and clausal density.

Results: Mean length of T-unit and the use of nominal, relative and adverbial clauses were greater during expository task than the conversational task for all groups. No group differences were revealed by the conversational task. However, on the expository task, the TLD group outperformed both the SLI and NLI groups on mean length of T-unit and the TLD group outperformed the NLI group on relative clause use.

Conclusions: Speech-language pathologists may wish to employ expository discourse tasks rather than conversational tasks to examine syntactic development in adolescents.

Relevance to current work: This article is relevant to the current study because it explains some to the research that has been done comparing adverbial clauses in children with and without LI. Additionally, it suggests an implication for types of language samples that should be used yield better results of syntactic development that has also become a suggestion for further research for the current study.

Rice, M. L. & Wexler, K. (1995). Specific Language Impairment as a period of extended optional infinitive. *Journal of Speech and Hearing Research*. 38(4), 850-863.

Purpose: To evaluate an Extended Optional Infinitive (EOI) account of specific language impairment (SLI). In this model, -ed, -s, BE and DO are regarded as finiteness markers. The model predicts that finiteness markers are omitted for an extended period of time for nonimpaired children, and that this period will be extended for a longer period of time in

children with SLI. It also predicts that if finiteness markers are present, they will be used correctly. These predictions were tested in this study.

Design: Experimental measures were derived from language samples and linguistic probes designed to elicit instances of past tense –ed and third-person singular –s forms on lexical verbs, as well as productions of copula and auxiliary BE in questions and statements and auxiliary DO in questions. The language samples were collected using a standard set of toys. The samples were audio-recorded and were then transcribed and coded for grammatical morphemes following the conventions of the Kansas Language Transcript Database. Grammatical analyses were conducted by means of the SALT transcript analysis procedures. Study sample: Sixty children participated in this study. Eighteen were diagnosed with SLI (ages 55 to 68 months). The 42 non-SLI children formed two comparison groups. Twenty-two were of the same chronological age as the SLI sample (ranged from ages 55 to 67 months). The remaining 20 children were at an equivalent level of language, as indexed by their mean length of utterance (ages 30 to 40 months).

Results: Overall, it was found that children with SLI used nonfinite forms of lexical verbs, or omitted BE and DO, more frequently than children in the chronological age equivalent group and the mean length of utterance matched group. At the same time, like the normally developing children, when the children with SLI marked finiteness, they did so appropriately. Most strikingly, the SLI group was highly accurate in marking agreement on BE and DO forms.

Conclusions: The findings of this study conclude that evidence supports the EOI model of SLI. This study also indicated that these children do not seem to know that tense-marking is obligatory in a main clause. This was manifested in two ways: first, they produce a higher proportion of nonfinite matrix clauses than expected for their MLU levels; and second, they persist in producing nonfinite matrix clauses to an older age than do normal children.

Relevance to current work: This article is relevant to the current study because it explains some of the research that has been done on nonfinite forms and infinitives. Additionally, it gives important information about children with SLI because language samples of children with SLI are used in the current study.

Scott, C. M. (1988). Producing complex sentences. *Topics in Language Disorders*, 8, 44-62.

Purpose: To explore the growth of syntactic complexity in children.

Design: This article gives an overview of the development of syntactic complexity in typically developing children and highlights some of the differences in development of complexity in children with language impairment. The structural framework for complex language proposes that complexity is of two basic types: clausal complexity and nonclausal complexity. In clausal complexity, clauses are added to sentences by either coordination or subordination. Coordination adds clauses by linking and the clauses are supposedly related semantically and the syntactic status of both clauses is equal. In subordination, clauses are added not by linking with equal status, but by embedding one clause within a main clause. There are two structural subtypes of subordinating clauses, in the first type, the subordinate clause functions as an element in the main clause. Within these, nominal clauses fill subject, object, and complement slots, while adverbial clauses fill adverbial slots in the main clause. In the second type, subordinate clauses play a major role as a part of an element- postmodifying the head noun, adverb or adjective phrases. The most common of these are relative clauses. Nominal, adverbial and relative clauses may have a nonfinite verb, a form that is not marked for tense, mood, or number. The other type of complexity listed: nonclausal complexity could include a long list of structures including but not limited to, sentence connectivity, adverbial conjunct, adverbial disjunct, interrupting forms, nominalization, word order, comparative, sentential relative and cleft. Developmentally, for preschool children many structures are used with a restricted range of meaning and intention as well as structural flexibility. The challenge for the older child is the selective application of resources with varying types of discourse and channel. Finally, this article mentions that children with language impairment have difficulty developing many structures that contribute to complexity and the frequency for which forms are produced once they are learned may be much smaller than typically developing children.

Relevance to current work: This article is relevant to the current study because it outlines the development of complex structures, including adverbial clauses, which will be used in the current study. Nonfinite forms, infinitives and children with language impairment are also mentioned, all topics being used in the current study.

Tyack, D. L., & Gottsleben, R. H. (1986). Acquisition of complex sentences. *Language, Speech and Hearing Services in the Schools, 17*, 160-174.

Purpose: To analyze the acquisition of complex sentences of children.

Design: Language samples were collected from 110 linguistically normal children ages 1;8 to 4;9. Each sample was analyzed from complex sentences and any relationships were noted.

Results: Data analysis indicated a direct relationship between chronological age, mean length of utterance, and percent of complex sentences. Analysis of the complex sentences in each sample indicated subcategories for each type of complexity which appeared to have their own order of acquisition. When children produced certain types of complex sentences initially, they did not produce all of its subcategories. Often these did not appear until after other types of embedding.

Conclusions: Forms of complex sentences emerge at various ages of development. Although one type of complex form may occur, all of its subcategories may not emerge until higher levels of embedding are achieved.

Relevance to current work: This study is relevant to the current study because it helps describe the order of acquisition of complex forms, particularly for the current study, adverbials. It also says that age and MLU correlate directly with percentage of complex sentences, these were all items addressed in the current study.