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Authors
Finestack, Lizbeth H
Rohwer, Bobbi
Hilliard, Lisa
et al.

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Tutorial

Using Computerized Language Analysis to Evaluate Grammatical Skills

Lizbeth H. Finestack,[a] Bobbi Rohwer,[a] Lisa Hilliard,[a] and Leonard Abbeduto[b]

Purpose: Conducting in-depth grammatical analyses based on language samples can be time consuming. Developmental Sentence Scoring (DSS) and the Index of Productive Syntax (IPSyn) analyses provide detailed information regarding the grammatical profiles of children and can be conducted using free computer-based software. Here, we provide a tutorial to support clinicians' use of computer-based analyses to aid diagnosis and develop and monitor treatment goals.
Method: We analyzed language samples of a 5-year-old with developmental language disorder and an adolescent with Down syndrome using computer-based software, Computerized Language Analysis. We focused on DSS and IPSyn analyses. The tutorial includes step-by-step procedures for conducting the analyses. We also illustrate how the analyses may be used to assist in diagnosis, develop treatment goals focused on grammatical targets, and monitor progress on these treatment goals.
Conclusion: Clinicians should consider using Computerized Language Analysis's IPSyn and DSS analyses to support grammatical language assessments used to aid diagnosis, develop treatment goals, and monitor progress on these treatment goals.
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Language samples can serve as rich sources of information when evaluating the language skills of children with language impairment. Measures derived from language samples represent all aspects of language: phonology, morphology, syntax, vocabulary, and syntax. Clinicians may use measures derived from language samples to assist in diagnosis, development of treatment goals, and progress monitoring. Although clinicians report often using language samples in their evaluation process, they are often limited in the analyses they conduct and the application of the information gained from language samples. In this tutorial, we focus on morphology and syntactic structures, which we refer to as grammatical structures.

Conducting in-depth grammatical analyses based on language samples can be time consuming. Analyses that may be particularly useful for clinicians to use include the Index of Productive Syntax (IPSyn; Scarborough, 1990) and Developmental Sentence Scoring (DSS; Lee & Canter, 1971). There are several programs available to assist with completing IPSyn and/or DSS analyses, including Computerized Profiling (Long et al., 2004), the AC-IPSyn system (Hassanali et al., 2014), and Computerized Language Analysis (CLAN; MacWhinney, 2000). Both IPSyn and DSS analyses may be beneficial to clinicians when diagnosing or describing language impairment and may be even richer sources of information for developing treatment goals and monitoring progress. CLAN may be particularly useful for clinicians as it is a free computer-based program that automatically conducts IPSyn and DSS analyses when a language sample transcribed using CLAN's CHAT or Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2010) conventions is inputted.[1] Thus, the focus of this tutorial is how to use CLAN to conduct IPSyn and DSS analyses and use this information to assist in diagnosis, develop treatment goals, and monitor progress for grammatical language targets.

Clinical Use of Language Samples

Surveys of clinicians indicate that they often use language samples in their evaluation process, but their analyses

[a]Department of Speech-Language-Hearing Sciences, University of Minnesota, Minneapolis
[b]MIND Institute, University of California, Davis
Correspondence to Lizbeth H. Finestack: finestack@umn.edu
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[1]See *A Clinician's Complete Guide to CLAN and PRAAT* (Ratner & Brundage, 2018) for more complete information regarding the use of CLAN for analyzing child language samples.

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of those samples and application of the information derived are quite limited. In an early survey of 253 speech-language pathologists (SLPs) based in the United States, Kemp and Klee (1997) found that 85% of the SLPs sampled reported using language samples when assessing preschool children. Of these, 92% reported using language samples for diagnosis, 85% for treatment planning, 64% for progress monitoring, and 44% for screening. Reasons cited for not using language samples included lack of time, lack of computer resources, and lack of training or expertise. Half of the clinicians reported using nonstandardized procedures (e.g., Brown's stages) to analyze language samples. The most commonly cited standardized analyses clinicians reported using were DSS (35%); Bloom and Lahey's Form/Content/Use Analysis (Lahey & Bloom, 1988; 29%); Assigning Structural Stage (Miller, 1981; 17%); and the Language Sampling, Analysis, and Training procedure (Tyack & Gottsleben, 1974; 12%). Few clinicians reported using computer-based analyses. Only 6% of respondents reported using SALT (Miller & Iglesias, 2010), and 2% reported using some other program. No clinicians reported using IPSyn or CLAN to conduct language sample analyses.

In another survey (Pavelko et al., 2016), which included 1,336 school-based SLPs in the United States, 67% of the respondents reported using language sample analysis during the 2012–2013 school year. The majority (52%) of participants indicated that they transcribe the sample in real time while communicating with the child, and 43% of the participants reported that they record and later transcribe language samples for analyses. Respondents indicated that they use language samples for initial evaluations (87%), re-evaluations (73%), measuring progress in therapy (68%), and screening (50%). The researchers found that only 29% of the participants used a specific method or protocol for language sampling analysis, with the most commonly identified method being SALT (24%). The most commonly cited barrier to using language sample analyses reported was limited time (67%–89% depending on caseload size); however, limited training and/or expertise was also commonly cited as a barrier to use of language sample analyses (9%–33% depending on caseload size). More than 70% of respondents also noted that they would be interested in receiving increased training and support focused on analysis of language samples, interpretation of language sample analysis results, and development of treatment goals based on language samples.

More recently, Fulcher-Rood et al. (2018) interviewed 39 school-based SLPs regarding their child language assessment practices. This qualitative study revealed that language sampling was cited as among the most common informal assessment tools used in their assessments (72% of respondents). The respondents reported using such informal measures to gain information regarding language performance in functional contexts (44%) and naturalistic settings, such as the classroom (21%), but only a small number of respondents reported using language sampling alone for diagnostic purposes (8%). Of these respondents, 40% reported collecting language samples in real time and 21% (n = 6) reported completing traditional language sample analyses based on samples transcribed from audio recordings. Common rationales that emerged for using standardized assessments as part of the respondents' assessment battery included (a) "can be used to measure specific language skills"; (b) "follows state and/or district policy to qualify a student for speech-language services"; (c) "provides a complete, comprehensive assessment of a student's language abilities"; and (d) "requires relatively little time to complete and is easy to administer." Thus, presumably, respondents believed that informal language sampling procedures failed to assess language skills central to diagnosis, could not be used for diagnostic purposes, and were difficult to administer and time consuming.

Finestack and Satterlund (2018) surveyed SLPs working with children of early education age (n = 114) or elementary age (n = 224) regarding their clinical practices for interventions focused on grammar development. Eighty-one percent of the early education group and 73% of the elementary group reported sometimes or frequently using language sampling to monitor progress on grammatical goals. These clinicians noted that they most frequently use mean length of utterance (MLU; 86%–94% of clinicians) and type–token ratio (TTR; 25%–33% of clinicians) analyses. MLU is a commonly used metric of overall language complexity. TTR is a measure of semantics that reflects diversity in vocabulary but provides little to no information regarding use of grammatical forms. Developmental norms are available for both measures for younger children, but these are very broad measures of syntax, morphology, and semantics that offer limited information to monitor treatment progress. Less than 20% of clinicians reported frequently using CLAN; DSS; IPSyn; Language Assessment, Remediation and Screening Procedure (Crystal et al., 1981); or an alternative method for conducting analyses, which may provide more detailed information regarding use of grammatical language forms.

Given the findings from these surveys and interviews, it appears that SLPs do use language samples to support child language assessments but are not using language samples for diagnostic purposes or to conduct in-depth analyses of grammatical development. They also do not appear to use free resources to assist in analysis. Additionally, survey results indicate that clinicians desire more education to better analyze and use language samples to support clinical work. IPSyn and DSS analyses are two potentially beneficial tools that clinicians may use to support diagnostic assessments, develop treatment goals, and monitor progress. Once a transcript is transcribed using the TalkBank transcription conventions (CHAT) or imported from plain text (using CLAN's TEXT2CHAT utility) or from a SALT file (using CLAN's SALT2CHAT utility), CLAN can be used to derive both IPSyn and DSS measures.[2] It is important to note that CLAN has an automatic parser that identifies and marks all syntactic forms, including morphological

[2]See *A Clinician's Complete Guide to CLAN and PRAAT* (Ratner & Brundage, 2018) for more information regarding how to import text or SALT files.

affixes. Thus, there are minimal transcription conventions for users to follow, which reduces the time demands associated with training on transcription.

IPSyn

The IPSyn (Scarborough, 1990) evaluates the emergence of 59 different morphological and syntactic forms across four domains. For each morphological or syntactic form, coders assign a score of 0, 1, or 2 to indicate no uses of the form, a single use of the form, or two or more uses of the target form, respectively. These scores are then summed to yield individual domain scores: noun phrases, verb phrases, question and negation constructions, and sentence structure. Altenberg et al. (2018) recently published revised guidelines to streamline IPSyn coding. To complete IPSyn analyses, Scarborough (1990) recommended using the first 100 utterances in the sample that do not have any unintelligible portions and are not repeated or imitated utterances, although more recently, a small number of self-repetitions have been included (Altenberg et al., 2018).

Researchers have used IPSyn to assess children representing a broad range of ages, dialects, languages, and disorders (Hewitt et al., 2005; Hollister et al., 2015; Komesidou et al., 2017; Moody et al., 2018; Oetting et al., 2010; Rescorla et al., 2001; Rice et al., 2006; Thal et al., 2004; Yoder et al., 2011). For example, Komesidou et al. (2017) examined language growth of 39 children with fragile X syndrome over a 5-year period when the children were between 32 and 121 months of age. Four times over the study period, participants engaged in a 20-min interaction with their mothers that comprised free-play or craft, naturalistic unstructured interaction, and snack. Researchers used these language samples to derive IPSyn and MLU measures. Results indicated growth over time for both measures and for the IPSyn subscales.

A study conducted by Oetting et al. (2010) provides another example of the use of IPSyn measures by researchers. This study included fifty-two 4- to 6-year-old children of typical development and ten 6-year-old children with specific language impairment (SLI), all of whom were speakers of African American English. Each child participant completed a language sample based on a play interaction with the examiner. The researchers completed an item analysis of IPSyn scores, which revealed that all but one of the IPSyn items (Q8: Yes/no question with inverted modal, copula, or auxiliary, *Is he tired?*) are appropriate for children who speak African American English. However, it is important to note that results did not indicate significant differences between the children with typical language development and children with SLI. The authors suggest that IPSyn may not be a sensitive diagnostic tool for identifying older children with language impairment, such as the 6-year-olds in their study. These results are consistent with the findings of Ratner and MacWhinney (2016) that IPSyn scores tend to plateau well before children reach 6 years of age.

Although IPSyn measures are readily used by researchers, IPSyn output has the potential to be highly beneficial to clinicians as well. There are no known studies that report the sensitivity and specificity of IPSyn measures for diagnostic purposes. Scarborough (1990) provides normative data based on a sample of 15 children followed every 6 months from 24 to 48 months of age. Other empirical studies provide means and standard deviations of IPSyn scores across age groups, which may serve as useful comparisons (see Hewitt et al., 2005; Oetting et al., 2010). Additional normative information is available using CLAN's KIDEVAL.

KIDEVAL reports include more than 30 different measures derived from language samples (see Appendix A), one of which is the total IPSyn score. When creating a KIDEVAL report, there is an option for users to compare scores to other children aged 2–6 years of the same gender within a 6-month age range using a large database of CLAN transcripts obtained from North American English-speaking children (the current reference samples exceed 2,000 samples). The KIDEVAL report provides, in standard deviations, the difference between the target child's IPSyn score and the mean IPSyn score derived from the database. KIDEVAL also reports the database's mean and standard deviation used for comparison and the number of files (participants) that contributed to the normative data. Thus, clinicians can use this information to compare their client's performance to that of other children of the same age to help determine if the client falls outside of the average range to support diagnostic decision making and qualifications for services based on state and insurance guidelines. However, as is noted in the KIDEVAL file, these comparisons alone should not be used for clinical diagnosis.

Clinical use of IPSyn goes beyond developmental tools for diagnosis, particularly for older children. Clinicians may use IPSyn to identify areas of strengths and weaknesses across the four domains assessed. This information can be helpful when monitoring progress. Additionally, item analysis of performance within each domain can provide useful information regarding which particular structures the child appears to have in their repertoire, which appear to be emerging, and which there is no evidence of use. Clinicians can use this information to conduct further probes to identify treatment targets.

DSS

DSS (Lee & Canter, 1971) evaluates language complexity across eight grammatical categories: (a) indefinite pronoun/noun modifier, (b) personal pronoun, (c) main verb, (d) secondary verb, (e) negative, (f) conjunction, (g) interrogative reversal in questions, and (h) *wh*-questions. In each category, forms are assigned scores ranging from 0 to 8, with higher scores indicating the use of more complex later-developing grammatical forms. Lee recommends that DSS analyses be completed on samples with at least 50 fully intelligible, consecutive utterances that are not repetitions or imitations and that include a subject + verb. Table 1 includes a sample of the DSS system for three categories. DSS also includes a Sentence Point score, which evaluates the average number of utterances that meet standard adult grammatical rules.

Table 1. Sample of the Developmental Sentence Scoring system.

Score	Indefinite pronouns or noun modifiers	Personal pronouns	Main verbs
1	■ *it, this, that*	■ First and second person: *I, me, my, mine, you, your(s)*	■ Uninflected verb: I *see* you ■ Copula, is or 's: *It's* red. ■ is + verb + ing: He *is* coming.
2		■ Third person: *he, him, his, she, her, hers, its*	■ *–s* and *–ed*: *plays, played* ■ Irregular past: *ate, saw* ■ Copula: *am, are, was, were* ■ Auxiliary: *am, are, was, were*
3	■ *no, some, more, all, lot(s), one(s), two (etc.), other(s), another* ■ *something, somebody, someone*	■ Plurals: *we, us, our(s), they, them, their, these, those*	
4	■ *nothing, nobody, none, no one*		■ can, will, may + verb: *may go* ■ Obligatory DO + verb: *don't go* ■ Emphatic DO + verb: *I do see.*
5		■ Reflexives: *myself, yourself, himself, herself, itself, themselves*	
6		■ *wh*-pronouns: *who, which, whose, whom, what, that, how many, how much: I know who came. That's what I said.* ■ *wh*-word + infinitive: *I know what to do. I know whom to take.*	■ *could, would, should, might + verb: might come, could be* ■ Obligatory does, did + verb ■ Emphatic does, did + verb
7	■ *any, anything, anybody, anyone* ■ *every, everything, everybody, everyone* ■ *both, few, many, each, several, most, least, much, next, first, last, second (etc.)*	■ *(his) own, one, oneself, whichever, whoever, whatever: Take whatever you like.*	■ Passive with get, any tense ■ Passive with BE, any tense ■ must, shall + verb: *must come* ■ have + verb + en: *I've eaten.* ■ *have got: I've got it.*
8			■ have been + verb + ing ■ had been + verb +ing ■ Modal + have + verb + en: *may have eaten* ■ Modal + be + verb + ing: *could be playing* ■ Other auxiliary combinations: *should have been sleeping*

Although to a lesser extent than IPSyn, DSS has been used by researchers to assess children representing a broad range of ages, languages, and disorders (Buhr & Zebrowski, 2009; Deevy & Leonard, 2018; Eisenberg et al., 2018; Finestack & Abbeduto, 2010; Jalilevand et al., 2016; Miyata et al., 2013; Rice et al., 2006). For example, Rice et al. (2006) compared the performance of 39 children with SLI (M_{age} = 4.85 years), 40 children with typical development of similar MLU (M_{age} = 2.96 years), and 45 children with typical development of similar age (M_{age} = 4.99 years) based on MLU, IPSyn, and DSS measures. Examiners collected conversational language samples from the participants by following the child's conversational lead, engaging in parallel talk and play, and introducing topics related to the past. Results indicated that the children with typical development who were of similar age to the children with SLI outperformed the other two groups. Additionally, the three measures were all significantly correlated.

Finestack and Abbeduto (2010) compared the expressive language profiles of 24 individuals with Down syndrome (M_{age} = 16.9 years), 17 individuals with fragile X syndrome (M_{age} = 15.79 years), and 21 children with typical development (M_{age} = 4.82 years). In addition to measures based on standardized, norm-referenced assessments, primary dependent measures included DSS Sentence Point and Total. Finestack and Abbeduto also compared the groups based on a subset of the individual DSS categories. DSS measures were derived from narrative language samples elicited using a wordless picture book. Results indicated that the groups differed on the two primary DSS measures and on the DSS Conjunction category. The adolescents with fragile X syndrome and the children with typical development outperformed the adolescents with Down syndrome based on the DSS Sentence Point. The children with typical development outperformed both the fragile X syndrome and Down syndrome groups based on the DSS Total. Additionally, the children with typical development outperformed the adolescents with Down syndrome based on the Conjunction category score. Both of these studies (Finestack & Abbeduto, 2010; Rice et al., 2006) illustrate how researchers have used DSS measures to better understand the language profiles of children and adolescents with developmental disabilities. The Finestack and Abbeduto study also demonstrates use of the DSS categories to evaluate language abilities across disorders.

Although researchers have primarily relied on DSS measures to broadly characterize the language abilities of children and adolescents, DSS may be used clinically for varying assessment needs. DSS overall score may be used to support diagnostic decisions. Similar to IPSyn, there are no known studies to report the sensitivity and specificity of DSS measures; however, early normative data exist (Lee & Canter, 1971) based on 200 typically developing children aged 2–6 years. Data include means and standard deviations of the overall DSS score for each age group as well as ranges and score percentiles for each age group. Like IPSyn, additional normative information is available using CLAN's KIDEVAL, which has the option for clinicians to compare a child's DSS overall score with those of other children of the same gender within a 6-month age range. Clinicians can use the difference in standard deviations between their client's score and the database's mean score to support diagnostic decisions but should not solely rely on such scores for clinical diagnosis. DSS measures may be of particular use to clinicians when selecting treatment goals and monitoring progress. Clinicians may use DSS output to identify linguistic categories of particular weakness. The DSS chart may also be used to select specific treatment targets to advance linguistic complexity. Additionally, clinicians may use overall category scores and the DSS Total to monitor progress at a broader level.

Although both IPSyn and DSS analyses may be of great benefit to clinicians, these analyses can be time consuming to complete. As is described above, in the survey conducted by Pavelko et al. (2016), up to 89% of clinicians cited limitations in time as a barrier to using language sample analyses. Although to conduct thorough language sample analyses, manual or automated, requires transcription of the language sample, the time spent analyzing the sample can be significantly reduced using automated information. Additionally, automated IPSyn and DSS analyses have the potential to provide fine-grained, detailed information regarding a child's grammatical language skills that standardized assessments are unable to provide. Thus, the use of automated analyses may help to alleviate the time barrier and allow SLPs to more readily use language sample analyses to support their clinical practice.

CLAN Analyses

There are several programs available to assist with completing both IPSyn and/or DSS analyses, including Computerized Profiling (Long et al., 2004), the AC-IPSyn system (Hassanali et al., 2014), and CLAN. Here, we only focus on the use of CLAN, but certainly, use of the other systems should be considered by researchers and clinicians. Advantages of CLAN include that it is a free downloadable software program that runs with Microsoft Windows, macOS, and Linux; it can be used with language samples transcribed using either CHAT or SALT conventions; and it can be used to analyze multiple transcripts simultaneously. It is also important to note that CLAN's IPSyn and DSS analyses are reliable. The reliability of CLAN's parser for identifying grammatical relations averages 94% accuracy (Sagae et al., 2010). Additionally, Sagae et al. (2005) report that human and CLAN IPSyn scoring point-to-point accuracy measurements yield a mean interagreement of 94%.

Ratner and Brundage (2018) and MacWhinney and Fromm (2016) have developed free written guidelines and tutorial screencasts to complete DSS and IPSyn analyses using CLAN with samples transcribed using CHAT conventions. The procedures also include information regarding how to convert SALT files into files that can be analyzed by CLAN and how to produce the IPSyn and DSS output using KIDEVAL. It is important to note that transcripts do not need to be in SALT format for CLAN to analyze. Language samples can be transcribed using CHAT conventions, which are detailed in the clinician guide developed by Ratner and Brundage. Using transcripts in either CHAT or SALT format, the method to complete DSS and IPSyn analyses using CLAN is relatively easy but requires several steps. Here, we provide a summary of the steps we followed to use CLAN to derive a KIDEVAL report and complete IPSyn and DSS analyses from a transcript in CHAT format and a transcript in SALT format. We have included detailed information regarding the process in Appendix B.

Using CLAN to Analyze Transcripts

CLAN must complete IPSyn and DSS analyses using transcripts in CHAT format. Samples can be transcribed directly into CLAN using the guidelines described by Ratner and Brundage (2018). Such transcripts do not require special coding (e.g., marking of morphemes), with an exception that transcribers must flag ungrammatical utterances with the symbol [*] somewhere in the utterance to ensure that they do not receive a sentence point for DSS analyses. Transcripts that have been transcribed using SALT conventions can be converted into CHAT format using CLAN's programs. The conversion is done by running the "SALT2CHAT" command on all .slt files in CLAN. This conversion creates .cha files.

Next, it is necessary to run the "MOR" command on the .cha files (MacWhinney, 2000), which requires a separate download of MOR (English-eng). Upon running the MOR command, CLAN tags each morphological and syntactic form and creates two separate lines (one for morphology [%mor] and the other for syntax [%GRA]) that correspond to each utterance in the transcript. If MOR fails to find certain words in the transcript in its dictionary, these errors can be manually corrected, as can any obvious misparses of the utterance. For example, proper nouns are not in most computer dictionaries, but capitalizing them in the transcript (as you would in ordinary writing) instructs MOR to use its syntactic parser to assign likely identity as either noun or modifier. Additional common errors are included in Table 2, along with corrections recognized by MOR.

After running "MOR" and correcting all word errors not found in CLAN's lexicon, the file is ready to be analyzed using IPSyn and DSS. The first of three commands is "KIDEVAL" (MacWhinney, 2000). The KIDEVAL output is a Microsoft Excel spreadsheet and contains a wide range of data, including total number of utterances in each language

Table 2. Common errors identified by Computerized Language Analysis's MOR.

Error type	Example error	Correction
Proper nouns	donald	Donald
Numbers	fortyfour	forty four
Titles	mr, mrs, ms	mister, missus, miss
Informal conjunctions	liketa, hafta	liketa [: like to], hafta [: have to]
Filler words	umm, hmm	um, hm

sample, MLU data, and TTR data, among several other measures. The KIDEVAL spreadsheet also includes the total number of IPSyn utterances and DSS utterances. This first-level report will inform the clinician whether or not the IPSYN and DSS total scores fall within expectations for the child's age and gender. The next set of commands will perform more detailed reports of the DSS and IPSYN analyses.

The second command is "ipsyn +t*CHI -leng" used to complete the IPSyn. Note that the first part of the string (ipsyn) commands the program to run IPSyn. The next part instructs the program to examine the speaker tier (+t) labeled as the CHILD (*CHI). The remainder of the string specifies that the language (-l) is English (eng). This command string yields a .cex file (CLAN executed file), which indicates the points earned for each item and the child's exemplar that was counted toward the item. Appendix C contains a sample of the .cex output. The third command is "dss +t*CHI -leng" used to complete DSS. Note that the initial segment of the string (dss) commands the program to run DSS. The remaining string comments are the same as those used for the IPSyn command. The DSS command yields a .tbl.cex file (table CLAN executed file) that includes a table with the DSS scores awarded to each utterance for each of the eight categories. The bottom of the file indicates total scores for each category and the overall Developmental Sentence Score, which is the total, not including the Sentence Point, divided by the number to DSS utterances (must contain a subject and a verb). Appendix D contains a sample of the .tbl.cex output. This file can be reformatted using Excel by selecting the text, clicking on "Text to Columns" under Data, selecting Delimited, and specifying "|" as the delimiter. As with all analyses (hand-scored or automated), it is necessary to examine the scoring and output for errors. For example, upon obtaining the DSS output, it is necessary to inspect the analysis chart for errors. Common errors include assigning scores for verbs with errors ("buy" for "bought"), incorrect identification of an interrogative reversal, scoring nouns (e.g., "aid") as a verb, and scoring *wh*-forms as both pronouns and question forms.

Case Illustrations

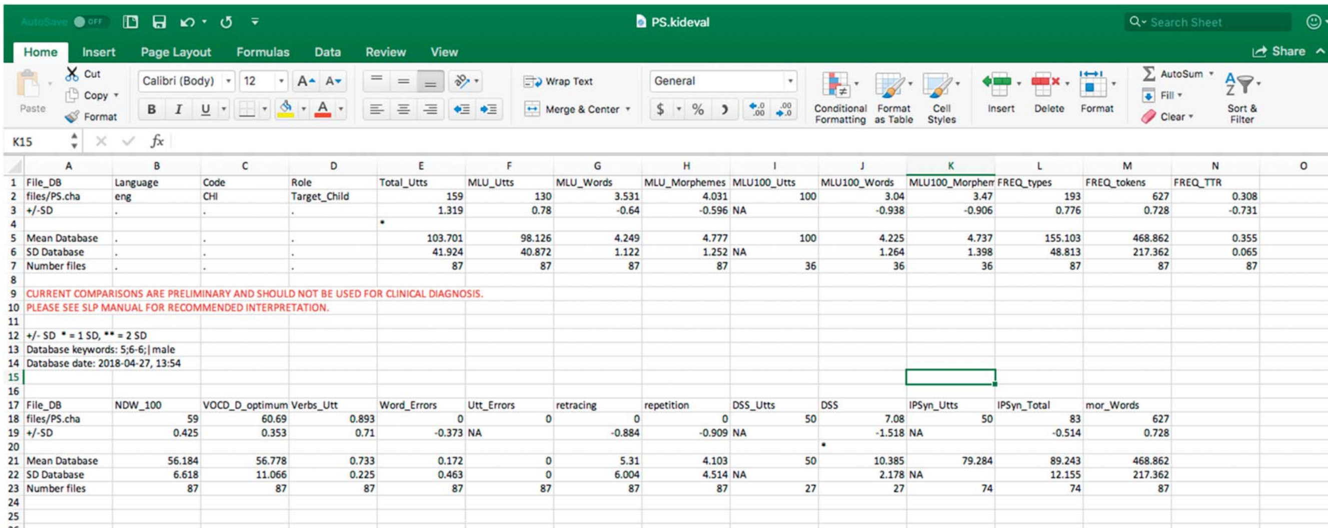
Case 1: Diagnostics—PS

PS is 5.6 years old. He is a Caucasian boy who only speaks English. His kindergarten teacher noticed that PS often did not use complete sentences and seemed to have weak grammar and referred him to the school SLP who assessed his language skills. On the Test for Auditory Comprehension of Language–Revised (Carrow-Woolfolk, 1985), an omnibus test of receptive language ability, PS's overall standard score was 95 (M = 100, SD = 15). On the Structured Photographic Expressive Language Test–Third Edition (SPELT-3; Dawson et al., 2003), a test of grammatical language, his standard score was 70 (M = 100, SD = 15). On the Rice/Wexler Test of Early Grammatical Impairment (TEGI; Rice & Wexler, 2001), PS's Elicited Grammar Composite Score was 44.75%, which was well below the Criterion Score based on PS's age of 71%. PS's performance on the individual TEGI probes was as follows: Third-Person Singular Probe Score: 10% (criterion = 81%), Past Tense: 100% (criterion = 79%), BE Probe: 33% (criterion = 83%), and DO Probe: 36% (criterion = 56%). A school-based psychologist administered the Leiter International Performance Scale–Revised (Roid & Miller, 1997), a test of nonverbal cognitive ability. His Brief IQ Composite Score was 124 (M = 100, SD = 15). These test results suggest that PS has significant weaknesses associated with his expressive use of grammatical forms, with average nonverbal cognitive abilities and receptive language skills.

As part of his assessment battery, PS engaged in a 15-min conversation with an examiner, following procedures outlined by Abbeduto et al. (1995). The examiner introduced and followed up in scripted ways about a predetermined set of topics, such as hobbies, school life, and home life. A research assistant transcribed the sample in CLAN using CHAT conventions (see Supplemental Material S1). Although transcription of PS's sample required approximately 60 min of the research assistant's time, to complete the necessary checks and run the KIDEVAL report required no more than 15 min. CLAN's KIDEVAL report indicated that PS produced 130 complete and intelligible utterances, which yielded an MLU-words of 3.53, an MLU-morphemes of 4.03, and a TTR of 0.31. PS's KIDEVAL appears in Figure 1. According to the KIDEVAL report, PS's MLUs and TTR are within 1 *SD* of the database mean.

Further examination of PS's KIDEVAL report indicates that his DSS overall score was 7.08, more than 1.5 *SD*s below the CLAN database mean and his IPSyn total score was 0.5 *SD*s below the mean, based on the first 50 available utterances. Based on Lee's (1974) normative DSS data, PS's DSS overall score is 1.11 *SD*s below the mean and well below the 25th percentile. Additional IPSyn comparisons to the Hewitt et al. (2005) data set indicated that his IPSyn total score was 0.76 *SD*s above the mean. Thus, based on the IPSyn data, it appears that PS has an appropriate range of syntactic forms that he uses in his conversational language. However, based on his DSS overall score, it appears that the complexity of his language is significantly

Figure 1. PS's sample KIDEVAL report.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	File_DB	Language	Code	Role	Total_Utts	MLU_Utts	MLU_Words	MLU_Morphemes	MLU100_Utts	MLU100_Words	MLU100_Morphem	FREQ_types	FREQ_tokens	FREQ_TTR
2	files/PS.cha	eng	CHI	Target_Child	159	130	3.531	4.031	100	3.04	3.47	193	627	0.308
3	+/-SD	.	.	.	1.319	0.78	-0.64	-0.596	NA	-0.938	-0.906	0.776	0.728	-0.731
4					*									
5	Mean Database	.	.	.	103.701	98.126	4.249	4.777	100	4.225	4.737	155.103	468.862	0.355
6	SD Database	.	.	.	41.924	40.872	1.122	1.252	NA	1.264	1.398	48.813	217.362	0.065
7	Number files	.	.	.	87	87	87	87	36	36	36	87	87	87
8														
9	CURRENT COMPARISONS ARE PRELIMINARY AND SHOULD NOT BE USED FOR CLINICAL DIAGNOSIS.													
10	PLEASE SEE SLP MANUAL FOR RECOMMENDED INTERPRETATION.													
11														
12	+/- SD * = 1 SD, ** = 2 SD													
13	Database keywords: 5;6-6;|male													
14	Database date: 2018-04-27, 13:54													
15														
16														
17	File_DB	NDW_100	VOCD_D_optimum	Verbs_Utt	Word_Errors	Utt_Errors	retracing	repetition	DSS_Utts	DSS	IPSyn_Utts	IPSyn_Total	mor_Words	
18	files/PS.cha	59	60.69	0.893	0	0	0	0	50	7.08	50	83	627	
19	+/-SD	0.425	0.353	0.71	-0.373	NA	-0.884	-0.909	NA	-1.518	NA	-0.514	0.728	
20										*				
21	Mean Database	56.184	56.778	0.733	0.172	0	5.31	4.103	50	10.385	79.284	89.243	468.862	
22	SD Database	6.618	11.066	0.225	0.463	0	6.004	4.514	NA	2.178	NA	12.155	217.362	
23	Number files	87	87	87	87	87	87	87	27	27	74	74	87	

reduced in conversational language relative to other children of similar age.

Inspection of PS's standardized assessment data alone suggests that he will qualify for services. This finding is further supported by his DSS overall score derived from his language sample. It is important to note, though, that his MLU, TTR, and IPSyn scores are all within the average range. Thus, his low DSS score suggests that his conversational weaknesses go beyond use of forms but suggest that he frequently uses simple grammatical structures and produces a considerable number of grammatical errors. This finding substantiates the observations made by his teacher.

Case 2: Treatment Planning and Monitoring—SH

"SH" participated in a large study examining the language profiles of adolescents with Down syndrome or fragile X syndrome (Abbeduto et al., 2003; Finestack & Abbeduto, 2010; Keller-Bell & Abbeduto, 2007). SH is an adolescent with Down syndrome who is 15.18 years old and whose parent identifies him as a Caucasian male adolescent. He received a Full Scale score of 55 (M = 100, SD = 15) on the Stanford–Binet Intelligence Scales (Thorndike et al., 1986), a test of cognitive ability. This standard score corresponded to a mental age of 6.46 years. On the Test for Auditory Comprehension of Language–Revised, SH's quotient was 65. On the Oral and Written Language Scales (Carrow-Woolfolk, 1995), an omnibus test of expressive language ability, SH's overall standard score was 45 (M = 100, SD = 15). These test results suggest that SH has significant weaknesses in cognitive, receptive, and expressive language abilities, with his receptive language abilities being relatively strong.

As part of his assessment battery, SH engaged in a 10-min conversation with an examiner, following the same procedures described for PS (Abbeduto et al., 1995). SH also completed a narrative language sample based on the wordless picture book, *Frog Goes to Dinner* (Mayer, 1974), with the task administered following procedures developed by Abbeduto et al. (1995). SH first looked through each page of the book. Then, the examiner asked SH to tell the story, with minimal scaffolding provided by the examiner. An assistant transcribed both samples using SALT conventions to yield a conversational sample and a narrative language sample (see Supplemental Materials S2 and S3, respectively), requiring approximately 70 min. The assistant then completed KIDEVAL, IPSyn, and DSS analyses, which required no more than 15 min to run, including converting the SALT file and checking it. KIDEVAL indicated that the conversational sample included 100 complete and intelligible utterances for analyses, which yielded an MLU-words of 4.46, an MLU-morphemes of 5.04, and a TTR of 0.34. The narrative sample included 91 complete and intelligible utterances, which yielded an MLU-words of 5.84, an MLU-morphemes of 6.63, and a TTR of 0.31. CLAN IPSyn and DSS analyses were each based on 50 utterances for both samples, but CLAN automatically corrected the IPSyn results to be based on 100 utterances. Because SH is older than the KidTalk developmental norms available at this time, age comparisons cannot be made.

IPSyn Analysis

For the conversational sample, CLAN's IPSyn analysis yielded the following scores: Noun Phrases = 20 (91%), Verb Phrases = 20 (59%), Questions & Negations = 11 (50%), Sentence Structure = 28 (70%), and total score = 79. The conversational .sltin.ipsyn (IPSyn) output appears in Appendix C. Table 2 lists the forms scored 2, 1, and 0 points for each subscale based on the conversational sample. For the narrative sample, CLAN's IPSyn analysis yielded the following scores: Noun Phrases = 17 (77%), Verb Phrases = 23 (68%), Questions & Negations = 10 (45%), Sentence

Structure = 24 (60%), and total score = 74. Table 3 lists the forms scored 2, 1, and 0 points for each subscale based on the narrative sample.

A simple comparison of the raw number output indicates relatively similar scores across the two sampling contexts. Comparison of percentages based on the total number of possible points for each subscale suggests lower performance on the narrative sample. Across subscales, the Questions & Negations subscale followed by the Sentence Structure and Verb Phrases had the lowest percentages. Noun Phrases scores were the highest for both contexts. Examination of Tables 3 and 4 supports these general findings, with the most structures receiving 0 points on the Verb Phrases subscale.

Tables 3 and 4 can help identify potential areas to consider for treatment targets. The IPSyn forms are listed developmentally so that V1 (Verb) and V2 (Participle/Preposition) are considered early developing and V15 (Emphasis or Ellipsis) and V16 (Past Tense Copula) are considered later developing. Thus, when examining performance for potential targets, it will be important to consider the lower numbered forms first. Additionally, clinicians should consider the forms that are likely to have the greatest functional impact on social and classroom performance. Some areas that may be of concern and warrant further probing based on Verb Phrases subscale performance include Verb + Infinite (V5), Modal before Verb (V9), and Past Tense Modal (V11), which received 0 points in both contexts, as well as Past Tense Copula, which received 1 point in each context. On the Sentence Structure subscale, items of concern include Conjunction (S5) and Infinitive (S8), which received 1 point in each context, as well as Let/Make/Help/Watch (S9) and Conjoined Clauses (S12), which received 1 point in the conversational context and 0 points in the narrative context. On the Questions & Negations subscale, Negative between Subject and Verb (V5) received 0 points in both contexts. Less consideration should be given to the question forms in this case, because the conversational and narrative contexts used did not pull for question forms. Alternative contexts such as an interview or question game may yield better representation of performance on question structures.

Because IPSyn indicates emergence of forms and not mastery, further examination is required. A standardized, norm-referenced assessment such as the SPELT-3 (Dawson et al., 2003) may provide further normative information about SH's grammatical language development broadly. However, the SPELT-3 contains one to six opportunities for the examinee to produce the 35 unique morphosyntactic test forms; thus, level of accuracy cannot be obtained. A criterion-referenced assessment such as the TEGI (Rice & Wexler, 2001) yields normative data and level of accuracy;

Table 3. Index of Productive Syntax performance of "SH" by points earned based on narrative sample.

Nouns		Verbs		Questions/negations		Sentence structure	
				2 points			
N1	Noun	V1	Verb	Q1	Intonation	S1	2 Words
N2	Pronoun	V2	Particle/preposition	Q2	Routine, etc.	S2	Subject–verb
N3	Modifier	V3	Prepositional phrase	Q8	Y/N inverted copula/modal/aux	S3	Verb–object
N4	2-word NP	V4	Copula linking 2 nouns			S4	Subject–verb–object
N5	Article before noun	V6	Auxiliary *BE, DO, have*			S6	Any 2 verbs
N6	2-word NP after verb	V7	Progressive *–ing*			S7	Conjoined phrase
N7	Plural suffix	V8	Adverb			S11	V + nominal clause, mental state
N8	2-word NP before verb	V10	Third-person singular present			S16	Relative clause
		V12	Regular past tense				
		V13	Past tense auxiliary				
		V14	"Medial" adverb				
				1 point			
N11	Other morph. noun/adj	V16	Past tense copula	Q3N	No(t) + X	S5	Conjunction (any)
				Q4	*Wh*-question + verb	S8	Infinitive
				Q6	*Wh*- with inversion	S10	Subordinate conjunction + clause
				Q7N	Negative copula/modal/aux		
				Q9	*Why, When, Which, Whose*	S13	If or *wh*-clause
						S14	Bitransitive predicate
						S15	3 or more (non aux.) verbs
						S16	If or *wh*-clause
						S18	Gerund
						S19	Front, center subordinate
						S20	Passive or full tag comment
				0 points			
N9	3-word NP	V5	Verb + infinitive	Q5N	Negative between S + verb	S9	*Let/Make/Help/Watch*
N10	NP adverb	V9	Modal before verb	Q10	Tag question	S12	Conjoined clauses
		V11	Past tense modal	Q11	Question with negation + inversion	S17	Infinitive clause: new subject
		V15	Emphasis or ellipsis				
		V17	Other morp. V/adv				

Note. NP = noun phrase; aux = auxiliary; V = verb; morph. = morpheme; adj = adjective; adv = adverb; S = subject.

Table 4. Index of Productive Syntax performance of "SH" by points earned based on conversation sample.

Nouns		Verbs		Questions/negations		Sentence structure	
				2 points			
N1	Noun	V1	Verb	Q1	Intonation	S1	2 words
N2	Pronoun	V2	Particle/preposition	Q2	Routine, etc.	S2	Subject–verb
N3	Modifier	V3	Prepositional phrase	Q8	Y/N inverted copula/modal/aux	S3	Verb–object
N4	2-word NP	V4	Copula linking 2 nouns			S6	Any 2 verbs
N5	Article before noun	V6	Auxiliary *BE, DO, have*			S7	Conjoined phrase
N6	2-word NP after verb	V8	Adverb			S10	Subordinate conjunction + clause
N7	Plural suffix	V13	Past tense auxiliary			S11	V + nominal clause, mental state
N9	3-word NP	V14	"Medial" adverb			S14	Bitransitive predicate
N11	Other morph. noun/adj	V15	Emphasis or ellipsis			S16	Relative clause
						S20	Passive or full tag comment clause
				1 point			
N8	2-word NP before verb	V7	Progressive *–ing*	Q3N	No(t) + X	S4	Subject–verb–object
N10	NP adverb	V16	Past tense copula	Q4	*Wh*-question + verb	S5	Conjunction (any)
				Q6	*Wh*- with inversion	S8	Infinitive
				Q7N	Negative copula/modal/aux	S9	*Let/Make/Help/Watch*
				Q9	*Why, When, Which, Whose*	S12	Conjoined clauses
						S13	If or *wh*-clause
						S18	Gerund
						S19	Front, center subordinate
				0 points			
		V5	Verb + infinitive	Q5N	Negative between S + verb	S15	3 or more (non aux) verbs
		V9	Modal before verb	Q10	Tag question	S17	Infinitive clause: new subject
		V10	Third-person singular present	Q11	Question with negation + inversion		
		V11	Past tense modal				
		V12	Regular past tense				
		V17	Other morp. V/adv.				

Note. NP = noun phrase; Morph. = morpheme; adj. = adjective; aux = auxiliary; V = verb; adv. = adverb; S = subject.

however, the TEGI test forms are limited to Third-Person Singular *–s*, Past Tense, BE forms, and DO forms. In this case, the TEGI would not be particularly useful. Instead, the clinician should develop probes specific to the forms identified as weaknesses with at least 10 items; preferably, these items will elicit use of the forms with varied vocabulary and in several syntactic frames, if possible. Probe data will provide information regarding SH's performance in another context, level of accuracy, and if the form should be targeted in treatment. The clinician can use this information to develop specific treatment goals or short-term objectives. Across treatment sessions, the clinician should track SH's progress on his individual goals. Once data indicate that he has met his goals based on the clinician's informal probes, the clinician may obtain additional conversational and narrative language samples and rerun IPSyn analyses to determine if PS's performance generalizes to other contexts and to document growth. If there is no generalization, the clinician should consider working on the targeted forms in more varied contexts. If the target forms indicate emergence, the clinician may analyze the samples obtained and additional probe data to help determine the next targets for intervention, as described above.

DSS Analysis

For SH's conversational sample, CLAN's DSS analysis yielded the following scores: Indefinite Pronoun/Noun Modifier = 3.00, Personal Pronoun = 1.80, Main Verb = 1.33, Secondary Verb = 2.40, Negative = 4.00, Conjunction = 4.36, Interrogative Reversal in Questions = NA and *Wh*-Questions = 2.00, and total score = 6.26. The .sltin.tbl (DSS) output appears in Appendix D. Note that the output provides sums for each category. Here, we report the average score for each category (e.g., sum/number of scores). For the narrative sample, DSS analysis yielded the following scores: Indefinite Pronoun/Noun Modifier = 2.50, Personal Pronoun = 2.38, Main Verb = 1.83, Secondary Verb = 5.00, Negative = 5.00, Conjunction = 3.18, Interrogative Reversal in Questions = NA and *Wh*-Questions = 2.00, and total score = 6.18.

The DSS total scores based on the conversational and narrative samples are quite similar: 6.26 and 6.18, respectively. Performance on each DSS category is also similar across sampling contexts. SH's scores in the Interrogative Reversal in Questions and *Wh*-Questions categories were low, but this is to be expected given that the language sampling contexts were not designed to elicit questions. CLAN identified only one occurrence across both categories for the conversational sample and two for the narrative sample. Similarly, there was a low occurrence rate of negatives, with two in the conversational context and three in the narrative context. Categories with higher occurrence rates for both contexts included Main Verbs, Personal Pronouns, and Conjunctions. Analyses also reveal moderate consistency of these scores across the conversational and narrative contexts, respectively (Main Verbs: 1.33 vs. 1.83, Personal Pronouns: 1.80 vs. 2.38, Conjunctions: 4.36 vs. 3.18).

With these data, clinicians should consider developing goals in three ways. First, clinicians should examine categories with few occurrences and consider building goals that aim to increase the inclusion of forms within the category. For example, there were few attempts of the forms that fall under the Indefinite Pronouns or Noun Modifiers category, with four in the conversational sample and three in the narrative sample with scores of 1, 3, and 7. Thus, it may be beneficial to focus on increasing SH's use of these forms at any level.

Second, clinicians should consider increasing the level of complexity represented by the forms under specific categories. For example, SH's Main Verb score was 1.33 based on his conversational sample and 1.83 based on his conversational sample. SH attempted or produced a main verb 68 times in his conversational sample and 61 times in his narrative sample. In his conversational sample, the majority of his main verbs received a score of 1 (41 verbs); the next most frequent score was 2 (21 verbs). Review of SH's conversational sample indicates that he used each of the 1-point Main Verb forms, including uninflected verb, copula "is," and auxiliary "is" forms. In the narrative sample, the majority of his main verbs received a score of 2 (44 verbs); the next most frequent score was 1 (15 verbs). Review of SH's narrative sample indicates that he often used the third-person singular *–s* and regular and irregular past tense forms. Given this information, a potential goal could be to increase SH's verb complexity by using more varied copula and auxiliary forms (i.e., "am," "are," "was," and "were"), which are within the 2-point Main Verb category. Target forms could also be more developmentally advanced forms such as the use of modals (i.e., "can," "will," "may," "could," "would," "should," or "might" plus a verb).

Third, clinicians should consider forms that the child or adolescent produced with error. For example, SH received 0 points for his pronoun usage error in his utterance, "Her I got." There are other instances in which SH produces "her" in the correct position, such as "Miss Tammy's gone so she has a replace for her" and "Well, it's cookies, raisins, nuts, cashews, and coleslaw and noodles, bread and milk and eggs for her." The error does not appear to be a consistent error for SH and likely does not need to be targeted in treatment. Thus, it is important for clinicians to examine forms that receive 0 points and determine if they are truly problematic by either further examining the sample or administering probes focused on the form in question.

As described above, clinicians can also use CLAN's DSS data to monitor goals. Once the clinician's daily data suggest that SH increased his use, complexity, and/or accuracy of target forms, the clinician may obtain additional conversational and narrative language samples and rerun DSS analyses. The average points earned within categories can be examined to monitor progress on short-term goals, while the overall Developmental Sentence Score may serve as a measure to monitor progress on long-term goals. Comparisons of the initial and subsequent analyses will indicate the extent of SH's progress. The clinician can also analyze the DSS as described above to determine new targets for intervention.

Conclusions

IPSyn and DSS offer clinicians rich data that can be used to assist in diagnosis, develop treatment goals, and monitor progress on treatment goals. An advantage of using data drawn from language samples is that language samples are likely to be more representative of individuals' language in social and academic environments compared to performance on highly structured standardized assessments. Additionally, children and adolescents have more opportunities to demonstrate use of many grammatical forms within a language sample than many structured, standardized tests. Moreover, language samples afford the advantage of repeated administration within a short time period that structured standardized assessments do not. This makes language sampling a strong assessment tool. However, when using language samples, it is important for clinicians to consider the sampling context. In our case illustration, SH's performance across the conversational and narrative contexts was similar; however, there were some notable differences. For example, there was much more frequent use of past tense forms in the narrative context than in the conversational context.

CLAN is a free, relatively simple, reliable, and time-efficient tool that clinicians can use to facilitate language sample analyses, including IPSyn and DSS. Although it is necessary for clinicians and researchers to transcribe language samples when using CLAN to obtain KIDEVAL, IPSyn, and DSS reports, much time can be saved using this automated system. As Heilmann (2010) reports, a 50-utterance language sample may be elicited in as little as 5 min and require 25 min to transcribe (5 transcription minutes per sample minute). Automated CLAN analyses require less than 5 min to complete. Based on these estimates, clinicians and researchers can complete the entire assessment in approximately 35 min. This time demand is similar to the time required to administer and score standardized assessments but will yield richer information. As we demonstrated in our case illustrations, both IPSyn and DSS analyses may prove to be of great benefit to clinicians to support diagnostic decisions, to develop treatment goals focused on grammatical forms, and to monitor progress on these goals.

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Appendix A

Language Sampling Measures Included in CLAN's KIDEVAL Report

KIDEVAL variable	Description
Total_Utts	Total number of utterances the speaker produced
MLU_Utts	Number of utterances used to calculate MLU
MLU_Words	MLU in words
MLU_Morphemes	MLU in morphemes
MLU100_Utts	Number of utterances in the first 100 utterances (documents if there were 100 available)
MLU100_Words	MLU in words based on the first 100 utterances in the sample
MLU100_Morphemes	MLU in morphemes based on the first 100 utterances in the sample
FREQ_types	Number of different words used in the sample (types)
FREQ_tokens	Total number of words used in the sample (tokens)
FREQ_TTR	Type–token ratio
NDW_100	Number of different words based on the first 100 words
VOCD_D_optimum_average	Vocabulary diversity measured using VOCD
Verbs_Utt	Number of verbs per utterance
Word_Errors	Number of words involved with errors
Utt_Errors	Number of utterances involved with errors
Retracing	Number of retracings or revision mazes
Repetition	Number of repetitions or repetition mazes
DSS_Utts	Number of utterances with a subject and a verb used to calculate DSS
DSS	Developmental Sentence Score
IPSyn_Utts	Number of utterances available to calculate IPSyn score
IPSyn_Total	Total IPSyn score
mor_Words	Number of words based on the %more tier
*-PRESP	Number of occurrences of the present participle *–ing*
In	Number of occurrences of the preposition *in*
On	Number of occurrences of the preposition *on*
*-PL	Number of occurrences of the regular plus *–s*
*PAST	Number of occurrences of irregular past tense
*-POSS	Number of occurrences of the possessive *–'s*
cop*	Number of occurrences of the uncontractible copula
det:art	Number of occurrences of determiners/articles
*-PAST	Number of occurrences of the regular past tense *–ed*
*–3S	Number of occurrences of the third-person singular *–s*
*3S	Number of occurrences of the irregular third-person singular present
aux*	Number of occurrences of the uncontractible auxiliary
cop*	Number of occurrences of the contracted copula
aux*	Number of occurrences of the contracted auxiliary
Total_non_zero_mors	Total number of

Appendix B (p. 1 of 2)

Step-by-Step Guide for Using CLAN to Conduct IPSyn and DSS Analyses

1. Introduction

a. This tutorial breaks down the steps to successfully analyze grammar complexity with DSS or IPSyn using samples transcribed in CLAN using CHAT conventions or samples transcribed using SALT conventions. However, clinicians should reference *A Clinician's Complete Guide to CLAN and PRAAT* (Ratner & Brundage, 2018) as well as tutorial screencasts created by Fromm (https://talkbank.org/screencasts/) for more complete information.

b. This tutorial uses the latest software updates as of March 2019. Please note, if you are using an older version of CLAN, the command terms may have changed. Likewise, command terms may change in the future.

c. NOTE: commands in bold are NOT case sensitive.

2. Getting Started

a. To analyze your language sample, you will need to transcribe it using either CHAT conventions within CLAN or SALT conventions. Using CHAT conventions makes the analysis process more seamless, but either method is relatively simple. See *Part 1: The CHAT Transcription Format* (MacWhinney, 2000) and *A Clinician's Complete Guide to CLAN and PRAAT* (Ratner & Brundage, 2018) for procedures for transcribing using CHAT conventions. See the SALT website (https://www.saltsoftware.com) and associated training resources (https://www.saltsoftware.com/training) for procedures to transcribe using SALT conventions.

b. You will need CLAN software. CLAN is the child language component of a program known as TalkBank. TalkBank was created by Brian MacWhinney to increase the amount and quality of research conducted on spoken communication. You can learn more at www.talkbank.org. CLAN is what we use to convert SALT files and analyze the files using IPSyn or DSS. There are several versions available depending on your transcription and analysis needs. Please choose the best one for your needs. You can download CLAN at http://dali.talkbank.org/clan/.

3. Converting SALT files

a. If you transcribed your sample using CHAT conventions, skip to Step 4.

b. If you transcribed your sample using SALT conventions, you will need to convert your SALT file (which ends in **.slt**) to a **.sltin.cha** file.

c. Open CLAN. A larger output window should open with a smaller command window in which to type. Type **SALT2CHAT** in the command window. Once that is done, a "File In" button should appear, next to a "Tiers" and "Search" button. Press the "File In" button. Using the Drives and/or Directories menus, find the file on which you wish to run the conversion.

d. You can double-click this file to add it to the right side of your window, or you can select it by pressing the "Add->" button.

e. Selecting the file will close the box and bring you to the original command window where you typed "SALT2CHAT." An "@" symbol will appear. Press "Run."

f. The last line of the output will be a link. Triple-click this link to access your .cha file. It will appear in the form of a typical transcript.

g. In the command window, type **CHECK**, "File In" your new .cha file, and remove your original .slt file. Press "Done" and then "Run." This will display any errors that need to be corrected.

h. If errors are present, triple-click the output link. Correct errors within the transcript.

i. You will need to check until there are no more errors. Be sure to save your file after correcting errors and before each new check.

j. When the last errors are checked, the file will be ready for the next step. This file is automatically saved as a **.cha** file now and can be found in its original location.

4. Running MOR

a. Once you have created a **.cha** file, the file needs to be analyzed on the morphological level. Running the MOR command will break the utterances apart for analysis of each component. To download MOR, within the CLAN application, go to "File" in the toolbar and select "Get MOR Grammar." For English parsing, select "English-eng."

b. To run MOR, open CLAN. A larger output window will open with a smaller command window in which you can type. Type **MOR.** Once that is done, a "File In" button will appear, next to a "Tiers" and "Search" button. Press the "File In" button. Using the Drives and/or Directories menus, find the file on which you wish to run the MOR command. You can double-click this file to add it to the right side of your window, or you can select it by pressing the "Add->" button.

c. Selecting the file will close the box and bring you to the original command window. An "@" symbol will appear. Press "Run."

d. A large CLAN output window will appear. The red output will indicate how many words appear in your transcript and how many of those words the MOR command does not recognize. Under this output, you should also see a black "output file" link. Triple-click this link. Triple-clicking the output file link will provide a list of the specific words that are not recognized, prompting you to manually correct them. Errors may be as simple as a misspelling, or you may need to use CHAT transcription methods to have the software recognize a proper noun or a filler word. Please refer to Table 1 for common errors in this process and how to fix them.

e. To fix errors, triple-click on the "File" link under the error identified. This will bring you directly into the transcription file for editing. Fix the error, click the save button at the top of the screen, and then run the **MOR @** command again. This will bring you back to the original list, with one less error. Repeat until all errors have been resolved.

f. Once all errors are resolved, triple-click the output file and run the **check @** command. If no other errors are present, you have successfully run the MOR command to check for errors that would have possibly invalidated your IPSyn or DSS results.

5. Running KIDEVAL

a. To initiate KIDEVAL analysis, open CLAN and, in the small command window, type "**kideval**." Select "Option" to the right of "Progs" and select the same .cha file you saved after running MOR. You can select "Compare to Database" to get normative data. Once this is done, an @ sign will appear. Press "Run."

b. The large output window will appear with an output file link. The file will now end in **.xls**. Triple-click this link.

c. You can now access your KIDEVAL scores. The kideval.xls file contains 37 unique language sampling measures, including total IPSyn score and the DSS, along with database comparisons. Appendix A lists the variables included in the KIDEVAL file along with brief descriptions of each variable. To obtain full DSS and IPSyn reports, you will need to complete the two additional steps described below.

6. IPSyn Analysis

a. To initiate IPSyn analysis, open CLAN again and, in the small command window, type "**ipsyn +t*CHI -leng**". "File In" the same .cha file you saved after running MOR. An @ sign will appear. Press "Run." (Note: If running a file with less than 50 utterances, you will need to specify your utterances with **+c**. For example, a file with 37 utterances would be specified with **+c37**. In its entirety, it would read: **ipsyn +t*CHI -leng +c37**.)

b. The large output window will appear with an output file link. The file will now end in **.ipsyn.cex.** Triple-click this link.

c. You now can access your Index of Productive Syntax scores.

7. DSS Analysis

a. To initiate DSS analysis, open CLAN again and, in the small command window, type "**dss +t*CHI +le +e**". "File In" the same .cha file you saved after running MOR. Once this is done, an @ sign will appear. Press "Run."

b. The large output window will appear with an output file link. The file will now end in **.tbl.cex**. Triple-click this link.

c. You now can access your Developmental Sentence Analysis table.

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CLAN IPSyn Analysis

```
ipsyn +t*CHI -leng +c
Tue Apr 09 11:35:55 2019
ipsyn (11-Oct-2017) is conducting analyses on:
  ONLY speaker main tiers matching: *CHI;
    and those speakers' ONLY dependent tiers matching: %MOR:; %GRA:;
****************************************
From file <c:\Ipsyn102c.sltin.cha>
*** Speaker: *CHI:
Ipsyn102c.sltin.cha
Rule: N1
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point1: n|white
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point2: n|day
  Score: 2
Rule: N2
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point1: pro:per|you
      File "c:\Ipsyn102c.sltin.cha": line 35.
    Point2: pro:obj|me
  Score: 2
Rule: N3
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point1: det:art|the
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point2: adj|white
  Score: 2
Rule: N4
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point1: det:art|the n|white
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point2: adj|white n|day
  Score: 2
Rule: N5
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point1: det:art|the n|white
      File "c:\Ipsyn102c.sltin.cha": line 22.
    Point2: det:art|a n|red
  Score: 2
Rule: N6
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point1: v|have det:art|the n|white
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point2: v|do adj|different n|thing-PL
  Score: 2
Rule: N7
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point1: n|thing-PL
      File "c:\Ipsyn102c.sltin.cha": line 43.
    Point2: n|good&dadj-DIM-PL
  Score: 2
Rule: N8
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point1: adj|white n|day cop|be&3S
  Score: 1
Rule: N9
      File "c:\Ipsyn102c.sltin.cha": line 154.
    Point1: det:art|a adj|new n|choir
      File "c:\Ipsyn102c.sltin.cha": line 159.
    Point2: det:art|a adj|nice n|guy
  Score: 2
Rule: N10
      File "c:\Ipsyn102c.sltin.cha": line 118.
    Point1: adv|about det:num|fifteen
  Score: 1
```

CLAN IPSyn Analysis

```
Rule: N11
        File "c:\Ipsyn102c.sltin.cha": line 46.
  Point1: grand#n|ma
        File "c:\Ipsyn102c.sltin.cha": line 66.
    Point2: n|teach&dv-AGT
  Score: 2
Rule: V1
        File "c:\Ipsyn102c.sltin.cha": line 12.
    Point1: v|have
        File "c:\Ipsyn102c.sltin.cha": line 17.
    Point2: cop|be&3S
  Score: 2
Rule: V2
        File "c:\Ipsyn102c.sltin.cha": line 30.
    Point1: prep|on
        File "c:\Ipsyn102c.sltin.cha": line 35.
    Point2: prep|in
  Score: 2
Rule: V3
        File "c:\Ipsyn102c.sltin.cha": line 30.
    Point1: prep|on det:art|a n|shop
        File "c:\Ipsyn102c.sltin.cha": line 35.
    Point2: prep|in adj|seventh n|hour
  Score: 2
Rule: V4
        File "c:\Ipsyn102c.sltin.cha": line 22.
    Point1: n|day cop|be&3S pro:per|you
        File "c:\Ipsyn102c.sltin.cha": line 189.
    Point2: pro:per|it cop|be&3S det:art|a
  Score: 2
Rule: V5
  Score: 0
Rule: V6
        File "c:\Ipsyn102c.sltin.cha": line 115.
    Point1: aux|be&PAST&13S part|amaze-PASTP
        File "c:\Ipsyn102c.sltin.cha": line 127.
    Point2: ~aux|have cop|be&PASTP
  Score: 2
Rule: V7
        File "c:\Ipsyn102c.sltin.cha": line 162.
    Point1: part|tell-PRESP
  Score: 1
Rule: V8
        File "c:\Ipsyn102c.sltin.cha": line 9.
    Point1: adv:tem|today
        File "c:\Ipsyn102c.sltin.cha": line 30.
    Point2: adv|out
  Score: 2
Rule: V9
  Score: 0
Rule: V10
  Score: 0
Rule: V11
  Score: 0
Rule: V12
  Score: 0
Rule: V13
        File "c:\Ipsyn102c.sltin.cha": line 76.
    Point1: mod|do&PAST
        File "c:\Ipsyn102c.sltin.cha": line 115.
    Point2: aux|be&PAST&13S
  Score: 2
```

Appendix C (p. 3 of 5)

CLAN IPSyn Analysis

```
Rule: V14
      File "c:\Ipsyn102c.sltin.cha": line 27.
    Point1: adv:tem|today cop|be&PAST&13S
      File "c:\Ipsyn102c.sltin.cha": line 95.
    Point2: adv|never v|hear&PAST
  Score: 2
Rule: V15
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point1: cop|be&3S
      File "c:\Ipsyn102c.sltin.cha": line 62.
    Point2: mod|do
  Score: 2
Rule: V16
      File "c:\Ipsyn102c.sltin.cha": line 27.
    Point1: cop|be&PAST&13S
  Score: 1
Rule: V17
  Score: 0
Rule: Q1
    ADD: score: 2
  Score: 2
Rule: Q2
    ADD: score: 2
  Score: 2
Rule: Q3
      File "c:\Ipsyn102c.sltin.cha": line 127.
    Point1: ~neg|not
  Score: 1
Rule: Q4
      File "c:\Ipsyn102c.sltin.cha": line 162.
    Point1: pro:int|what v|do
  Score: 1
Rule: Q5
  Score: 0
Rule: Q6
      File "c:\Ipsyn102c.sltin.cha": line 107.
    Point1: pro:int|what cop|be&PAST&13S
  Score: 1
Rule: Q7
      File "c:\Ipsyn102c.sltin.cha": line 127.
    Point1: mod|do ~neg|not
  Score: 1
Rule: Q8
      File "c:\Ipsyn102c.sltin.cha": line 22.
    Point1: cop|be&3S pro:per|you
      File "c:\Ipsyn102c.sltin.cha": line 27.
    Point2: cop|be&PAST&13S det:art|a n|white
  Score: 2
Rule: Q9
      File "c:\Ipsyn102c.sltin.cha": line 17.
    Point1: conj|when
  Score: 1
Rule: Q10
    Score: 0
Rule: Q11
    Score: 0
Rule: S1
      File "c:\Ipsyn102c.sltin.cha": line 9.
    Point1: co|yeah cm|cm
      File "c:\Ipsyn102c.sltin.cha": line 12.
    Point2: co|well adv:tem|today
  Score: 2
```

Rule: S2
File "c:\Ipsyn102c.sltin.cha": line 12.
Point1: pro:sub|we v|have
File "c:\Ipsyn102c.sltin.cha": line 17.
Point2: n|day v|do
Score: 2
Rule: S3
File "c:\Ipsyn102c.sltin.cha": line 12.
Point1: v|have det:art|the n|white
File "c:\Ipsyn102c.sltin.cha": line 17.
Point2: v|do adj|different n|thing-PL
Score: 2
Rule: S4
File "c:\Ipsyn102c.sltin.cha": line 17.
Point1: pro:per|you v|do adj|different n|thing-PL
Score: 1
Rule: S5
File "c:\Ipsyn102c.sltin.cha": line 35.
Point1: coord|and
Score: 1
Rule: S6
File "c:\Ipsyn102c.sltin.cha": line 71.
Point1: v|have v|do
File "c:\Ipsyn102c.sltin.cha": line 95.
Point2: v|say&PAST v|hear&PAST
Score: 2
Rule: S7
File "c:\Ipsyn102c.sltin.cha": line 35.
Point1: pro:obj|me coord|and n:prop|Miss_fan
File "c:\Ipsyn102c.sltin.cha": line 53.
Point2: n|coleslaw coord|and n|noodle-PL
Score: 2
Rule: S8
File "c:\Ipsyn102c.sltin.cha": line 71.
Point1: inf|to
Score: 1
Rule: S9
File "c:\Ipsyn102c.sltin.cha": line 121.
Point1: v|let~pro:obj|us v|see
Score: 1
Rule: S10
File "c:\Ipsyn102c.sltin.cha": line 17.
Point1: conj|when
File "c:\Ipsyn102c.sltin.cha": line 132.
Point2: conj|like
Score: 2
Rule: S11
File "c:\Ipsyn102c.sltin.cha": line 121.
Point1: v|see
File "c:\Ipsyn102c.sltin.cha": line 167.
Point2: v|go
Score: 2
Rule: S12
File "c:\Ipsyn102c.sltin.cha": line 17.
Point1: n|day conj|when pro:per|you
Score: 1
Rule: S13
File "c:\Ipsyn102c.sltin.cha": line 127.
Point1: pro:int|where det:art|the n|place-PL
Score: 1
Rule: S14
File "c:\Ipsyn102c.sltin.cha": line 12.
Point1: v|have det:art|the n|white n|day
File "c:\Ipsyn102c.sltin.cha": line 71.
Point2: v|have qn|some n|subtraction n|problem-PL
Score: 2

Appendix C (p. 5 of 5)

CLAN IPSyn Analysis

Rule: S15
Score: 0
Rule: S16
File "c:\Ipsyn102c.sltin.cha": line 102.
Point1: eq|eq
File "c:\Ipsyn102c.sltin.cha": line 127.
Point2: cop|be&PASTP
Score: 2
Rule: S17
Score: 0
Rule: S18
File "c:\Ipsyn102c.sltin.cha": line 35.
Point1: n:gerund|shop-PRESP
Score: 1
Rule: S19
File "c:\Ipsyn102c.sltin.cha": line 132.
Point1: conj|like
Score: 1
Rule: S20
File "c:\Ipsyn102c.sltin.cha": line 115.
Point1: aux|be&PAST&13S part|amaze-PASTP
File "c:\Ipsyn102c.sltin.cha": line 132.
Point2: aux|get&PAST part|confuse-PASTP
Score: 2
N = 20
V = 20
Q = 11
S = 28
Total = 79

Appendix D (p. 1 of 2)

CLAN DSS Analysis

dss +t*CHI -leng
Sat Apr 20 12:10:36 2019
dss (12-Apr-2019) is conducting analyses on:
  ONLY speaker main tiers matching: *CHI;
    and those speakers' ONLY dependent tiers matching: %MOR:;
****
From file <c:\SYN102c.sltin.cha>
@Font:

Developmental sentence analysis

Sentence	IP	PP	MV	SV	NG	CNJ	IR	WHQ	S	TOT
&um well today, we have the white day .		3	1						1	5
white day is when you do different things .			1 1			8			1	11
a red day is you do different things too .			1 1						1	3
so today was a white day.			2						1	3
&um I went out on a shop seventh hour .		1	2						1	4
well (.) in seventh hour, me and miss gold went shopping .		1	2			3			1	7
I buy [^ ew:bought] goodies .		1	~~1~~ 0						~~1~~ 0	3
she was sick .		2	2						1	5
well, it's cookies, raisins, nuts, cashews, and coleslaw and noodles, bread and milk and eggs for her .			1			3 3 3 3	~~1~~		1	15
I do math .		1	1						1	3
they have some subtraction problems for me to do .		3 1	1 2 1						1	9
so I did that .		1	2						1	4
I do science .		1	1						1	3
I was a star .		1	2						1	4
well (.) missus Smith, my aid, said ‚Äúhm, <I> [/?] I never heard of this rule before‚Äù .		1 1	~~1~~ 2 2						1	8
‚Äúhm, this is something new‚Äù .	1 3		1						1	6
‚Äúhm, well <&w> [/?] what was the answer ‚Äù ?		~~6~~	2					2	1	11
and then I said ‚Äúxxx‚Äù .		1	2			3			1	7
she was amazed .		2	7						1	10
well, let's see .		3	1 ~~1~~	2					1	8
sometimes, I get [^ ew:am] tardy .		1	1						1	3
and 0I don't know where the places I've been .		1	4 1		4	3			0	13
red days, I have math first hour .		1	1						1	3
white days, I got [^ ew:have] choir first hour .		1	~~2~~ 0						~~1~~ 0	~~4~~ 3
choir, we even got a new choir teacher named mister Tom .		3	2 2						1	8
he is a nice guy .		2	1						1	4
he is telling the people what to do .		2 6	1					2	1	12
like, altos sing wherever you go .			1 1			8			1	11
then they all sing .		3	1						1	5
I know .		1	1						1	3
yeah, I do .		1	1						1	3
it is a him .		2	1						1	4
&um he is a popular guy .		2	1						1	4
he's from minneapolis .		2	1						1	4
he goes to school there .		2	2						1	5
and <&uh (.) he's> [/?] he's like happy as a teacher .		2	1			3 8			1	15
so, he came in this room and said ‚ÄúI'm a new teacher everyone‚Äù .	7	2 1	2 2 2			3			1	20
there are [^ ew:is] missus betz .			~~2~~ 0				~~1~~		~~1~~ 0	~~4~~ 3
that's John's aid .	1		1						1	3

Appendix D (p. 2 of 2)

CLAN DSS Analysis

Sentence	IP	PP	MV	SV	NG	CNJ	IR	WHQ	S	TOT
her I got [^ eu] .		~~2~~ 0 1	~~2~~ 0						~~1~~ 0	~~6~~ 5
then there's &uh missus Sterling, Matt's aid .			1				~~1~~		1	3
miss Tammy's gone so she has a replace [^ ew:replacement] for her .		2 2	1 2			5			~~1~~ 0	~~9~~ 8
she retired .		2	2						1	5
so did mister Dave .			2						1	3
<&um then I have> [/?] let's see, then I had a new P_T teacher named missus Hammond .		3 1	1 1 2	2 4					1	15
then I have a [^ ew:an] O_T teacher,		1	1						~~1~~	~~3~~
missus jenny .									0	2
<he> [/?] she is from Kansas .		2	1						1	4
well, yeah I do .		1	1						1	3
<&um I &um (.)> [/?] oh yeah &um let's see, I have lunch .		3 1	1 1 1	2					1	10
let's see, <I I> [/?] oh yeah, I have Stromboli, if you don't know .		3 1	1 1 1 4 1	2	4	5			1	24
Total	12 3.00	88 1.80	91 1.33	12 2.4	8 4.00	61 4.36	0 0	2 2.00	39	313
Developmental Sentence Score: 6.26										

Note. Names and places have been changed to protect the participant's identity. Key for unusual symbols: & = filled pauses; (.) = unfilled pauses; [^ ew: "word"] = word error: correct word; Äú = quotes; <> = repetitions; [/?] = unclear maze or retracing type; [^ eu] = utterance error; 0 = missing word.