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Automated Identification of Noun Clauses in Clinical Language Samples

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AUTOMATED IDENTIFICATION OF NOUN CLAUSES

IN CLINICAL LANGUAGE SAMPLES

by

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ABSTRACT

AUTOMATED IDENTIFICATION OF NOUN CLAUSES

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Master of Science

The identification of complex grammatical structures including noun clauses is of clinical importance because differences in the use of these structures have been found between individuals with and without language impairment. In recent years, computer software has been used to assist in analyzing clinical language samples. However, this software has been unable to accurately identify complex syntactic structures such as noun clauses. The present study investigated the accuracy of new software, called Cx, in identifying finite *wh*- and *that*-noun clauses. Two sets of language samples were used. One set included 10 children with language impairment, 10 age-matched peers, and 10 language-matched peers. The second set included 40 adults with mental retardation. Levels of agreement between computerized and manual analysis were similar for both sets of language samples; Kappa levels were high for *wh*-noun clauses and very low for *that*-noun clauses.

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Introduction

Several grammatical constructions emerge as a child progresses from creating utterances organized around a single verb to utterances organized around multiple verbs. One of these grammatical constructions is the noun clause. Early forms of noun clauses are said to develop as young as 30 months (Scott, 1988). However, research has suggested that children with language impairment produce fewer noun clauses and produce them later in development when compared to typically developing peers.

Although noun clauses are of developmental significance, they are also rare, even for typically developing children. Thus, the manual isolation of utterances containing noun clauses can be a tedious task for clinicians. Therefore, it might be useful if a computer program could quickly scan a language sample and list any utterances likely to contain noun clauses. Several software programs have been developed to aid in language sample analysis looking at various grammatical structures, but none have directly targeted the isolation of complex clauses such as noun clauses. The present study examines whether a new software program known as Cx (Channell, 2008) can reliably locate and isolate noun clauses in language samples from typically developing children, children with language impairment, and adults with mental retardation (MR).

A noun clause is made when an entire clause is used in the grammatical position that a pronoun might occupy in the sentence. For example, in the sentence *They know* ***I hate chocolate,*** the noun clause *I hate chocolate* occupies the position that could be filled by a pronoun such as *it* or *something* (e.g. *I know something* or *I know it).* Noun clauses are a type of subordinate or embedded clause in that they fit syntactically with a matrix clause (which contains the main verb of a sentence) and cannot stand independent of the matrix clause (Diessel, 2004). Other types of subordinate clauses are relative clauses and adverbial clauses. Noun clauses are often called nominal or complement clauses and most frequently take the place of an object in a sentence. For example, in the sentence obtained from Diessel (2004), *The teacher noticed* ***that Bill wasn't in class****,* the noun clause *that Bill wasn't in class* takes the grammatical role of the object. This object adds a second verb to the sentence, but the clause *that Bill wasn't in class* cannot stand on its own.

Noun clauses can be divided into finite and nonfinite types. Finite complements imply that the verb within the clause is marked for tense or number. Nonfinite complements use the same verb independent of the subject or tense. According to Diessel (2004), finite complement clauses can be divided into three categories: *wh*-noun clauses (WNC), *that*-noun clauses (TNC), and *if*-noun clauses (INC). Nonfinite clauses can be divided into *to*-infinitives and *gerunds.* Noun clauses are typically paired with a matrix clause which contains the main verb of the sentence. These matrix clause verbs are most often mental state verbs such as *think*, *believe*, and *assume,* but can also be use and communication verbs such as *see, say,* and *tell* (Diessel, 2004; Owen & Leonard, 2006).

Complex language begins to develop as young as two to two and a half years (Diessel, 2004; Scott, 1988) and typically begins with noun clauses. The earliest types of noun clauses take the place of an object in a subject-verb-object (SVO) sentence structure (Limber, 1973; Scott, 1988). Around age two, noun clauses begin to appear when attached to formulaic attention getters (Diessel, 2004) or as nonfinite clauses introduced with *wanna* and *gonna* (Bloom, Tackeff, & Lahey, 1991; Limber, 1973; Owen & Leonard, 2006; Tyack & Gottsleben, 1986). Next to appear are often full constructions of the *to*-infinitives, WNCs, and TNCs (Limber, 1973). As the language of a child continues to mature, further complex clauses emerge such as relative and adverbial clauses (Scott, 1988). Determining the appearance and the frequency of these clauses can provide important information about the acquisition of complex language for individuals in a clinician's caseload, specifically individuals with language impairments.

In recent years, the emergence of complex syntax in children with impaired language has become an area of interest. Several studies have looked at children with impaired language, often addressing children with Specific Language Impairment (SLI) although some reports of children with nonspecific language impairment (NLI) have also been included. Children with impaired language display delayed acquisition of complex syntax. Although delayed, the language constructs tend to be acquired in the same order as they are for typically developing peers. However, children with SLI tend to omit many important grammatical markers. For example, although nonfinite noun clauses requiring the infinitival *to* are used frequently, the *to* is often deleted as in *I want eat ice cream* (Owen & Leonard, 2006; Schuele & Dykes, 2004). Delayed acquisition of complex structures and frequent omissions of grammatical markers can be important diagnostic factors for clinicians when addressing children with language impairment.

Individuals with MR also show delays in complex language acquisition. Research by Rosenberg (1982) showed that individuals with MR achieved a lower level of proficiency in grammatical structures and complex sentences than did individuals with typical language development.

Because noun clauses play an important role in child language development, the isolation of noun clauses has long been a focus for the clinical analysis of child language samples. For example, Lee (1974) awarded six out of eight points to *wh*-subordinating pronouns in her "personal pronouns" category and eight points to *that*-subordinators that mark a noun clause under "conjunctions" as part of the Developmental Sentence Scoring (DSS) procedure. Paul (1981) included noun clauses among the structures to be specified as part of an analysis of complex utterances. Crystal, Garman, and Fletcher (1989) included noun clauses at stage five of seven in the Language Assessment, Remediation and Screening Procedure (LARSP). Scarborough (1990) also included noun clauses as counting as one of the 56 syntactic/morphological items scored in the Index of Productive Syntax (IPSyn). All of these analysis procedures have given importance to noun clauses; however, no research has been performed addressing the ability of software to identify and isolate noun clauses as a diagnostic contributor for delayed versus typically developing language.

Although a skilled clinician or researcher can examine a child language sample and isolate specific grammatical structures (Long, 1996), the only clinical language sample analysis software to date that attempts to isolate noun clauses is Computerized Profiling (CP; Long, Fey, & Channell, 2008) which performs a LARSP analysis of a sample. No data are available regarding CP's accuracy (i.e., agreement with manual coding) on specific LARSP items such as noun clauses. However, the accuracy of analysis on LARSP's sub-clause level was poor (15%) overall (Long & Channell, 2001). Thus, although grammatical structures such as noun clauses are of developmental and clinical interest, no possible alternative to the manual isolation of noun clauses has been available until now.

The present thesis evaluates the accuracy of software, known as Cx (Channell, 2008), which uses a predictive markings approach to isolate those utterances in a sample which are likely to contain a noun clause. Cx attempts to identify structures of interest by relying on markers (such as matrix verbs) that predict the occurrence of a grammatical structure of interest (noun clauses). Of clinical importance, this thesis examines whether the structures identified by Cx can help to distinguish between individuals who are language-impaired and those with typically developing language.

Review of Literature

This review targets three main areas. First, complex clauses and their development for children with typically developing language, children with language impairment, and adults with MR will be addressed, focusing mainly on noun/complement clauses. Next, the review covers methods of eliciting complex clauses. Lastly, clinical techniques (both manual and computerized) for language sample analysis will be discussed.

Complex Clauses and Their Development

One of the first signs of advancing syntactic development is the appearance of noun clauses. In typical development, language progresses from one and two word utterances to simple SVO sentences (Limber, 1973). As children acquire more vocabulary (particularly verbs), the SVO structure is expanded to accommodate the increased amount of information conveyed in language. Thus, new structures such as noun clauses develop.

Types of complex clauses. Complex clauses have been divided in the literature into three distinct categories. These include (a) relative clauses, which modify or give added information to a noun phrase, (b) adverbial clauses, which take the place of an adverb that modifies the matrix clause, and (c) noun clauses, which take the place of a subject or object pronoun attached to the matrix clause (Diessel, 2004).

Noun clauses are of particular interest to our study and have been identified in various forms. Noun clauses can take the place of a subject *or* of an object in a typical SVO sentence structure (Diessel 2004; Limber, 1973; Paul, 1981). According to Limber, object-position noun clauses are the earliest developing, perhaps because the objects of sentences are more frequently inanimate objects.

However, before noun clauses are added to a child's repertoire of language, he or she must first acquire a list of complement-taking verbs. These verbs are known as matrix verbs (Limber, 1973; Diessel, 2004). Once these verbs are learned, the verb's complement will typically develop within a month (Limber, 1973).

There are more than 200 possible matrix verbs within the English language; the most common are mental state verbs such as *think* and *know* (Bloom, Rispoli, Gartner, & Hafitz 1991; Diessel, 2004; Owen & Leonard, 2006). Other typically used matrix verbs are *want*, *need*, *like*, *watch*, *see*, *lookit*, *let*, *ask*, *say*, *go*, *make*, *guess*, *hope*, *show*, *remember*, *finish*, *wonder*, *wish*, *help*, *pretend*, *decide*, and *forget* (Limber, 1973). Limber also points out that although children may begin to use many matrix words, they have difficulty interpreting some verbs such as *ask* and *promise* because they struggle in finding the referent of the noun clause when these verbs are used.

Noun clauses appear in two main forms, finite or nonfinite. Finite noun clauses are clauses in which the complement verb is marked for tense or number. For example, in the sentence *I thought* ***(that) he left***, the verb *left* is conjugated for past tense. However, nonfinite noun clauses contain a complement verb that is not marked for tense or number. For example, in the past tense sentence *I wanted* ***to go swimming***, the verb *go* is not marked for past tense.

According to Diessel (2004), there are three types of finite noun clauses: *s*-complements, *wh*-complements, and *if*-complements. *S*-complements (also known as *that*-noun clauses or TNCs) can be marked by the subordinator *that* or by nothing at all. *Wh*-complements are marked by *wh*-words. *If*-complements are marked by the word *if*. Nonfinite noun clauses are divided into *to*-infinitives and *gerunds.* According to Paul (1981), *to*-infinitives are marked by the word *to* and *gerunds* are *–ing* words and phrases that are used as nouns (e.g., *I liked* ***cutting carrots***).

The study by Diessel (2004) also addressed three typical combinations of complement clauses with a matrix clause in finite sentences: formulaic, performative, and assertive. A formulaic clause is a clause used typically as an attention getter rather than an embedded clause (e.g., ***You know****, we've been here before*). A performative use is similar to the formulaic use in that the matrix clause information can be omitted but not quite as easily because it merely suggests what someone will do with the complement clause (e.g., ***I believe*** *that this is a mistake*). The assertive use requires both matrix and complement, because the complement is embedded within the matrix and therefore the complement clause is only relevant to the situation stated by the matrix clause (e.g., ***Peter saw*** *that Mary was coming).*

Typical development. In general, older children produce longer utterances and thus produce more complex sentences than do younger children (Tyack & Gottsleben, 1986). Yet, as in all aspects of child development, no specific formula can be assigned to the development of complex clauses. According to Tyack and Gottsleben, "children do not learn all the subcategories of a certain type of embedding at one time" (p. 172). However, several researchers have developed a rough outline for the development of complex clauses. Limber (1973) reports that language development begins with single words and moves to referential pronouns (e.g., *that, it*). Multi-word constructions then begin to form with *wh*-questions (Bloom, Lahey, Hood, Lifter, & Fiess, 1991; Limber, 1973). As a child begins to combine words into sentences, the child begins to add more complex features such as noun clauses. Because matrix verbs are an essential part of the complex clause sentence, they emerge before noun clauses. Typically around age two, *want* and *watch* are the first matrix verbs to emerge. The catenative forms of this verb (*wanna* and *gonna*) are followed by forms using *to* such as *I want to go* (Bloom, Tackeff, & Lahey, 1991; Limber, 1973; Owen & Leonard, 2006; Tyack & Gottsleben, 1986). According to Bloom, Tackeff, et al. (1991) the *to* originally develops as a continuation of the matrix verb to help it move forward and not in connection with the more complex complement clause. Diessel (2004) points out that children typically acquire formulaic matrix clauses first. Acquisition is then followed by the performance matrix clauses and finally by the acquisition of the assertive matrix clauses.

After matrix verbs have been acquired, noun clauses emerge as objects of a sentence around age two and can later move to the subject of a sentence around age three (Limber, 1973). Then simple nonfinite complement clauses that require the word *to* are developed. These are known as infinitives and are used frequently at early ages; however, use tends to diminish as the child develops other complex structures (Tyack & Gottsleben, 1986). Infinitives appear, as was mentioned above, in the catenative form first. According to Diessel (2004), the next type of noun clause to form is the *s*-complement or TNC. At first, *s*-clauses are typically missing the subordinator *that* (e.g., *I think* ***she's here).*** According to research by Owen and Leonard (2006) the use of *that* appears later (e.g., *I think* ***that*** *she's here)*. WNCs (e.g., *I show you* ***how to do it)*** and INCs (e.g., *I ask* ***if we can go)*** typically follow next (Diessel, 2004). According to Limber (1973) and Scott (1988), adverbial clauses and relative clauses will begin to develop shortly after noun clauses.

Development in children with SLI. Although complex clauses are often acquired in a specific pattern, this pattern is altered or delayed for children with language impairments. Complex sentence structure in children with language impairment has become an area of increasing interest over the last several years. Many researchers have discovered that although a child may be able to function at a typically developing level when using simple sentences, breakdowns occur with more complex language.

Marienellie (2004) looked at differences between the complex language of 15 children with SLI and 15 children with typically developing language on 100-utterance samples in child-adult interactions. Marienellie found that children with typically developing language used more complex sentences than children with SLI. Specifically, adverbial, relative, and coordinated clauses were used more frequently. Complement clauses, however, both finite and nonfinite, were not used frequently by either of the groups studied and thus did not yield any significant differences.

Scheule and Dyke (2005) performed a preliminary, longitudinal study targeting the development of complex syntax for one child with SLI. Twelve language samples were taken from ages three to seven. Even in the earliest stages some forms of complex syntax were emerging. These were limited to catenatives (*wanna*, *gonna*, *hafta*) and infinitives. Complex syntax began to increase after the child reached an MLU of 3.0. A large range of complex syntax did not appear until age 5;9 when MLU had reached 4.27.

The child in this study showed emergence of complex structures in the same order as children with typically developing language; however, it was on a much delayed path. Research has shown that children with typically developing language show an increase in complex structures around age 3;0, but this child did not show an increase until age 5;0. In addition to delayed language, many grammatical structures were omitted from the complex syntax used by the child for much of the study. Omissions included infinitival *to*, relative markers and pronouns, and *wh*-pronouns. According to the review by Scheule and Dyke, these omissions disappear at younger ages in typically developing children.

Complement clauses were addressed in greater detail in a study by Owen and Leonard (2006), which looked at the abilities of several children with SLI to use complement clauses (both finite and nonfinite) as proficiently as their typically developing peers. Three groups of children participated in this study: 13 children with SLI, 13 age-matched typically developing (TD) children, and 13 children matched for vocabulary abilities to the group with SLI. Most participants were over the age of 5;0 and had an MLU greater than 5.0. Thus, complex structures were likely to be present. Each child watched short clips of scenarios that were likely to elicit complex sentence completion.

All three groups of children were more likely to use finite complement clauses but nonfinite clauses were more grammatically correct. According to Owen and Leonard (2006), this is because nonfinite complement clauses and verbs have fewer rules for conjugation. However, children with SLI were less likely to produce grammatically correct responses. Grammatical markers such as *to* were often omitted from nonfinite complement clauses. Children with SLI were even more likely to use a nonfinite verb construction and to use an alternative response rather than a complement clause. Nonetheless, children with SLI showed MLUs comparable to their TD peers. Despite comparable MLUs, these children were not functioning at age appropriate levels on complement clauses. Therefore, as this and other studies show, MLU may not be a good predictor of a child's complex language abilities. Other measures should be used to address complex syntax.

Development in adults with MR. Some similarities are found between language in individuals with SLI and language in individuals with MR. According to research by Rosenberg (1982), language development in individuals with MR follows a similar path to typically developing individuals; however, it begins to develop later, progresses more slowly and does not reach as high a level of mastery. In addition, individuals with MR tend to have lower proficiency on certain linguistic tasks such as grammatical morphology and complex sentences.

Rosenberg and Abbeduto (1987) addressed complex syntax in seven individuals with MR and found that 30% of the conversational turns contained one or more complex syntactic structure. Seven developmental levels were established for the order of acquisition of complex structures such as finite noun clauses. The individuals with MR were competent in all seven levels except level five, which is used more frequently in written than in spoken language. Use of level seven by the participants was high; therefore, the authors concluded that individuals with MR eventually reach a relatively high level of mastery of complex sentences. The authors noted however that complex sentences in these individuals tended to be more disfluent than did simple sentences.

Fujiki, Brinton, Watson, and Robinson (1996) found similar results in a study which addressed the language of 42 individuals with MR. Participants were divided into two separate groups based on age: the young group (ages 20–36) and the older group (ages 55–77). Although the participants all scored similarly on IQ tests, their language abilities were quite variable. Complex structures were identified from language samples and analyzed. These structures included relativization (the presence of a relative clause), complementation (the presence of a noun or adverbial clause), and coordination (the presence of two clauses joined by a conjunction word). The purpose of the study was to address the production of complex sentence forms in older versus younger adults with MR. However, no statistically significant differences were found between the two groups. Approximately 30–37% of all utterances on average were complex sentences; however, there was a large standard of error of 20–30%. The percent of well-formed clauses ranged from 50% for relativization to 60% for coordination and 72% for complementation. Productivity (meaning that four or more examples of a certain complex structure were used) resulted in 45% for relativization, 95–100% for complementation, and 80–95% for coordination. This study also addressed the developmental levels described by Rosenberg and Abbeduto (1987). Although levels two and three (which included *wh*-infinitive clauses, sentences conjoined with a coordinating conjunction, compound sentences, object noun phrase relative clauses, and object noun phrase complements) were used most frequently, no statistically significant differences were found between levels. Fujiki et. al found that individuals with MR frequently used a variety of complex sentence types. However, only half to two-thirds of these complex sentence types were well-formed.

Methods for Eliciting Noun Clauses

Syntactic complexity in children with language impairments is an issue of great importance to clinicians; however, children with language impairment may avoid these structures (Owen & Leonard, 2006). Therefore, it is important to realize the best ways to elicit the language for analysis. A study by Nippold, Mansfield, Billow, and Tomblin (2008) focused on using expository discourse (providing an explanation) versus conversation as the means of extracting and evaluating complex language in children with SLI and NLI and children with typically developing language (TDL). Nippold et al. found that in 8^{th} grade, all three groups used more complex structures with the expository elicitation method. Additionally, children with SLI produced a reduced mean length of utterance when compared to their typically developing peers when using this method. Expository discourse also revealed that relative clauses were used less frequently by children with NLI than by children with TDL. Additionally, increased use of subordination coincided with increased mean length of utterance. Nippold et al. claimed that expository discourse was the best method with which to target and assess complex syntactic abilities for children with language impairment.

Use of Language Analysis

Hux, Morris-Frehe, and Sanger (1993) performed a study in which 239 speech pathologists were given a 51 question survey about their transcription analysis procedures. Most were in favor of doing the analyses, but only three percent reported using computer-assisted analysis. Most used MLU and qualitative language descriptions. Most of those studied used the language sampling to either help assess for planning treatment or for follow-up after treatment. The speech pathologists in the study used language sampling most often for preschool and kindergarten aged clients. The sampling was also most often used for children with moderate to severe language impairment. Most procedures for eliciting and addressing language samples were not standardized. Clinicians were in favor of performing language analysis procedures but reported using one of only a few analysis options.

Language Analysis Procedures

Several instruments and methods have been developed in order to describe an individual's level of syntactic performance.

MLU. Although MLU has been debated throughout the years, it is still frequently used by clinicians as a measure to analyze the length of utterances. Brown (1973) performed a longitudinal study in which the language acquisition of three children was followed over several years. Brown established guidelines for quantifying utterance length in terms of the number of words and inflectional morphemes that were used.

Blake, Quartaro, and Onorati (1993) found MLU to be an appropriate and valid measure for simple language. However, MLU failed to be a valid measure for utterances above an MLU of 4.5, which is when complex language begins to be evident. Phrasal complexity increases were not detected using MLU, but other measures showed better sensitivity to these increases.

Mean Syntactic Length. Mean Syntactic Length (MSL) is similar to MLU in that it counts the words and morphemes used within an utterance to determine the length of the utterance. It differs from MLU in that it excludes single word utterances in order to reduce the number of counted utterances that are simply answers to others questions (i.e., *yes, no, good*). As a result of leaving out these one-word utterances and answers, MSL typically tends to be higher than MLU, and some consider it to be a more valid measure of the average length of a child's utterances. A study performed by Klee (1992) addressed the issue of various quantitative measures, including MSL, Total Number of Words (TNW), and Number of Different Words (NDW) being good diagnostic measures for children with language impairments. Forty-eight children were studied, half of whom had SLI. MSL showed a high correlation with age and was able to differentiate between children with SLI and children with TDL. Klee (1992) claimed that MSL was a good measure of language change over time.

MLU-2. Johnston (2001) looked at a measure that is similar to MSL. The language samples of 47 children were analyzed using a measure known as MLU-2. This measure is similar to MSL in that it excludes one word utterances. It also excludes elliptical question responses and imitative utterances. Johnston found results similar to those of Klee. Removing specified types of utterances affects MLU by increasing it an average of 18% and could provide greater developmental sensitivity.

LARSP. LARSP (Crystal et al., 1989) involves procedures for describing language samples, including a development chart in which the clausal and phrasal components of language are organized into seven different developmental stages. Stage one is typically one word utterances. Complex structures begin to appear around stage four with noun clauses appearing in stage five. Although this can provide a lot of information concerning a language transcript, many researchers have found it to be excessive and time consuming; thus, variations have been developed.

Picture-Elicited Screening Procedure. The Picture-Elicited Screening Procedure (PESP) was developed in order to simplify the use of LARSP and to enhance the use of the Renfrew Action Picture Test (RAPT). As developed by Ward and Fisher (1990), children are shown specific pictures that elicit utterances. These utterances are then

LARSP-coded by marking the structures used on the LARSP sheet. The marked utterances are then counted at each stage. The frequency of use is not taken into account. The number of utterances at each stage is then multiplied by the number of that stage. For example a structure marked in stage five would receive five points, but a structure in stage two would only receive two points. The scores are then totaled to provide a PESP score.

IPSyn. The IPSyn (Scarborough, 1990) was developed in order to be an efficient and valid measure of the occurrence of syntactic complexity. It does not take into account the frequency of these syntactic forms, merely the occurrence. It was developed to be used as a tool for research. In the 1990 study, the language of 12 children was scored by awarding points for structures found in the four general categories: noun phrases, verb phrases, questions and negations, and sentence structure.

In IPSyn, a syntactic form must be used twice to receive maximum points. A point system of 0, 1, or 2 is awarded for the occurrence of syntactic and morphological forms. The two examples of a syntactic form must fulfill one of the following three criteria: lexical (two different words), contextual (two different contexts), or phrasal (two different types of phrase, clause, or sentence). Lastly, if a child uses a more advanced form but does not use its simpler form, points are still awarded for that simpler form.

Scarborough (1990) cautioned that IPSyn is not a normed scale, and it can only suggest grammatical areas that should be analyzed in more detail. Scarborough also studied the sample length necessary for a reliable analysis and determined that 100 utterances give a more reliable description of syntactic abilities than samples of 75 or 50 utterances.

DSS. DSS (Lee, 1974) allows clinicians to quantify a child's language sample by assigning points to certain syntactic structures that fit into the following eight categories (a) indefinite pronouns or noun modifiers, (b) personal pronouns, (c) main verbs, (d) secondary verbs, (e) negation, (f) conjunction, (g) interrogative reversal in questions, and (h) wh-questions. Lee selected these eight categories because they showed developmental progression in language. Each category has eight levels of possible points. Structures which occur later in development are awarded higher point values. An additional "sentence point" is added to any sentence that is correct according to adult rules. Thus each sentence scores a number of points, based on the structures it contains and its correctness. The average number of points per utterance yields the DSS score.

Comparison of language analysis procedures. All of the measures listed above can contribute to language analysis. However, some are limited to simple language constructs and others work well with complex language. Kemper, Rice, and Chen (1995) compared various measures such as Mean Clauses per Utterance (MCU), Propositional Density (PropD), Developmental Level (Dlevel), MLU, IPSyn, and DSS. Sixty-two samples of child language from children ages five to ten were analyzed using the above procedures. MLU, IPSyn, and PropD showed little increase across the five to ten age span. However, MCU, DSS, and DLevel showed increases of syntactic complexity up to age seven. The MCU results showed an age-related increase of the frequency of embedded and subordinate clause use. Overall, Kemper et al. reported that DSS was the most accurate technique for describing syntactic complexity in the age range studied.

Computerized Analysis Programs

Because many of the manual methods listed above are time consuming, software systems have been developed to analyze transcripts of language samples. These computerized analyses not only save time but allow for more than one of the methods listed above to be computed simultaneously.

Computerized Language Analysis. Computerized Language Analysis (CLAN; MacWhinney, 2008) was developed as part of the Child Language Data Exchange System (CHILDES; MacWhinney, 2000) project beginning in 1984. According to MacWhinney (1996), the CHILDES database was developed as an international database made specifically to study children's acquisition of first and second languages. However, it also became a means for sharing language samples among researchers.

CLAN is a set of computer programs that can be used to analyze the database's language samples which contain both English and foreign language samples or new samples which have been transcribed using CHAT guidelines (MacWhinney, 1996). A recent version allows for researchers to use tools that link transcripts with digital audio and video records to aide in the ease of transcription and recall (MacWhinney, 2008).

Systematic Analysis of Language Transcripts. Another frequently used program is called Systematic Analysis of Language Transcripts (SALT; Miller, 2008). This software was developed in order to assist in standardizing transcript analysis and to minimize the time required to compute simple language constructions such as MLU, frequency of bound morphemes, type-token ratio, total number of words, types and frequency of various word sets (e.g., questions, negations, conjugations, pronouns), frequency of pauses and mazes (e.g., fillers, restarts), and categories of utterances (e.g., imitations, responses to questions, spontaneous utterances). The software comes with a training program that provides instructions on eliciting, transcribing, and analyzing language transcripts.

Although the software performs the language analysis tabulations, a trained individual is responsible for entering the transcript into SALT format. This is accomplished by dividing the segments into p-units (utterances marked by prosody) or c-units (an independent clause and all of its surrounding dependent clauses), identifying speakers, slash-coding bound inflectional morphemes, placing parentheses around mazes, and other formatting procedures. Codes are available for correct punctuation, bound morphemes, utterance segmentation, standardized spelling, mazes, part words, overlapping speech, pauses (time), omissions, etc. Although formatting requires some training, in the end the effort saves time. Once correct coding is complete, the SALT software allows automated comparison of the tabulations of a sample to hundreds of child reference samples stored in the SALT database. SALT, however, does not provide information or tabulations for more complex sentence structures.

GramCats. The GramCats software (Channell & Johnson, 1999) uses probabilistic methods to grammatically code each word in a sample as to grammatical category ("part of speech"). The software uses a dictionary of common words and their grammatical tag options. Some words only have one option. Some have several options, but one option has a greater probability of being used. The software tags words using various probability matrices. Channell and Johnson used the software on 30 language samples of typically developing children and found a mean word-by-word agreement level of approximately 95%, which is almost as high as the manual reliability that was obtained on the same samples. However, the whole utterance agreement level (i.e., full utterances that did not have any word coding disagreements) was approximately 78%.

The language samples of younger children had higher levels of human-computer agreement than did the samples of older children.

CP. Another program known as Computerized Profiling (Long, Fey, & Channell, 2008) automates many phonological and syntactic language sample analyses, including LARSP, MLU, MSL, IPSyn, PESP, and DSS. A score can be reported for each of these measures in a matter of minutes once the transcripts have been entered into and run through the program. Studies of the accuracy of CP's automated analysis have been published by Long and Channell (2001) and by Channell (2003). Manual editing of CP's analysis is recommended by these researchers.

Long (2001) addressed the efficiency of CP to determine if it could help clinicians save time when analyzing language samples. Two hundred and fifty six students and practicing clinicians were selected to analyze phonological and grammatical components of language samples. Each sample was analyzed manually and by the CP software using various methods including MLU, LARSP, IPSyn, and DSS. CP achieved a score of 4.7 out of 5.0 (94%) and took less than an hour to complete. CP proved to be more time efficient with grammatical analysis than were manual methods. The authors concluded that “the only manual grammatical analysis procedures likely to be time efficient are simple structural counts performed by efficient clinicians on samples obtained from children with very young language ages” (Long, 2001, p. 413). The time needed will depend on the efficiency of the clinician using the software for grammatical analysis. Those who are efficient should be able to complete one computerized grammatical analysis in approximately 10–45 minutes. The lower end of this range (10 minutes) is manageable for most clinicians.

Cx. Computerized analysis methods have proven to be fast and effective measures of simple language and some complex language structures. Up to this point, however, no software has attempted to mark complex language structures such as noun clauses in order to help point out possible language impairment or delay in children who should be developing these structures. The Cx software (Channell, 2008) has been developed in order to aid in this process. It relies on predictive markings to identify and isolate utterances which are likely to contain a complex clause. Its accuracy for finite adverbial and relative clauses was addressed by Michaelis (2009) and Clark (2009), who found overall Kappa levels of .88 for relative clauses and .89 for adverbial clauses. Accuracy on finite complement clauses remains to be addressed, as well as its accuracy on all nonfinite structures. The present thesis targets the ability of the Cx software to isolate finite noun clauses from existing language samples obtained from individuals with typically developing language, individuals with SLI, and individuals with MR. It looks at overall accuracy and compares accuracy between children with SLI and children with typically developing language.

Method

Language Samples

Language samples for the current study were obtained from studies by Fujiki, Brinton, and Sonnenberg (1990; referred to hereafter as the Reno samples) and by Fujiki et al. (1996; referred to as the Parsons samples).

The Reno samples were collected from 10 children with LI, 10 chronological age (CA) matched peers, and 10 language age (LA) matched peers. Five males and five females were included in each group. Children with LI ranged in age from 7;6 to 11;1, CA-matched children ranged from 7;6 to 11;2, and LA-matched children ranged in age from 5;6 to 8;4. Children with LI were diagnosed by demonstrating delays in both language comprehension and production. Comprehension delays were determined by receiving a score outside of one standard deviation from the mean on two or more of the following tests: 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 (TOLD-P; Newcomer & Hammill, 1982), and the Clinical Evaluation of Language Functions Screening Test (CELF-S; Semel & Wiig, 1980). Production delays were determined by the following: subtests taken from the TOLD-P and CELF-S and the Clinical Evaluation of Language Functions-Diagnostic Battery (Semel-Mintz & Wiig, 1982). All children with LI did not show any signs of mental retardation and were receiving speech-language services. LA-matched children were matched to the children with LI by scores from the Utah Test of Language Development (Meacham, Jex, & Jones, 1967). Each child in the CA group was a match within four months to a child with LI and attended the same elementary school.

Language samples were obtained during a 30 minute conversation with an adult examiner using several games and toys, including Viewmasters, the *Guess Who* game, Transformer toys, and a magic kit. Topics were also introduced by the clinician (e.g., movies, Christmas vacation). Two hundred to six hundred utterances were collected from each participant.

The Parsons samples were collected from 42 adults with mild to moderate mental retardation. Forty of these samples were available from the CLAN database and used for this study. The participants were originally divided into groups according to age;

however, no statistically significant differences were found between the groups. Therefore, both groups were treated as one group for the current study but are described separately here. The young group consisted of 20 participants between the ages of 20 and 36 (*M* = 29, *SD* = 3.67) with an average MLU of 5.49 and an average IQ of 60.70 on the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981). All participants in this group had received special education until secondary school. The older group consisted of 22 participants between the ages of 55 and 77 (*M* = 63, *SD* = 1.85) with an average MLU of 6.51 and an average IQ of 61.14 on the WAIS-R. Participants in the older group had received various levels of education. Some had received no formal education at all. All participants in both groups were living in community residential settings and passed a visual screening of 20/40 (with corrective lenses), a hearing screening at 45 dB HL at 1, 2, and 4 kHz, and a speech screening to assure that they displayed sufficient language abilities. Individuals with MR due to Down Syndrome or a current dual diagnosis were excluded from the study.

The language samples were elicited during two sessions. The first session generally lasted about 25–30 minutes and consisted of a question-and-answer format in order to familiarize the participant with the interviewer. The questions began with product questions (i.e. “How old are you?”) and progressed to open-ended extensive answer questions (i.e. “What do you like about your city?”). The second session lasted about 10–15 minutes and consisted of a conversational exchange. Both samples were typically collected on the same day. One hundred to five hundred utterances were collected from each participant.

Procedure

The sample transcripts were coded using SALT (Miller, 2008) guidelines. False starts, mazes, word and syllable repetitions, revisions, and interjections were marked with parentheses by other researchers and excluded from analysis. In addition, utterances that were an exact repetition of a previous utterance (whether the participant was repeating himself or the interviewer in an echolalic fashion) were excluded from analysis. Utterances containing one or more finite complex clause were then identified manually and placed into the following categories: WNCs (including INCs), TNCs, relative clauses, and adverbial clauses. The general guidelines and exceptions used for manual identification of complex clauses can be found in Appendix A. All complex clauses were identified with the help of other researchers for the Reno samples, and were double checked by the author. Eleven percent of the samples were re-measured and inter-rater reliability of 91% was established with a second coder.

Following manual analysis, each utterance was scanned by the Cx software (Channell, 2008), which identified and isolated any utterances in the sample which were likely to contain one or more finite noun clauses. The output from the computerized analysis was then compared to the manual coding of noun clauses. Relative and adverbial clauses were also compared on the Parsons samples.

Data Analysis

The data generated by this study were analyzed using several methods. First, each compared utterance was placed into one of the following categories *positive agreements*, *misses*, *intrusions*, and *negative agreements.* Positive agreements were utterances identified both manually and by Cx as containing a finite noun clause. Misses were utterances identified as containing a noun clause manually but not by Cx. Intrusions were utterances identified by Cx as containing a noun clause but were not marked by manual analysis. Negative agreements were utterances identified both manually and by Cx as not containing a finite noun clause.

Secondly, 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. Many researchers use the guidelines for Kappa interpretation published by Landis and Koch (1977) which rate Kappas from .61 to .81 as *substantial* and .82 to 1.00 as *almost perfect* (Boslaugh & Watters, 2008). A Kappa level is similar to an r^2, thus a Kappa level of .81 is comparable to an *r*-value of .90. These guidelines were used in the present study.

Additionally, MLU and DSS scores were computed via the CP software (Long, Fey, & Channell, 2008) for each participant and were compared for correlations with the obtained Kappa levels. Pearson's correlations among the frequencies of manually identified and computer-identified noun clauses were also examined for each group.

Finally, a one-way analysis of variance was used to compare Kappa values obtained on the three Reno sub-groups. This was used to check for statistically significant differences in the software’s ability to identify finite noun clauses in samples from children with typically developing language and from children with LI.

Results

Findings regarding noun clause identification are discussed by type (TNC, WNC) separately for children (the Reno samples) and for adults (the Parsons samples). See appendixes B and C for descriptive statistics from each sample.

Reno Samples

TNCs. The levels of agreement between manual and Cx software coding of TNCs were low. These levels (as shown by Kappa level) are displayed in Table 1, divided into the three subgroups. The average Kappa level was .0919 (*SD* = .1937).

Table 1
Manual and Computer Identified Th-Noun Clauses (TNC) for the Reno Samples

Group	a	b	c	d	*Kappa*
CA	7	59	0	4070	0.0809
LA	5	33	2	3560	0.1199
LI	2	58	1	3704	0.0846
Total	14	150	3	11334	0.1524

a = agreement on presence of a TNC in an utterance. b = misses; manually identified TNCs not found by Cx. c = intrusions; TNCs identified by Cx but not manual analysis. d = agreement on the absence of a TNC in an utterance.

As can be seen in Table 1, Kappa levels differed little between groups. A one-way analysis of variance confirmed that there was no difference between groups, F (2, 27) = 0.17; p = .849.

The obtained Kappa levels for each sample did not correlate with MLU (r = .11; p = .574) or with DSS levels (r = .19; p = .310) obtained for individual participants. The number of TNCs identified by the Cx software correlated moderately with the number identified manually, r = .68; p < .001.

WNCs. The levels of agreement between manual and Cx software coding of WNCs were much higher than those of TNCs; these levels are displayed in Table 2.

Table 2

Manual and Computer Identified Wh-Noun Clauses (WNC) for the Reno Samples

Group	a	b	c	d	*Kappa*
CA	67	24	6	4039	0.7864
LA	69	19	6	3671	0.8881
LI	93	16	16	3501	0.8387
Total	229	59	28	11211	0.8365

a = agreement on presence of a WNC in an utterance. b = misses; manually identified WNC not found by Cx. c = intrusions; WNC identified by Cx but not manual analysis. d = agreement on the absence of a WNC in an utterance.

As can be seen in Table 2, Kappa levels for the groups differed somewhat but all were substantial. A one-way analysis of variance found no significant difference between groups, F (2, 27) = 1.23; p = .311.

The obtained Kappa levels for each sample did not correlate with MLU (r = -.23; p = .242) or with DSS levels (r = -.37; p = .051). The number of WNCs identified by the Cx software correlated highly with the number identified manually, r = .97; p < .001.

Parsons Samples

TNCs. The levels of agreement between manual and Cx software coding of TNCs were low The overall Kappa level was .0748 with an average Kappa level of .0366 (*SD* =.1024); the Kappa level was .0000 for 33 of the samples.

The obtained Kappa levels for the Parsons samples correlated moderately with MLU (r = .46; p = .003) and DSS level (r = .37; p = .019). The number of TNCs identified by the Cx software also correlated moderately with the number identified manually, r = .41; p = .009. Participants who produced TNCs and thus had the possibility of a non-zero Kappa were those participants who also had higher MLU and DSS values.

WNCs. The levels of agreement between manual and Cx software coding of WNCs were substantial. The overall Kappa level was .7289 with an average Kappa level of .7065 (SD = .1741).

The obtained Kappa levels for each Parsons sample did not correlate with either MLU (r = -.043; p = .793) or DSS levels (r = .08; p = .614). The number of WNCs identified by the Cx software correlated highly with the number identified manually, r = .86; p < .001.

Discussion

In this study the Cx software was used to identify finite noun clauses in language samples of children with and without language impairment and from adults with MR. For WNCs, the Cx software achieved accuracy levels which would be described as substantial (Landis & Koch, 1977). For TNCs, accuracy levels were significantly lower. The Parsons samples challenged the software more than the Reno samples, perhaps because of the longer utterances and perhaps because of grammatical and structural errors made by the individuals with MR who produced these samples. Although imperfect, this study offers the only accuracy data available so far regarding automated noun clause identification in clinical language samples. To date, published data have shown poor accuracy in the identification of subclausal elements such as noun clauses. For example, Long and Channell (2001) found accuracy on the subclause line of LARSP for the CP software to be about 15%.

The correlation obtained between the total number of utterances identified as containing a noun clause both manually and by Cx showed a moderate correlation for TNCs for both groups and a high correlation for WNCs. Despite the fact that some of these selected noun clauses were misses or intrusions, the software was able to calculate a number for WNCs that was similar to the number identified manually. Although some differences were seen between each different group's use of noun clauses none of these differences were statistically significant. However, the TNC accuracy levels for the Parsons sample did correlate moderately with MLU and DSS levels. This could be due to the fact that individuals in the Parsons sample tended to use the matrix verb *mean* a lot (e.g., *I mean* he didn't go), which was mentioned by Diessel (2004) to be a formulaic use of a matrix/noun clause combination. This increased the use of TNCs for this sample and in turn could have increased the overall MLU and DSS scores. Many participants often used single-word utterances such as *yeah* and *uhhuh.* Correlations with MLU may have been higher had one-word utterances been excluded from the sample as is suggested by Klee (1992) and Johnston (2001).

In comparisons of manual and software coding of the Reno samples, Michaelis (2009) and Clark (2009) found overall Kappa levels of .88 and .87 for relative and adverbial clauses respectively. The present study obtained an overall Kappa of .84 for WNCs; all of these obtained levels fall within the Kappa level range described as *almost perfect* by Landis and Koch (1977). Yet, the software performed poorly in identifying TNCs in the same samples. In addition, when comparing the results obtained for the Parsons samples to the studies by Michaelis and Clark, there is a large difference in relative clause agreement, with .88 for the Reno samples and .58 for the Parsons samples. Adverbial clause agreement, however, was comparable, with .87 for the Reno samples and .83 for the Parsons samples.

Cx's lower performance on the Parsons samples might be related to the findings of Fujiki et al. (1996) concerning well- and ill-formed utterances. Using the same Parsons samples, Fujiki et al. discovered that relative clauses were only considered well-formed in 48 to 59% of attempts. Likewise, noun and adverbial clauses were only well-formed in 72% of attempts. The present study for the Parsons samples found that relative clauses produced the least amount of agreement, and noun clauses produced lower agreement as well. This finding could be related to the utterances that were well- or ill-formed; however, the specific utterances so described by Fujiki et al. are not available.

Types of Disagreements

No significant patterns were noted in the types of intrusions for TNCs. Overall, the software did not tend to over-identify TNCs. Only 11 intrusions were noted in both the Reno and Parsons samples. These few intrusions consisted mainly of relative clauses marked as noun clauses and the word *that* used as a determiner or an adjective but marked as a TNC subordinator.

However, three distinct patterns were noted for intrusions in WNCs for both the Reno and Parsons samples. These patterns included elliptically-shortened utterances, stand-alone dependent clauses, and questions. Elliptically-shortened utterances constituted 53% of all intrusions. These included utterances such as *I don't know* ***where*** and *I don't know* ***what else***. These types of utterances do not meet the requirements for a noun clause (i.e., one dependent clause containing its own verb embedded within an independent clause) and were thus not included in manual identification.

Secondly, stand-alone dependent clauses constituted 12% of all intrusions. These were clauses such as *what we did.* The entire utterance was a noun clause, but it was not embedded with a matrix clause and was thus not counted manually. Lastly, questions constituted 12% of all intrusions. These included utterances such as *what you think about me?* and *who my best friend?* It is important to note that the Parsons samples contained the majority (94%) of these two types of intrusions, which could be due to the style of language sampling used. The Parsons samples were elicited mainly by a question/answer format, and the Reno samples were elicited through participation in activities designed to stimulate talking. Thus more questions and more utterances used to clarify were used by the participants in the Parsons samples.

Other types of intrusions constituted the remaining 23% and included the following: (a) those missed by manual coding, (b) those missing a word and thus interpreted as a finite noun clause by Cx and as a nonfinite noun clause manually (e.g., *don't know how get it out either* was interpreted as *don't know how* ***to*** *get it out either* by manual tagging and *don't know how* ***I*** *get it out either* by Cx, and (c) a dependent noun clause in quotation marks (e.g., *they go "how much you wanna bet?")* was identified as a noun clause by Cx, but counted as a reported clause manually.

The majority of misses for TNCs were those in which the subordinator *that* was missing, which for most of the participants sampled occurred frequently. Occasionally, a clause containing the subordinator *that* was also missed. Overall, the Cx software significantly under-identified *TNC*s. Improvements will be needed in order for Cx to be used reliably in identifying TNCs.

Several patterns were noted for types of misses for WNCs. The pattern of misses that occurred most frequently in both samples concerned INCs which were considered as part of WNCs*;* this pattern constituted 61% of all misses. For example, *they didn't come out and see* ***if*** *everything was alright or nothing.* These structures were frequently identified as adverbial clauses by the Cx software.

About 25% of all misses included WNCs that renamed a noun which was also stated in the utterance. For example, *there's a **donut shop place where** they make the donuts.* The noun clause renames the word *place;* however, the Cx software frequently counted these as adverbial clauses.

Additionally, utterances beginning with *that is/was when*, such as *that is when I moved up here*, were frequently identified as adverbial clauses. These constituted 9% of all misses. A matrix verb plus *wh*-noun clause constituted an additional 9% of all misses. This category included utterances which typically had an infrequent matrix verb such as *remember* or *wonder* or had another word interfering with the typical structure of matrix/WNC combination such as *we don't know **what in the heck** did happen,* and *we'll let you know **really** what did happen.*

An additional pattern in which WNCs functioning as the object of a preposition were missed by Cx was identified in the Parsons samples only. This constituted 6% of the total misses and included utterances such as *it's right by **where I live**.*

Differences in identification of adverbial and relative clauses between manual and Cx coding for the Parsons samples consisted mainly of a missing subordinator for relative clauses and confusion with noun clauses for adverbial clauses.

Factors Contributing to Disagreements

Many factors contributed to the disagreements in the identification of noun clauses for these samples. One factor was clinician fatigue or distraction. This is one area in which the Cx software surpasses manual coding; the software does not get tired and does not get distracted by things happening around it.

Another factor is that of context. A manual coder is able to read the context surrounding an utterance to determine whether it is a complex structure and which type.

The Cx software, however, is unable to do that. A clinician is also able to infer the prosody of a sentence whereas the software is unable to do so. However, two human coders may infer prosody differently, whereas Cx is at least consistent.

Additionally, some differences exist in the guidelines for identifying noun clauses used manually and those programmed into the Cx software. Elliptically-shortened utterances and stand-alone noun clauses that were included by the software and INCs that were included manually are examples of these differences.

One factor in the differences between samples was the language abilities of those included in the samples. The adults with MR produced more utterances which were longer and grammatically unconventional than did the children in the Reno samples. Thus, these utterances challenged both the software and the manual coding and decreased agreement levels.

Limitations

One limitation of this study was that the samples had previously been obtained and transcribed. Thus, prosody often had to be inferred, which could change a judgment as to whether something was considered a complex clause or not. Additionally, the transcriptions used had different guidelines for utterance separation. In the Parsons samples, some utterances contained several different thoughts that may have appeared to be complex clauses, but in reality may have been separate thoughts or utterances. Yet transcribers for the Reno samples attempted to follow c-unit guidelines.

Another limitation of the study is the small sample size of each of the groups. Only 10 language samples from children with language impairment were studied, 20 children with typical language, and 40 adults with MR.

Strengths and Possible Cx Improvements

The Cx software can identify many noun clauses in a matter of seconds. It provides a quick way to isolate complex sentence structure. At its current level, it would work well for a quick screening of a sample, which could provide useful data as to whether further assessment was needed.

The two most common errors for WNCs could be addressed in the software's programming and would improve agreement with manual coding. Approximately 53% of all intrusions were elliptically-shortened utterances, and 61% of all misses were INCs. Therefore, the software could be adjusted to reduce these patterns of disagreement and thus improve its accuracy.

To improve the software's accuracy on TNCs, probabilistic data would need to be entered concerning the types of matrix verbs that commonly appear before a TNC despite the absence of a subordinator. Typical matrix verbs found in the samples studied were *think*, *know*, *say*, *see*, *tell*, *guess*, and *mean*. Others less typically found included *found*, *hope*, *bet*, *wish*, *remember*, *make*, and *play*. These results are similar to those listed by Limber (1973) as typical matrix verbs.

Future Research and Conclusion

Research will need to be performed on more and larger samples in order to address the validity of the software's abilities. Also, samples from other individuals with varying disabilities and levels of sentence structure would need to be assessed. In addition, addressing nonfinite noun clauses could be of clinical interest. As previous studies have shown, typically developing individuals and individuals with SLI tend to use nonfinite noun clauses at an earlier age and with greater accuracy than finite clauses, although they frequently omit the *to* (Owen & Leonard, 2006). This study also showed an approximate 2:1 ratio of nonfinite to finite use of noun clauses for the group with SLI. Thus, addressing the use of nonfinite noun clauses could further help to identify those who are struggling with complex constructions on a clinician's caseload.

Although more improvements need to be made within the Cx software to improve its accuracy, the software could be clinically useful in quickly scanning and identifying complex clauses from language samples that have been obtained and transcribed by clinicians. The present study has added specific insights into the strengths and limitations of the Cx software and has helped to illustrate the challenges which face any software designed to assist in the clinical analysis of language samples.

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Appendix A
Identification guidelines and exceptions

General guidelines:

- A complex clause is one dependent clause containing its own verb embedded within an independent clause.
- Exceptions: the utterance can be missing a modal or auxiliary verb if the clause still takes on the shape of a noun , relative, or adverbial clause
    - Examples: *That what I mean; If they scummy or ugly; The ball that red*

Adverbial clauses:

- Can stand alone, but must have a subordinator
- Can be missing the subject if the subordinator and the verb are present
    - Example: *Because go downtown*
- If an adverbial clause takes the position of a noun clause it is counted as the adverbial clause
- *so* does not count as an adverbial subordinator

Relative clauses:

- Cannot stand alone; must at least have the subject or object that it is modifying
    - Example: *The ball which was dropped>*
- Relative subordinator can be missing
    - Example: The ball he has is orange

Noun clauses:

- Cannot stand alone; need matrix clauses
    - Example: *I know where you are* = yes
    - Example: *where you are* = no
- Interrogative reversal does not count
    - Example: *what are you going to do?*
    - Exception: if a *wh*-question is functioning as the object or subject of a sentence as in *do you know what are you going to do?* then it is counted
- Wh-subordinators include: *what, when, where, why, how, which, whether,* and ***if***
- TNCs do not need the subordinator *that*
- A noun clause is still counted if part of the matrix verb is missing but the noun clause still takes its place as a noun clause
    - Example: *I don't [know] what them made them for*
- *I mean* is typically considered a matrix clause when followed by a noun clause unless it is excessively taking on the form of a filler or a restart as in *I want to go I mean I need to go*
- An overt subject must be present in the noun clause to be counted as a TNC
    - Example: *I didn't know that he came*= yes
    - Example: *I didn't know that came*= no

Other:

- Direct repetitions of self or of clinician do not count.

Appendix B
Descriptive Statistics for the Reno Samples

Participant	Age (months)	N utterances	MLU	DSS
LI1	111	244	5.18	6.30
LI2	90	459	5.67	8.46
LI 3	111	178	4.36	4.27
LI4	104	300	5.23	7.30
LI5	104	453	5.64	8.50
LI6	113	365	5.66	8.22
LI7	119	611	5.94	8.41
LI8	133	475	5.39	6.88
LI9	104	253	4.73	5.64
LI10	109	253	4.03	4.59
LA1	91	336	5.61	9.07
LA2	88	231	5.62	6.08
LA3	95	300	7.18	10.85
LA4	66	320	5.38	7.05
LA5	82	273	5.70	7.01
LA6	100	497	6.20	9.40
LA7	69	356	4.76	7.67
LA8	77	312	5.00	6.51
LA9	83	491	5.00	7.59
LA10	84	363	6.43	7.12
CA1	90	442	6.32	8.15
CA2	108	356	7.28	9.48
CA3	106	460	5.63	7.85
CA4	100	468	6.79	8.32
CA5	122	337	6.34	8.86
CA6	110	481	8.04	10.61
CA7	106	349	7.26	9.31
CA8	104	398	7.01	8.84
CA9	132	309	6.64	9.11
CA10	110	346	7.34	10.66

Appendix C

Descriptive Statistics for the Parsons Samples

Participant	Age(years)	N Utterances	MLU	DSS
Anthony	32	450	5.46	9.83
Arlon	63	507	7.25	11.18
Corey	58	409	5.12	9.94
Dee	34	445	2.69	4.69
Dick	26	199	2.45	5.85
Don	28	295	7.13	11.00
Harry	60	452	6.25	10.56
Jerry	30	245	2.54	4.47
Jess	58	336	2.34	6.23
John	72	436	4.61	8.05
June	28	381	3.19	6.65
Katy	34	410	6.95	12.68
Konnie	25	469	7.84	12.27
Lois	62	566	5.99	9.92
Mabel	29	148	3.12	5.61
Mark	20	330	8.58	12.43
Mary	63	505	7.77	11.96
Michael	28	229	4.53	8.82
Mickey	31	552	3.00	7.19
Misy	68	379	5.20	8.42

(table continues)

Participant	Age (years)	N Utterances	MLU	DSS
Natalie	72	562	11.50	14.19
Ollie	55	330	3.61	8.65
Pam	28	473	4.00	7.93
Reed	61	421	6.93	11.74
Reesa	26	483	7.16	11.88
Rita	77	363	7.91	11.62
Rob	71	129	5.74	9.24
Robert	64	388	8.87	12.52
Ron	66	345	5.95	8.46
Sam	64	411	6.52	9.59
Shelly	30	420	6.45	10.98
Sher	64	499	5.91	9.63
Sherry	29	321	5.15	8.63
Spence	36	484	5.99	10.20
Tim	63	480	4.74	8.40
Tom	28	538	4.27	7.92
Vivian	59	364	5.61	10.46
Walt	66	271	4.94	8.81
William	57	374	4.96	7.80
Winnie	24	345	4.26	7.83