ABSTRACT

Title of Document: THE DEVELOPMENT OF SYNTACTIC COMPLEXITY AND THE IRREGULAR PAST TENSE IN CHILDREN WHO DO AND DO NOT STUTTER.

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This study examined spontaneous language samples and standardized test data obtained from 31 pairs of children who stutter (CWS), ages 25-59 months, and age-matched children who do not stutter (CWNS). Developmental Sentence Scores (DSS; Lee, 1974) as well as the relationships among age, DSS, and other standardized test scores were compared for both groups. No substantial differences were found between groups in the syntactic complexity of spontaneous language; however, the two groups show different relationships between age and DSS and between test scores and DSS. Additionally, observed differences between CWS and CWNS in patterns of past-tense errors and usage are discussed in light of a recent theoretical model of language performance in populations with suspected basal ganglia involvement (Ullman, 2004).

THE DEVELOPMENT OF SYNTACTIC COMPLEXITY AND THE IRREGULAR PAST TENSE IN CHILDREN WHO DO AND DO NOT STUTTER

by

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1. Introduction

1.1 Syntactic complexity and disfluency in children who stutter

Children who stutter (CWS) produce stuttered disfluencies in all kinds of sentences. A variety of experimental and observational studies, however, have shown that they do so more frequently in sentences that are longer and more complex than their "average" sentences than they do in sentences that are shorter and simpler (Bernstein Ratner & Sih, 1987; Gaines, Runyan, & Meyers, 1991; Weiss & Zebrowski, 1992; Logan & La Salle, 1999; Logan & Conture, 1997; Zackheim & Conture, 2003). This is not the only known interaction between syntax and stuttering in children. The earliest reported onset of stuttering is at age 18 months, when children begin to combine words into the earliest sentence-like structures (Bloodstein & Bernstein Ratner, 2008). Furthermore, CWS stutter more frequently at clause boundaries than elsewhere in a sentence (Howell & Au-Yeung, 1995). Accordingly, utterances in which CWS stutter contain more clauses and clause constituents than utterances in which they do not stutter (Logan & Conture, 1997). Finally, young CWS stutter more on function words, the words that express grammatical relationships among words in a sentence, than on content words (Bernstein, 1981; Dworzynski, Howell, & Natke, 2003; Natke, Sandrieser, Pietrowsky, & Kalveram, 2006; Au-Yeung, Gomez, & Howell, 2006).

The effect of syntactic complexity on fluency is more robustly present at younger ages, but is less clear or absent at older ages. Experimental evidence from this line of research shows that adolescents and adults who stutter (AWS) do not stutter more frequently when imitating more complex sentences than when imitating less complex sentences (Silverman[1] & Bernstein Ratner, 1997; Logan, 2001), while younger children do (Bernstein Ratner & Sih, 1987).

While it is thus relatively well-established that syntactic complexity differentiates the relative degrees of fluency in the speech of young CWS, it remains a rather open question whether this relationship correlates with different patterns in the development of syntactic complexity for CWS and children who do not stutter (CWNS). That is, while it is clear that syntactic complexity plays a role in the moment of stuttering for CWS, it is less clear that differences in the development of syntactic complexity are associated with status as a CWS or a CWNS.

1.2 Comparative syntactic development in CWS and CWNS: a review of the research

The literature on syntax and stuttering, consisting of standardized test-based, experimental, and observational data, broadly supports the idea of noticeable differences between the syntactic development of CWS and CWNS, but does not do so unequivocally. As will be discussed below, standardized test-based research suggests either weaker syntactic performance by CWS or equal performance for the two groups; experimental research most clearly suggests weaker syntactic performance by CWS, and observational data provide evidence for weaker, equal, or even stronger performance by CWS. Because this study focuses on the language of very young CWS, the review of the literature will focus on this age group.

[1] Publishing later as Wagovich.

1.2.a Standardized language test performance

CWS have received lower scores than CWNS on standardized tests of language that include an expressive syntactic component in several studies. Studies reporting this finding have varied in the significance of the difference found between the two groups' scores. Differences in this direction have been reported using the *Pre-School Language Scale* (Zimmerman, Steiner, & Evatt, 1969; Murray & Reed, 1977), the *Test of Language Development - Primary* (Newcomer & Hammill, 1988; Ryan, 1992), the *Test of Early Language Development, 2nd edition* (Hresko, Reid, & Hammill, 1991; Anderson & Conture, 2000), *Clinical Evaluation of Language Functions – Preschool* (Wiig, Secord, & Semel, 1992; Bernstein Ratner & Silverman, 2000), and the *Test of Language Development, 3rd edition* (Newcomer & Hammill, 1997; Berman Hakim & Bernstein Ratner, 2004).

In contrast to the findings above, the University of Illinois Stuttering Project, a large cohort study, did not find an appreciable difference between the performance of pre-school-aged CWS on the *Preschool Language Scale-Revised* (PLS-R) (Zimmerman, Steiner, & Pond, 1979) and normative data provided for that test (Watkins, 2005). The authors of the University of Illinois Stuttering Project, furthermore, have pointed out that the standardized test scores of the control groups in several of the studies listed above have substantially exceeded normative expectations for the test (Watkins & Johnson, 2004). Since several of these studies have not controlled for maternal education, Watkins and Johnson (2004) posit that socio-economic status (SES) may be responsible for any difference between the CWS' and CWNS' performance on these tests.

While this argument raises a legitimate concern, it does not account for those instances where differences in test scores have been found where maternal education is matched (e.g., Silverman & Bernstein Ratner, 2000; Berman Hakim & Bernstein Ratner, 2004). It also does not exclude the possibility that CWS recruited to participate in a university-based research project may themselves not actually be perfectly SES-matched to normative data developed from a broader population sample.

In any case, standardized tests of any sort probably constitute inappropriately large-grained filters for the detection of language skill differences that do not correspond to clinical diagnosis of frank impairment (Bernstein Ratner, 1997). This reservation against placing too much weight on standardized-test-based data is compounded by the variety of tests used in the research gathering that data.

A use of standardized test data that might more closely approximate a fine-grained filter for examining subtle language skill differences would be to correlate standardized test data with other performance data. This would better enable comparisons between groups of the balance between language knowledge, as measured by standardized tests, and performance, as measured by language samples. It would also better enable comparisons of profiles across linguistic domains, such as relative strengths in syntax and semantics.

1.2.b Experimental Studies

The results of experimental studies, while also not unanimous, generally present a clearer picture of differences in syntactic development between the two groups than does the literature on standardized testing. Although CWS ages 3;11 to 6;4 show abilities to repeat sentences of varying complexity that are similar to the abilities of CWNS (Bernstein Ratner & Sih, 1987), CWS ages 3;3 to 5;5 have been shown to be both less efficient and less accurate at producing sentences with familiar syntactic forms than CWNS, and to show greater gains in speed of producing a sentence than CWNS when provided with a syntactic prime by an adult (Anderson & Conture, 2004). In the age range of 5;10 to 8;10, they are less accurate than CWNS when asked to judge the syntactic correctness of sentences (Bajaj, Hodson, & Schommer-Aiken, 2004), a pattern that has also been found for adults who stutter (AWS), although only when they are placed under a time constraint (Cuadrado & Weber-Fox, 2003). Watson et al. (1991) similarly found a subset of AWS to have a significantly greater number of errors on a variety of receptive and expressive syntactic tasks, including simple and complex discourse formation and resolution of syntactically ambiguous sentences.

1.2.c Language sample analysis

Comparisons of conversational language samples of CWS and CWNS have yielded a variety of results about the comparative length and complexity of sentences produced by CWS and CWNS. A large amount of data in this regard has come out of the University of Illinois Stuttering Project. Mean Length of Utterance (MLU), a measure of utterance complexity using length in morphemes, has not differed between participant data for CWS and normative data derived from CWNS in the broad age range of 2;3 to 5;5 (Yairi, Ambrose, Paden, & Throneburg, 1996), or between CWS who recovered from stuttering vs. those who persisted in stuttering in the same age range (Watkins, Yairi, & Ambrose, 1999).

For the narrower age range of children younger than three years, however, both CWS who persist in stuttering and those who recover do differ from CWNS by showing a greater MLU than normative data for CWNS (Watkins, Yairi, & Ambrose, 1999). This finding seems potentially in disagreement with the standardized test-based and experimental literature on differences in syntax between CWS and CWNS, which suggests either weaker performance by CWS or no difference.

CWS from this very young age group who recover from stuttering show a slower growth curve in syntactic complexity after this high point in MLU is reached than do CWS who persist in stuttering (Watkins, 2005). This finding has been replicated by another cohort study in Germany (Haege, 2001). Research in the treatment literature also shows that recovery from stuttering in the Lidcombe program is associated with slower-than-expected growth of MLU and Developmental Sentence Scores (DSS; Lee, 1974) between pre- and post-treatment scores (Bonelli, Dixon, Bernstein Ratner, & Onslow, 2000). This suggests that expressive performance in advance of age expectations and/or standardized language test performance may be a risk factor for the onset and/or continuation of stuttering.

Complicating the picture of higher-than-average or average MLU for young CWS is the fact that those who begin stuttering at later ages (i.e., three and four years) do not show this initial advanced stage of language performance (Watkins, Yairi, & Ambrose, 1999). Additionally, CWS between 4 and 5 years of age show steeper growth curves of syntactic development than age-matched CWNS peers, but do not actually have more syntactically complex spontaneous language (Buhr, 2007). Buhr's (2007) findings contradict the idea that all CWS below a certain age have significantly more complex syntax than CWNS, because if they did, there would be no way for them to show the demonstrated greater gains in complexity between ages 4 and 5 without continuing to have advanced syntactic complexity.

Constituent analyses of spontaneous language samples from CWS and age-matched peers have indicated that CWS ages 5 years to 6 years (Wall, Starkweather, & Cairns, 1981) and in the broad age range of 2 years, 7 months through 6 years 6 months (Howell & Au-Yeung, 1995) use simple sentences more frequently than CWNS and use complex sentences less frequently than CWNS. This difference appears to decrease with age (Howell & Au-Yeung, 1995).

A problem arising from constituent analysis, however, is that the results can depend quite heavily on the definition of "simple" and "complex" utterances; in fact, Howell & Au-Yeung's results disagree with a differently operationalized analysis of the same data set by the same research team, which found no difference in the use of simple and complex utterances (Kadi-Hanifi & Howell, 1992).

In sum, findings from spontaneous language analysis raise the very real possibility that asking questions about inter-group differences in terms of relative performance may be very different from asking the same questions in terms of relative timing.

1.3 Comparing the morphosyntax of CWS and CWNS further

1.3.a Developmental expectations

DSS may hold particular appeal as a measure of syntactic complexity for exactly these sorts of questions. DSS provides information beyond MLU because it differentially weights the child's use of developmentally more difficult syntactic constructions and forms, and provides a score that can be compared to age expectations. Two previous studies have used DSS to compare the spontaneous language of CWS and CWNS. Neither found significant differences between the two groups, but both yielded other results of interest. Westby (1979) found a significantly greater number of grammatical errors in the language of CWS, and Buhr (2007) found the previously mentioned difference in the trajectory of syntactic growth for the two groups.

DSS has also been used to compare stuttered and fluent utterances in the speech of CWS; for both persistent and recovered CWS and for a broad range of ages, less fluent utterances have been associated with higher DSS values (Gaines, Runyan & Meyers, 1991; Watkins, Yairi, & Ambrose, 1999). The University of Illinois Stuttering Project also found DSS results similar to those for MLU; CWS with stuttering onset younger than age 3 showed higher DSS than expected from normative data, and this trend disappeared with age (Watkins, Yairi, & Ambrose, 1999).

1.3.b Verb use: morphosyntactic and lexical influences

A further example of the limited utility of MLU in comparing the morphosyntax of CWS and CWNS is that utterance length in morphemes does not reflect other findings suggestive of potential differences in morphosyntax, particularly as MLU rises above an average of 4.0 (Brown, 1973).

The broader literature surrounding stuttering and verbs, which carry the bulk of morphosyntactic information in a sentence (Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005), strongly suggests subtle differences between CWS and CWNS with regard to the frequency of use of verbs and specific kinds of verbs, and with regard to the organization of verbs in the lexicon. With regard to usage frequency, in one study, CWS used fewer verbs per utterance than did CWNS (St. Louis, Hinzman, & Hull, 1985). CWS have also been shown to use significantly fewer verbs overall and fewer different verbs than CWNS (Wagovich & Bernstein Ratner, 2007) and to use fewer copulas (Wagovich & Bernstein Ratner, 2007; Pawlowska, Brown, Redden, & Weber-Fox, 2008). With regard to lexical organization, CWS have benefited more on noun-naming tasks from priming with verbs, while CWNS benefit more from priming with other nouns (Hartfield & Conture, 2006). Taken as a whole, these findings suggest subtle differences in the production and processing of verbs between CWS and CWNS.

In sum, similar to the experimental literature, the literature that has examined verbs and stuttering suggests that fine-tuned questions may reveal differences between the language of PWS and PWNS that broad-scoped questions addressed by standardized test data or spontaneous language analysis alone may miss.

1.4 The dual-system model of past-tense formation and the declarative-procedural model

Examination of past-tense inflection of CWS and CWNS might be one such fine-tuned question that could provide insight into potential differences in morphosyntactic organization between these two groups. One approach to understanding the mastery of past tense marking that could inform this question is provided by the declarative-procedural model (Ullman, 2004), which grew in part out of the dual-system model of past-tense formation (Pinker, 1991, in turn building on the work of Ervin, 1964).

The dual-system model posits that individuals retrieve irregular past-tense verbs directly from the lexicon (as frozen word representations), while they create regular past-tense verbs by performing morphosyntactic operations on the lexical entries for the root form.

The declarative-procedural model builds on this concept by positing that different neural pathways are associated with lexical retrieval than with those supporting morphosyntactic operations, and that this distinction underlies a broader variety of linguistic operations. Specifically, the declarative-procedural model posits that lexical retrieval is served by temporal lobe regions and that morphosyntactic operations are served by frontal lobe regions and basal ganglia circuits.

The experimental work of Ullman and colleagues (e.g., Ullman & Gopnik, 1999) has provided evidence that the distinction between declarative / lexical memory and procedural / grammatical memory may play a role in distinguishing the language of individuals with specific language impairment (SLI) from those with typical language. Evidence for this distinction includes at least three findings. First, individuals with SLI regularize the past-tense forms of nonce verbs whose stems resemble irregular verbs (i.e. *crive* for *drive*) less frequently than individuals with typical language do; that is, they rarely produce "crived" when given the prompt "Today he crives, yesterday he _____". Second, individuals with SLI produce nonce past-tense forms that resemble irregular forms (i.e., saying *crove* for the past-tense of *crive*) more frequently than individuals with typical language do. These two related phenomena indicate that individuals with SLI are less likely than individuals with typical language to attempt to apply a morphosyntactic operation to a nonce verb, and more likely to treat it as a lexical item, when there is a bias towards treating it lexically because of resemblance to other words. Finally, the likelihood of individuals with SLI forming the past-tense form of a real regular verb correctly is in a direct relationship with the number of regular-verb neighbors (other verbs sharing the same rime) it has, a pattern not seen among individuals with typical language because, of course, mistakes in the regular past-tense are very rare beyond a certain age. That is, individuals with SLI appear to form the past tense based on lexical information, computing what is most "probable" based on their lexical knowledge, whereas individuals with typical language appear to form the past tense by applying morphological affixes directly without any interference from lexical knowledge. Theoretically, this may be because morphosyntactic operations, and the neural circuits underpinning them, are impaired in individuals with SLI, while lexical memory, and the neural circuits underpinning it, is relatively spared.

1.4.a Relating the declarative-procedural model to stuttering

There are several reasons, following this model, to suspect that CWS might also rely excessively, if not as exclusively as individuals with SLI, on declarative memory circuits rather than procedural ones in performing morphosyntactic operations. First, there may be reason to posit some overlap of stuttering and SLI. Although CWS are not as a rule of thumb also children with SLI, the presence of clear subsets of children with SLI with stuttering or other fluency disorders, and of CWS with frank language impairments, is clearly documented (Arndt & Healey, 2001). Additionally, as discussed above, CWS are generally found to have weaker syntactic skills on standardized tests and in experimental research than CWNS, although this does not reach the clinical level of concern associated with SLI. Finally, significant impairment in non-word repetition appears to be present in both children with SLI and in CWS (Berman Hakim & Bernstein Ratner, 2004; Anderson, Wagovich, & Hall, 2006).

Second, as outlined above, Ullman (2004) has posited that the basal ganglia supports procedural memory and therefore plays a key role in applying morphosyntactic operations. The potential role of basal ganglia abnormalities in the motor component of stuttering has also been promisingly explored (Alm, 2004), leaving open the possibility of a role for these abnormalities to play in any subtle linguistic component, as well. Third, if it is the case that CWS rely more heavily on the lexicon than morphosyntactic operations for forming the past tense, this might explain several subtle differences between CWS and CWNS on lexical priming tasks, and in verb use.

With regard to lexical priming tasks, if verbs are particularly over-represented in the lexicons of CWS because of double entries (stems and past-tense forms), CWS might be expected to benefit more from priming nouns with verbs, rather than other nouns, as does in fact appear to be the case and is the opposite pattern of CWNS (Hartfield & Conture, 2006). Because of the "double entries" for verbs, CWS might also be expected to show lower vocabulary diversity for verbs, which has also been shown to be the case (Silverman & Bernstein Ratner, 2002), and to use fewer different verbs (Wagovich & Bernstein Ratner, 2007).

Finally, there is evidence from cognitive studies of adults that semantic knowledge and syntactic knowledge are concurrently activated in AWS to a degree not observed in AWNS (Weber-Fox & Hampton, 2008). Specifically, among most typical, non-stuttering listeners, hearing a semantically-implausible utterance activates a particular kind of brain wave, called the N400, on tests of event-related potentials (ERPs), which reveal electrical activity in the brain time-locked to stimulus processing. Similarly, hearing a syntactically implausible utterance activates another kind of brain wave, called the P600. AWS, however, show a pattern in which hearing either kind of implausible utterance activates both types of brain wave simultaneously; that is, syntactic / procedural processing seems to activate lexical activity and declarative knowledge for PWS, while semantic processing seems to also activate syntactic processing.

If the declarative-procedural model can be applied to CWS this way, then CWS might be expected to demonstrate different profiles of irregular past-tense verb formation than CWNS. Little other research has addressed the question of tense-marking in CWS before. Although Bajaj (2007) found no significant difference between CWS and CWNS on measures of tense-marking accuracy, his analysis included present tense third person marking and obligatory use of auxiliary "be" and "do", in addition to the past tense, perhaps blurring any observable difference in past-tense formation alone. Watkins, Yairi, and Ambrose (1999) compared the accuracy of a small list of morphemes between persistent and recovered CWS at ages 3 years, 4 years, and 5 years, and found no significant differences between the groups or between either group and normative expectations, although it is interesting to note, in light of the ideas presented here, that the only behavior without enough instances to analyze was use of regular past-tense (–ed) in the youngest group of persistent CWS.

Because this kind of analysis has not been frequently employed, other differences besides the one posited here might also be expected to arise. These could include CWS' and CWNS' relative frequency of use of regular and irregular forms, or differing frequencies of different kinds of over-regularization, such as double marking (*droved* for *drove*) or use of the incorrect irregular form (a vowel change such as *thunk* for *think* instead of a full stem change as in *thought*).

1.5 Questions addressed

This paper presents an analysis of the syntax of young CWS and CWNS (average age 36 months, range 25-59 months) to address three questions. First, do young CWS use less mature syntactic constructions in spontaneous language than age-matched CWNS, as measured by DSS? Although there is reason to believe that CWS younger than 3 years may have advanced syntactic complexity relative to normative data (Watkins, Yairi, & Ambrose, 1999; Watkins, 2005), there is reason to believe CWS older than this age may use utterances having relatively lower syntactic complexity, including results from previous constituent analyses and the literature on standardized test and experimental task performance, discussed above.

Second, do there appear to be different relationships among syntactic complexity of spontaneous language (as measured by DSS), age, and language test scores, in CWS and CWNS between ages 2 and 5? It is hypothesized that the relationship between age and DSS will be weaker for CWS than for CWNS, but that the relationship between DSS and test scores will be stronger for CWS than for CWNS.

Two cohort studies have found that CWS who recover from stuttering show slower-than-expected syntactic growth after an initially advanced level of syntactic complexity in the young age range of 2 years to 3 years (Haege, 2001; Watkins, 2005), while another, longitudinal study found CWS who persist in stuttering to have an accelerated rate of syntactic growth relative to both CWS who recover and CWNS at later ages, between 4 years and 5 years (Buhr, 2007). The overall effect of these varying trajectories would be a less “clean” correlation of syntactic complexity with age for CWS than CWNS, particularly when status as a CWS is considered separately from recovery status.

Test scores and DSS are hypothesized to have a stronger relationship for CWS than for CWNS for two different reasons, depending on the domain tested. The first reason pertains to tests assessing morphosyntactic performance. Previous research has fairly consistently shown lower (but still average range) test scores for CWS than for CWNS. Because it is hypothesized that CWS will also have lower DSS than CWNS in this study, it is also hypothesized that the predictably lower test scores from CWS will correlate strongly to DSS because they will both be reflecting an overall subtly lower range of language ability. For the CWNS, the correlation may also be expected to be strong, but because performance on both DSS and tests is expected to more frequently include above-average performances in addition to average and below-average performances, greater variability is expected. DSS and the test scores are also more immune to non-linear trends in performance when measured by age, since they reflect only performance profiles independent of age expectations.

Yet another reason pertains to tests assessing lexical knowledge. CWS are hypothesized to use lexical retrieval more frequently than CWNS when producing inflected forms, whereas CWNS are hypothesized to perform grammatical operations more frequently than CWS. If this is the case, lexical skills would be expected to correlate to DSS for CWS, but not for CWNS.

Finally, given hypotheses raised by the dual-system and declarative procedural models, do very young CWS and CWNS differ in their over-regularization of irregular past-tense verbs? Are there other differences in past-tense usage? The hypothesis is that CWS will over-regularize less often than CWNS because they may rely more heavily on lexical retrieval than morphosyntactic operations, potentially due to hypothesized basal ganglia abnormalities.

2 Methods

2.1 Participants

The total number of child participants was 62, derived by pooling data from several previous investigations. Participating children include those CWS and CWNS reported in Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002), those reported in Pawlowska, Brown, Redden, and Weber-Fox (2008), and CWS and CWNS studied by Wagovich and Hall (2007) and Hall et al. (2007), respectively. Children from both the CWS and CWNS groups in the Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002) studies were recruited by flyers in pediatricians' offices in the greater Washington, D.C. area. CWS and CWNS gathered by Pawlowska et al. (2008) were recruited in one of the following ways: referral from a speech-language pathologist or clinical professor; referral from an early childhood educator; newspaper ads; television commercials; Purdue University publications; and flyers about the study distributed at daycares, preschools, and libraries local to Purdue University in West Lafayette, Indiana. CWS from Wagovich and Hall (2007) were recruited through a University of Missouri community e-mail bulletin and from community daycares. CWNS from Hall et al. (2007) were recruited from preschools serving the University of Maine community. All data, once contributed to the current project, were blinded as to subject name and other personal identifying information.

CWS and CWNS were matched by age (within 3 months) and gender. This process led to 21 male and 10 female pairs of children. The average age of the CWS was 41 months, with a range of 25-59 months. The average age of the CWNS was 41 months, with a range of 27-59 months. Children had no history of speech or language issues other than stuttering. Pairs from Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002) and most pairs from Pawlowska et al. (2008) were roughly matched (within 3 years) for maternal education; all but one mother had completed secondary education and most had completed at least some post-secondary education. Pairs from Wagovich and Hall (2007) and Hall et al. (2007) were not matched for maternal education, but all mothers had completed at least some post-secondary education. Some pairs from Pawlowska et al. (2008) with mothers not matched for SES were included (N=6), in order to create a larger sample with potential post-hoc analysis for the effects of SES on children's performance.

CWS from the Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002) studies had been stuttering for 4 months at the most; on average they had been stuttering 2.53 months before the study. The average stuttering frequency for the CWS from these studies was 9.5%. CWS from Wagovich and Hall (2007) were on average 5 months post stuttering-onset, and all were within 8 months of stuttering-onset. Information about stuttering frequency from the CWS from Wagovich and Hall (2007) was not available, but all met a 3% or greater cut-off for frequency of stuttering-like disfluencies, and all were judged as mild or moderate in stuttering severity by researcher observation. CWS from Pawlowska et al. (2008) were an average of 16 months post-onset, met a 3% or greater cut-off for frequency of stuttering-like disfluencies, and were judged mild or moderate in stuttering severity by parent report.

The characteristics of the participants from each source are summarized in the table below:

Table 1: Participant data

Study	No. of pairs	No. of male pairs	No. of female pairs	Age Range	CWS' Time since onset	CWS' severity	SES data
Bernstein Ratner & Silverman (2000, 2002)	14	12	2	28-48 mos.	Average: 2.53 mos; Max. 4 mos.	Average stuttering frequency: 9.5%	Matched for years of maternal education
Wagovich & Hall (2007), combined with Hall et al. (2007)	5	3	2	25-44 mos.	Average: 5 mos; Max. 8 mos.	Minimum stuttering frequency: 3%; mild-to-moderate rating	Not matched for years of maternal education; all mothers had completed at least secondary
Pawlowska et al. (2008)	12	7	5	49-59 mos.		Minimum stuttering frequency: 3%; mild-to-moderate rating	Most pairs matched within 3 years of maternal education

2.2 Sampling

For all children, language samples of conversational dialogue were obtained in a sound-treated booth with a set of toys or, in a few cases, a book to elicit conversation. Depending on which study was the source of the transcripts, conversations were with either a parent or a clinician; the majority of samples were elicited with a parent as the child's conversational partner. Since the homogeneity of sampling methods affects the CWS and CWNS equally, it is not expected to affect the group differences that are hypothesized here.

The conversations were recorded both on videotape and audiotape. The language samples were then transcribed according to *CHAT* protocols (MacWhinney, 2000).

2.3 Language and temperament testing

CWS and CWNS from Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002) completed the *Peabody Picture Vocabulary Test – Revised (PPVT-R)* (Dunn, Dunn, Robertson, & Eisenberg, 1981), *Expressive One-Word Picture Vocabulary Test – Revised (EOWPVT-R)* (Gardner, 1990), and two subtests of the *Clinical Evaluation of Language Fundamentals – Preschool (CELF-P)* (Wiig, Secord, & Semel, 1992): "Linguistic Concepts" and "Word Structure".

CWS from Wagovich and Hall (2007) completed the *Preschool Language Scale – 4th edition (PLS-4)* (Zimmerman, Steiner, & Pond, 2002), *Receptive One-Word Picture Vocabulary Test* (Brownell, 2000), *Expressive One-Word Picture Vocabulary Test, 2000 edition* (Gardner, 2000), *Carey Temperament Scale* (Carey et al., 1995), and the *Vineland Adaptive Behavior Scales, 2nd edition (Vineland-II)* (Sparrow, Ciccheti, & Balla, 2005). CWNS from Hall et al. (2007) did not complete a standardized test battery.

CWS and CWNS from Pawlowska et al. (2008) completed the *Test for Auditory Comprehension of Language, 3rd edition (TACL-3)* (Carrow-Woolfolk, 1999), the *Structured Photographic Expressive Language Test, 3rd edition (SPELT-3)* (Dawson & Stout, 2003), and the *Bankson-Bernthal Test of Phonology (BBTOP)* (Bankson & Bernthal, 1999).

2.4 Analysis

2.4.a DSS

Children's transcripts were copied from the *CHAT* transcripts to an Excel spreadsheet tabulated to include the categories of DSS (Lee, 1974). The middle 50 utterances of every transcript were initially scored as per Lee's indication that in clinical settings, the middle 50 utterances are often the most productive part of language transcripts. For most children, however, the middle 50 utterances did not contain 50 utterances eligible for DSS scoring. This is because DSS requires a sentence to have a verb in order to be scored, and also because of the need to eliminate repetitions of adults' or the child's own sentences and utterances with unintelligible components. In cases where the middle 50 utterances did not yield 50 scorable sentences, the child's utterances after the middle 50 utterances were analyzed, as per Lee's indication that this portion of language sampling may be the next-most representative time during clinical language sampling. When analysis of the middle and final parts of transcripts did not yield 50 scorable utterances, utterances before the middle 50 were analyzed in reverse order (i.e., analyzing closer to the middle first and further from the middle subsequently) to avoid as much as possible gathering utterances from the beginning of the samples, which Lee indicates may be less representative of children's language abilities.

Fifty scorable utterances or close to it were obtained from most of the transcripts, although in many cases the CWS provided fewer, reflecting, perhaps, less frequent verb use. For some CWS, therefore, a greater portion of utterances came from later or earlier in the transcript than for their age-matched peers. The mean number of DSS-scorable utterances was 38 for CWS and 48 for CWNS.

Each utterance was scored using DSS scoring conventions (Lee, 1974). An average score was calculated for each child. DSS is an objective scoring system; some subjective judgment is necessary for utterances involving more complex clause structures; these were present in approximately a quarter of the files. A second judge scored one-quarter of the transcripts, yielding inter-rater reliability of 99%. Neither coder was blind to participants' group membership. A Mann-Whitney U-test was applied to both groups with group membership as the independent variable and DSS as the dependent variable. This test was used because of the non-parametric nature of DSS values.

2.4.b DSS and age

Since DSS data were available for all CWS and CWNS, a simple linear regression was calculated for both groups with age as the independent variable and DSS as the dependent variable.

2.4.c DSS and morphosyntactic and lexical Test Scores

For morphosyntactic test scores, different tests were available for different sets of participants. Subtest scaled scores from the *CELF-P* Word Structure subtest were used for participants from Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002). *Structured Photographic Expressive Language Test, 3rd edition (SPELT-3)* standard scores were used for participants from Pawlowska et al. (2008). For lexical test scores, standard scores from the *EOWPVT-R* were used for participants from Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002). A correlation matrix was applied to all test scores with DSS as the dependent variable and test scores as the independent variable.

2.4.d Irregular past-tense errors

Irregular past-tense verbs in each child's scored utterances were recorded in a spreadsheet. Past-tense forms of copula and auxiliary *be* (i.e., *was, were*) were excluded. Only the first use of each verb was recorded. The exception to this was that if the child produced two different iterations of the same verb, such as "falled" and "fell", each form was recorded once, because they represent different strategies of producing the target word. Double-marked forms such as *broked* were flagged for later analysis as they indicate a somewhat different kind of error than full over-regularization. Because there was a relatively small total number of past-tense forms in the 62 samples, and because some children did not use any irregular past-tense verbs, the groups' data were summed as total irregular-correct and total irregular-incorrect (including partially-incorrect forms). A Fisher exact test was used to compare the four resulting data points.

An attempt was made to analyze errors in the groups' use of the regular past-tense, because the declarative-procedural model suggests there could be differences in this as well if CWS employ a different set of strategies in creating past tense forms. These errors, however, present real challenges for analysis. First, while errors in the irregular past-tense are generally obvious in a transcript, errors in the regular past-tense are not. If a child says "I eated" instead of "I ate", it is clear what has happened; namely, they have applied a morphological rule where a simple lexical item should have been retrieved. If, however, the child says "I bake", it is not always clear that the child has failed to apply a morphological rule; the child may instead have shifted the temporal context of the conversation. Contextual information often helps to resolve this issue, but it does not always do so clearly. Second, errors in the regular past tense in which *–ed* is not omitted but in which the child "over-irregularizes" (i.e., *I bade* for *I baked*, from an analogy with *make / made*), while potentially more obvious, are very low frequency and also potentially more likely to be coded by the transcriber as unintelligible words. No such instances were noted in reviewing the transcripts.

3 Results

3.1 DSS

A Mann-Whitney U-test was applied to the two groups' matched pairs of overall DSS scores. As predicted, the mean DSS score of the CWS (6.302) was lower than the mean DSS score of the CWNS (6.868), but this did not reach statistical significance (U(62) = 575.5, z = 1.337, p = 0.182). It should be noted, however, that compared to the CWNS, the CWS provided almost 20% fewer utterances that were even eligible for DSS analysis, possibly in part because the CWS used fewer verbs.

Although MLU may be less preferable than DSS for measuring syntactic complexity for reasons discussed above, it does have the advantage of allowing verbless utterances to be scored, allowing a greater number of the CWS to have 50 utterances scored. In this case, 1458 utterances were analyzed for MLU for the CWS and 1538 utterances were analyzed for MLU for the CWNS; CWS had only approximately 5% fewer utterances. A *post-hoc* analysis of MLU, using a Mann-Whitney U-test, produced results that approached significance more closely than did DSS, but failed to meet it. The mean MLU of the CWS (3.94) was lower than the mean MLU of the CWNS (4.38), but this did not reach statistical significance (U(62) = 599.5, z = 1.675, p = 0.0947).

Results were not different for the youngest group of children, despite evidence that CWS who begin stuttering younger than three years of age may have advanced MLU and DSS relative to normative data (Watkins, 2005). The average DSS for CWS 24 months – 35 months was 5.1; for CWNS it was 5.28. According to Lee (1974), the mean DSS for this age range is 3.73, based on a sample of 40 participants.

This suggests that both the CWS and CWNS at these younger ages recruited for this study may have had language somewhat in advance of normative expectations. Although this trend did not continue for the other age ranges, it may be that the youngest age range is where relatively advanced syntactic complexity will show up most easily.

Table 2: Mean DSS for CWS and CWNS in this study and Lee (1974)

	Ages 2;0 – 2;11	Ages 3;0 – 3;11	Ages 4;0-4;11
Lee's (1974) participants	3.73	6.64	8.04
CWS	5.1	6.37	7.16
CWNS	5.28	7.3	7.7

3.2 DSS and age

A regression with age as the independent variable and DSS as the dependent variable was applied to data from all of the CWS and all of the CWNS. Results indicated comparable, significant correlations between DSS and age for the two groups (for CWS, $r = 0.6333$, p = 0.0001; for CWNS, $r = 0.5214$, p = 0.0026). A test for the difference between these independent correlations (Bruning & Kintz, 1968) does not show them to be significantly different from one another ($z = 0.6325$, ns).

Figure 1: Relationship of Age and DSS, all CWS

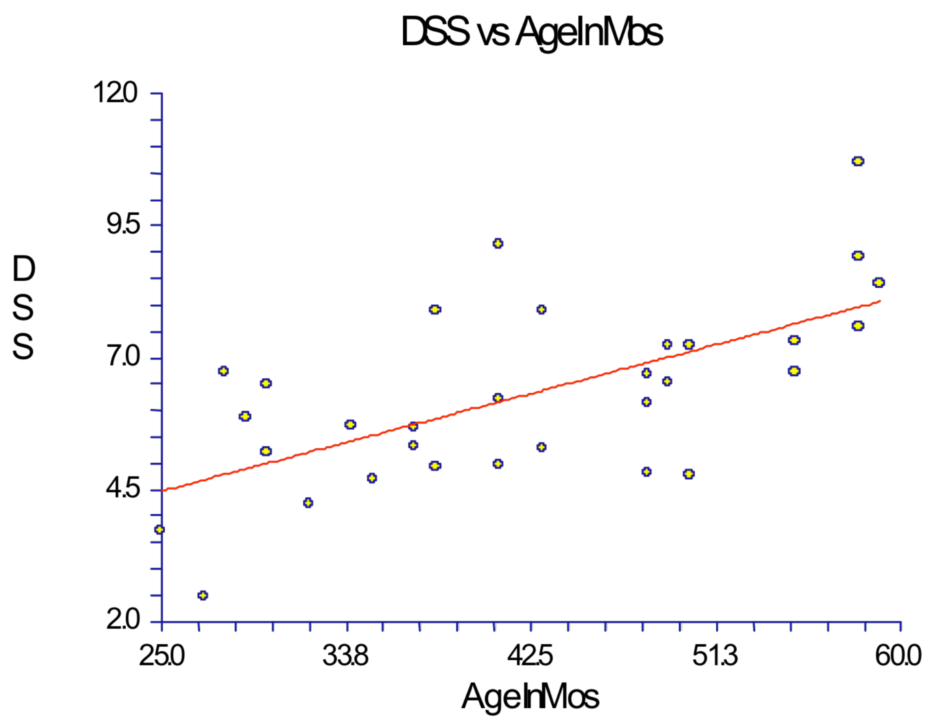
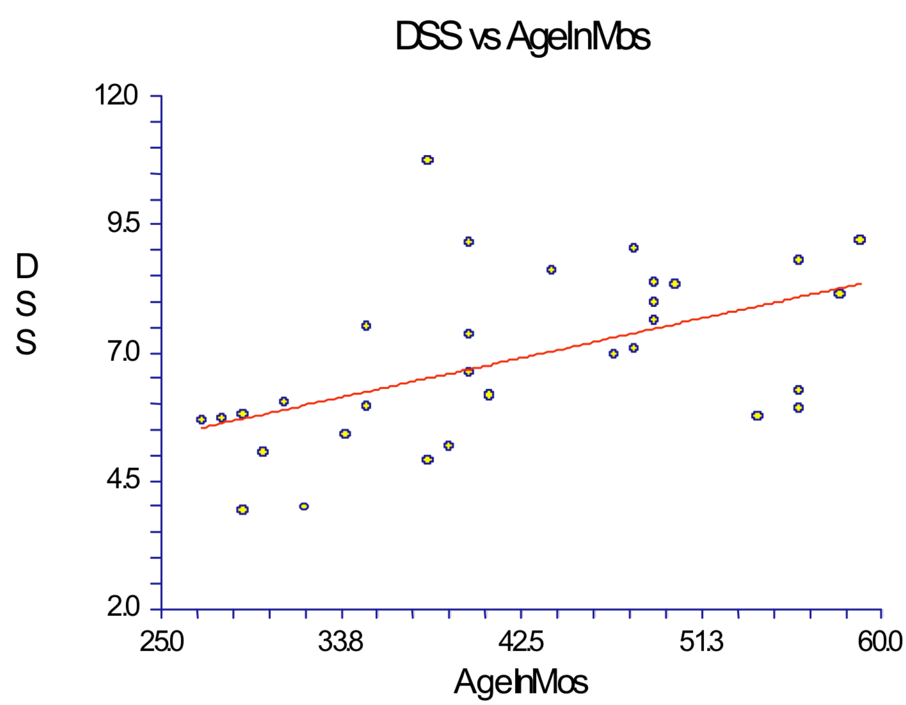


Figure 2: Relationship of Age and DSS, All CWNS



Because of data from other cohort studies (Haege, 2001; Watkins, 2005; Buhr, 2007) indicating that the relationship between age and syntactic growth for CWS may be timed differently from that of CWNS, linear regression with age as the independent variable and DSS as the dependent variable was also applied to a younger subset of participants from each group, between the ages of 25 months to 47 months, and to only the older participants between ages 48 months and 59 months, with the purpose of comparing the relationship between age and DSS for the two groups at younger and older ages.

For CWS and CWNS in the younger age range, the relationship between age and DSS was similar to that seen in the analysis containing all ages (for CWS, r = 0.4961, p = 0.0363; for CWNS, r = 0.5249, p = 0.021). A test for the difference between these independent correlations (Bruning & Kintz, 1968) does not show them to be significantly different from one another (z = 0.6325, ns).

Figure 3: Relationship of Age and DSS, CWS ages 2 - 4

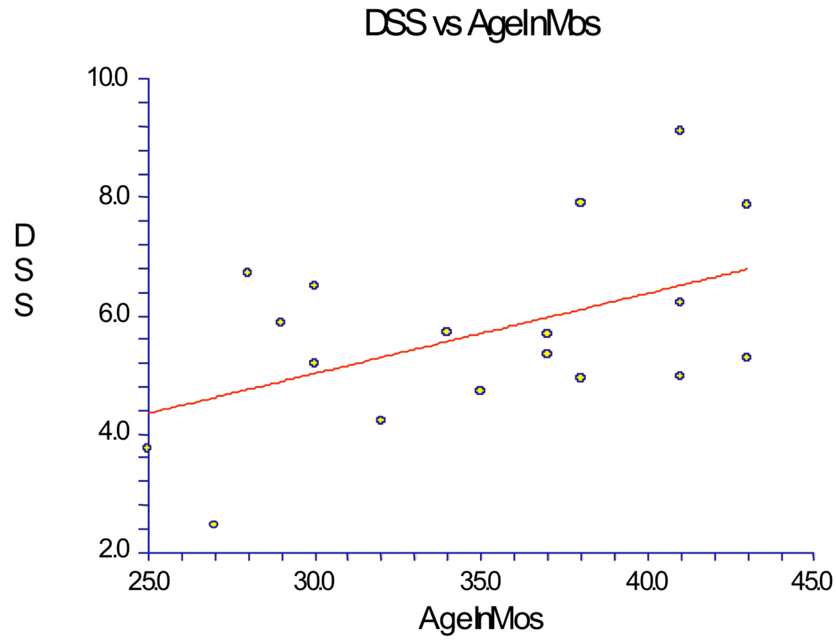
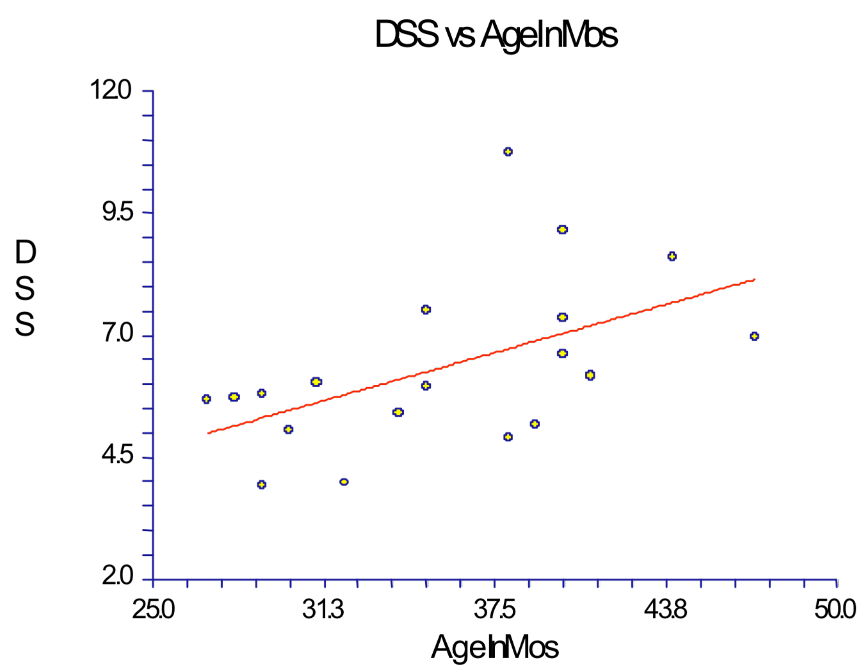


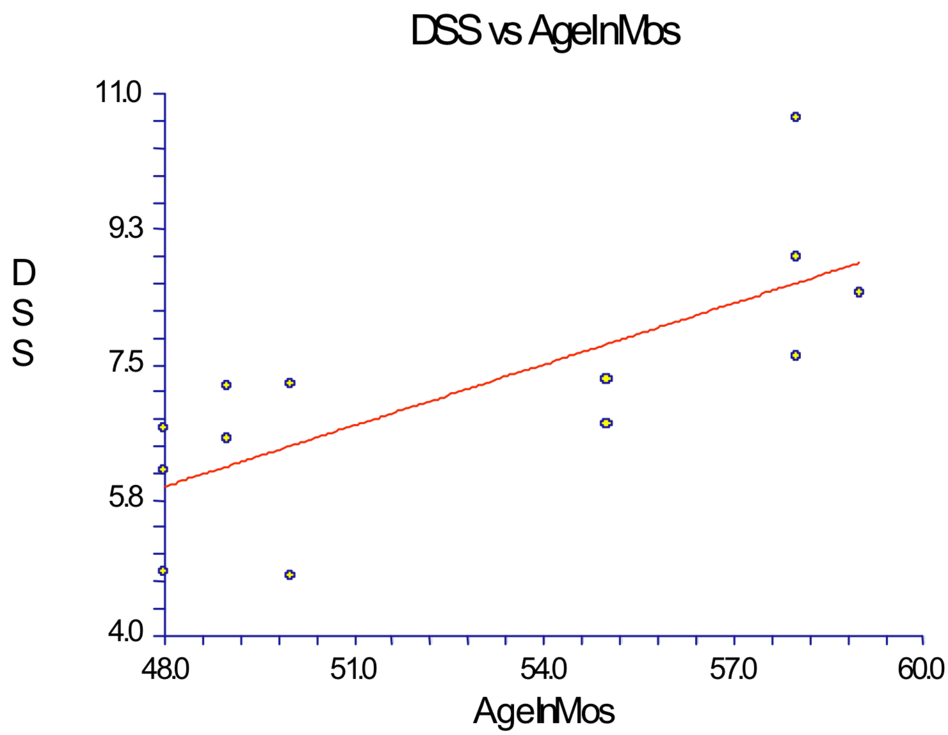
Figure 4: Relationship of Age and DSS, CWNS ages 2 – 4



For the CWS and CWNS between the ages of 4 years and 5 years, however, a different pattern emerged. For CWS in this age range, age and DSS appear significantly correlated (r = 0.7444, p = 0.0035). Because the CWS also had a clear upper and lower outlier in this age range, unlike the CWNS, a separate analysis was run with these two group members removed; the correlation was still significant (r = 0.7755, p = 0.0055). However, for CWNS in this age range, age and DSS do not appear significantly correlated (r = -0.1107, p = 0.7319).

These results must be interpreted with caution because of the difficulties associated with regression analyses in truncated ranges; that is, even when a variable is known to be correlated with the passage of time, as is DSS, if not enough time elapses, a correlation may not be revealed. While this may be influencing the lack of a correlation for the CWNS, the contrast between the two groups remains striking. A test for the difference between these independent correlations (Bruning & Kintz, 1968) does not show them to be significantly different from one another (z = 1.85, ns). However, this value approaches the significance cut-off z - value of 1.96, which is particularly of note in light of the small sample size used here.

Figure 5 and 5a: Relationship of Age and DSS, CWS 4 – 5, with and without outliers



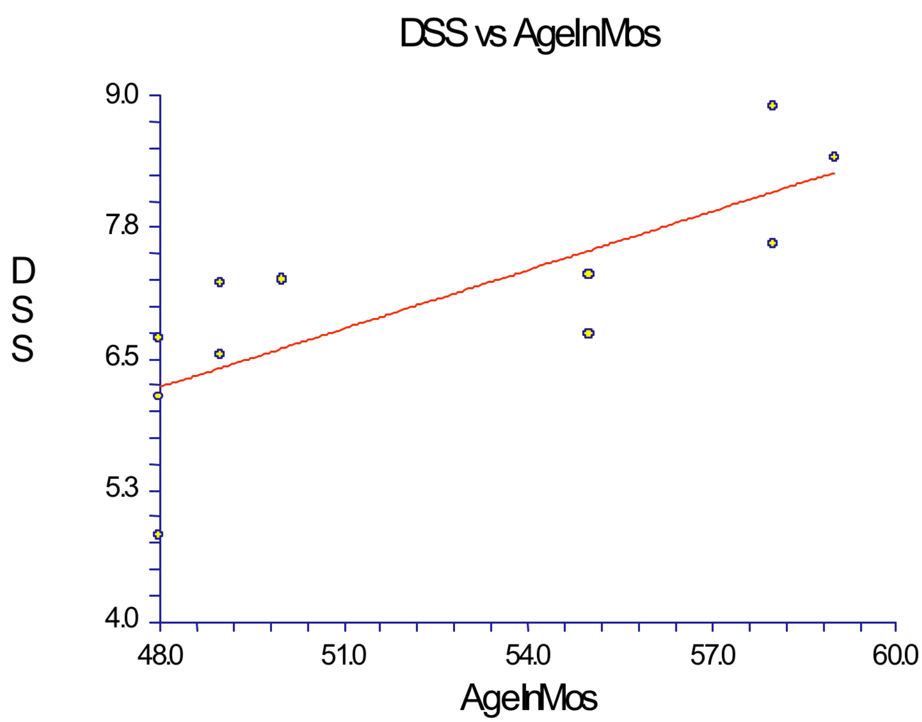
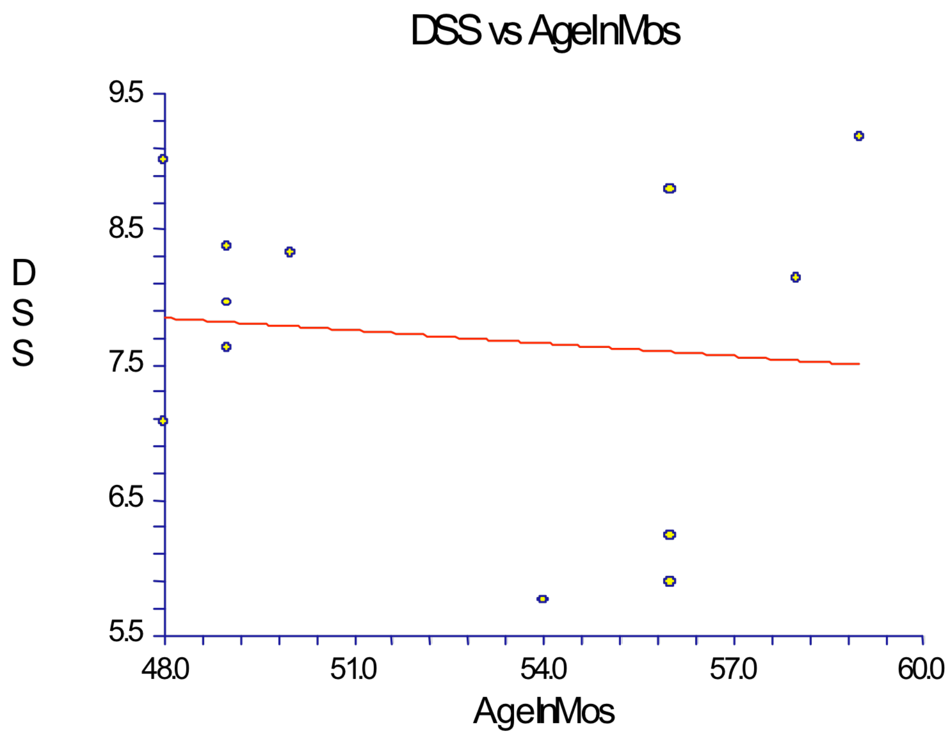


Figure 6: Relationship of Age and DSS, CWNS 4 – 5



3.3 DSS and morphosyntactic and lexical test scores

A correlation matrix with *CELF-P* Word Structure subtest scaled score, *EOWPVT-R* standard score, and *SPELT-3* standard score as the independent variables and DSS as the dependent variable was applied to 12 of the 14 pairs of CWS and CWNS from Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002) (2 pairs contained a member who did not complete testing and were excluded from analysis), and to the 12 pairs from Pawlowska et al. (2008). For all tests, the correlation with DSS approached (*CELF-P (WS)*) or reached (*EOWPVT-R, SPELT-3*) significance for CWS, but not for CWNS, as indicated in Tables 3 and 4.

Table 3: Correlations between test scores and DSS, CWS

		EOWPVT-R	*CELF-P (WS)*	*SPELT-3*
DSS	**Correlation (r)**	0.6819	0.5538	0.7696
	p-value	0.0146	0.0618	0.0034

Table 4: Correlations between test scores and DSS, CWNS

		EOWPVT-R	*CELF-P (WS)*	*SPELT-3*
DSS	**Correlation (r)**	0.0039	0.2663	0.2826
	p-value	0.9895	0.4027	0.3734

Tests for the difference between these independent correlations (Bruning & Kintz, 1968) give *z* -scores as follows:

Table 5: Comparisons of the correlations for DSS and test scores of CWS and CWNS

Correlation (r)	*z* - value of difference between CWS and CWNS
DSS-*EOWPVT-R*	1.75
DSS-*CELF-P (WS)*	0.747
DSS-*SPELT-3*	1.55

No correlations met a strict test of difference at $z = 1.96$. However, given the small sample size, with twelve individuals in each group, the differences between the DSS-*EOWPVT-R* and DSS-*SPELT-3* represent clear trends.

3.4 Irregular Past-tense Errors

As a group, the CWS used 1280 total verbs, 24% of their 5353 total words. Of the verbs, 82 (6.3%) were irregular past-tense verbs. Of these irregular past-tense verbs, 63 (78%) were formed correctly and 19 (22%) were formed incorrectly.

As a group, the CWNS used 1611 verbs, 23% of their 7016 total words. Of the verbs, 74 (4.6%) were irregular past-tense verbs. Of these irregular past-tense verbs, 58 (78%) were formed correctly and 16 (22%) were formed incorrectly. A Fisher's exact test comparing correct irregular past-tense forms and incorrect past tense forms for both groups fails to meet significance (p = 1).

Figure 7: CWS Irregular Past-Tense Correctness

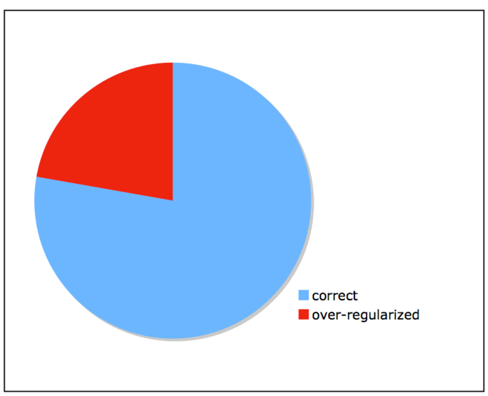
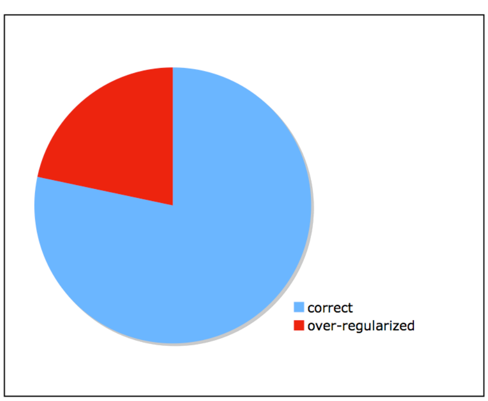


Figure 8: CWNS Irregular Past-Tense Correctness



A trend of note within the incorrectly marked-forms is that CWS had more instances of double-marking of irregular-past tense forms, including instances with a stem change as well as a final morpheme (i.e., *broked*), and instances with two final morphemes (i.e., *falleded*). Of the 19 incorrectly formed irregular past tense forms in CWS' transcripts, 6 (31.5%) were double-marked, with one instance each from three children and three from one child. Of the 16 incorrectly formed irregular past tense verbs in the CWNS' transcripts, 1 (6.25%) was double-marked, meaning also that only one CWNS made this sort of error. A Fisher exact test comparing the number of double-marking errors to all other errors (i.e., typical over-regularization) for the two groups indicates that this approaches but does not reach significance ($p = 0.093$).

Figure 9: CWS Ratio of Double-Marked Irregular Past-Tense to Other Irregular Past-Tense Errors

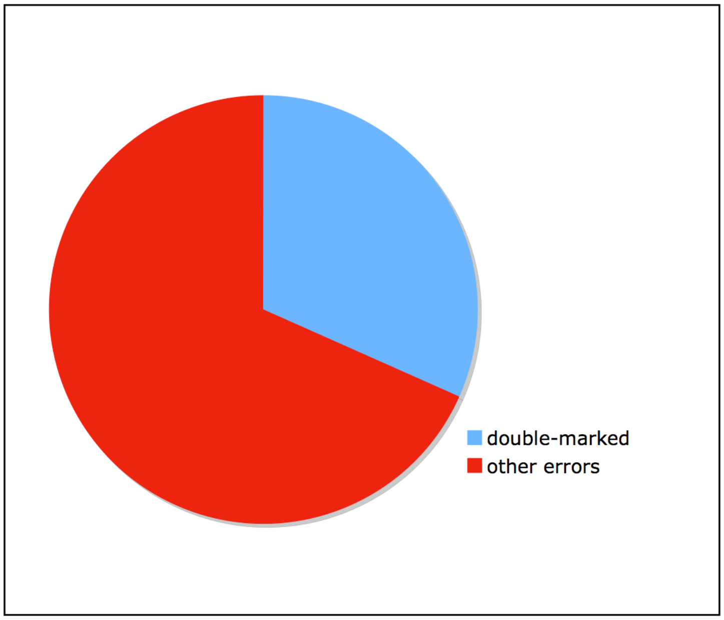
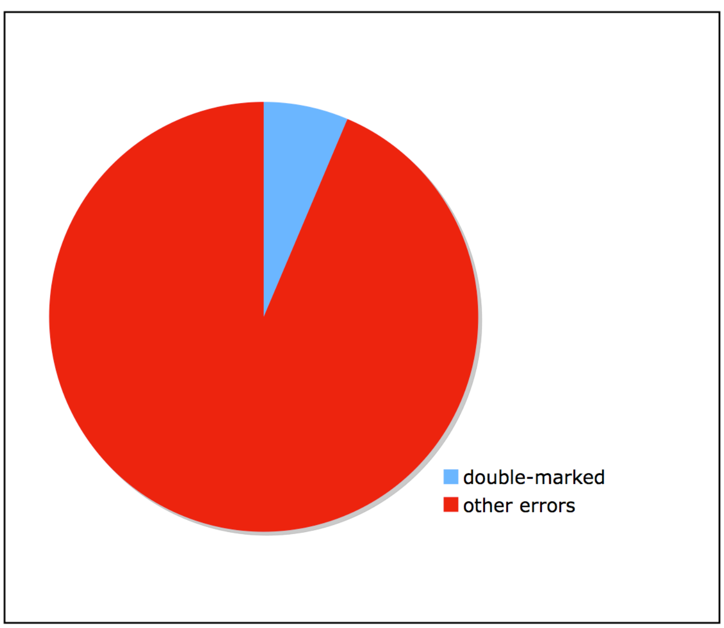


Figure 10: CWNS Ratio of Double-Marked Irregular Past-Tense to Other Irregular Past-Tense Errors



3.5 Irregular past-tense frequency of use

An additional finding of note in reviewing the data was that the two groups (CWS and CWNS) had a comparable number of occurrences of irregular past-tense forms, despite the fact that the CWS provided notably fewer verbs and words than the CWNS. Unique instances of correctly used irregular past-tense forms made up 4.9% of the verbs of CWS (63 out of 1280), but only 3.6% of the verbs of CWNS (58 out of 1611). A Fisher exact test comparing the number of correctly used irregular past-tense verbs with the number of all other verbs for each group indicated that the difference approaches but does not reach significance ($p = 0.08$).

Figure 11: CWS Ratio of Correctly Used Irregular Past-Tense Verbs to All Other Verbs

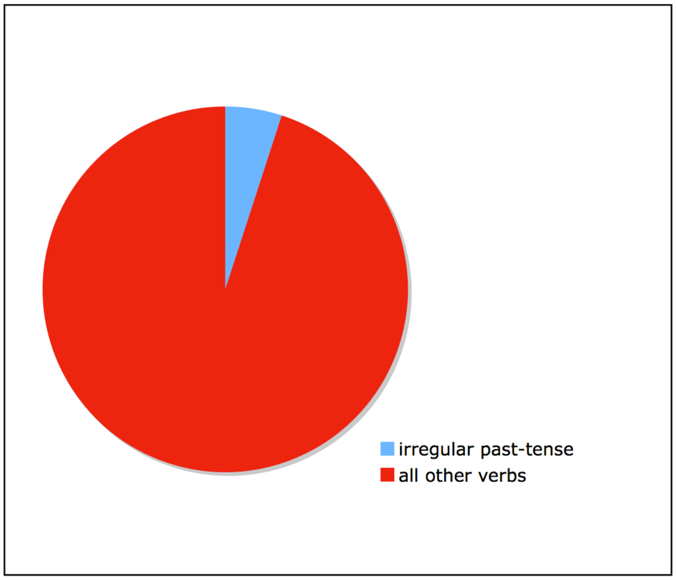
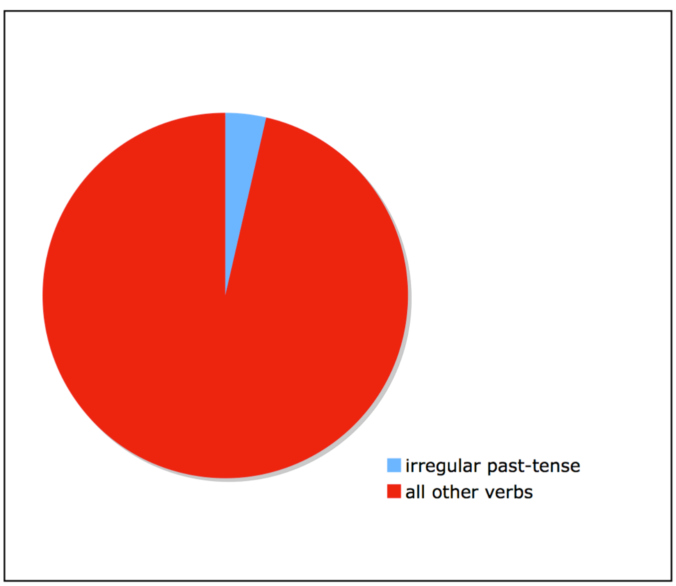


Figure 12: CWNS Ratio of Correctly Used Irregular Past-Tense Verbs to All Other Verbs



4 Conclusions

4.1 DSS by group

Contrary to the hypothesis, CWS and CWNS do not differ significantly in DSS profiles between the ages of 2 years and 5 years. This is in keeping with previous findings (Westby, 1979; Buhr, 2007), although the CWS in this study did not provide as many utterances eligible for analysis as did CWNS. Thus, our trend is likely to under-estimate real differences in the complexity of spontaneous language use in these two groups. A *post-hoc* analysis of MLU resulted in a better-matched set of samples in terms of eligible utterances, although CWS still provided 5% fewer eligible utterances. Differences between the groups on MLU approached but did not reach significance

4.2 DSS and age

In partial agreement with the hypothesis presented here, CWS do show a different relationship between DSS and age between the ages of 2 and 5 years than do CWNS. Specifically, for children between the ages of 4 and 5 years, the relationship between DSS and age is much stronger for CWS than for CWNS. This may be seen as consistent with Buhr (2007), who found in a longitudinal study that CWS in this age range have an accelerated rate of growth in syntactic complexity, relative to CWNS.

4.3 DSS and morphosyntactic and lexical test scores

In keeping with the hypothesis presented here, standardized test scores reflecting knowledge of morphology, syntax, and semantics appear to have a stronger relationship to the DSS of CWS than to the DSS of CWNS. This may be significant for several reasons.

First, it suggests adequate validity for standardized language tests assessing these domains administered to CWS. Second, it suggests that fairly consistent findings of non-significantly lower standardized language test scores of CWS relative to CWNS fit appropriately into broader language profiles of CWS. *Post-hoc t*–test comparisons of the groups' performance on DSS and previous *t*-test comparisons of standardized test data (*CELF-P (WS),* and *EOWPVT-R* from Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002)*, SPELT-3* from Pawlowska et al. (2008)) show a consistent trend of lower average performance as well as lower maximal performance by CWS, highly suggestive of a sub-clinical level of impairment relative to CWNS. The difference between the two groups' test scores reaches significance for the *SPELT-3* ($p = 0.026$) and approaches it for the *EOWPVT-R* ($p = 0.056$) and the *CELF-P (WS)* ($p = 0.087$). While this trend has already been noted separately for the *CELF-P and EOWPVT-R* scores in Bernstein Ratner and Silverman (2000) / Silverman and Bernstein Ratner (2002), and for the *SPELT-3* in Pawlowska et al. (2008), combining the groups strengthens the generalizability of the findings, particularly when viewed in the context of the current DSS analyses.

Figure 13: Error bars for DSS

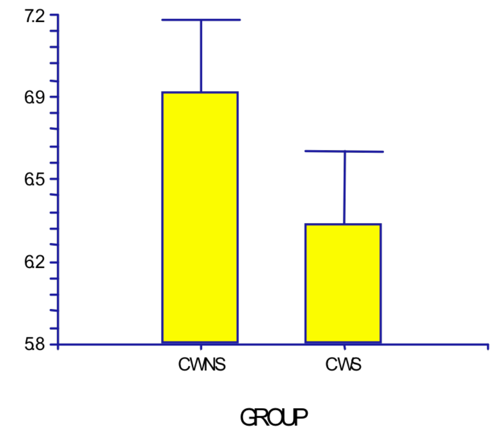


Figure 14: Error bars for CELF-P (WS)

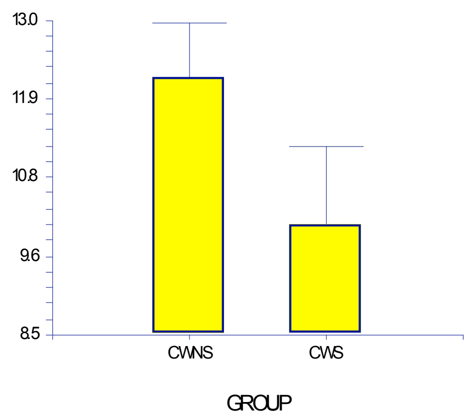


Figure 15: Error bars for EOWPVT-R

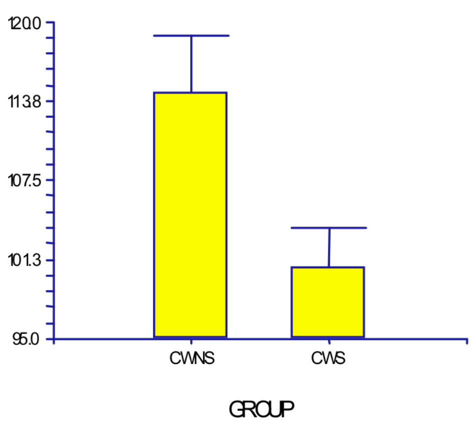
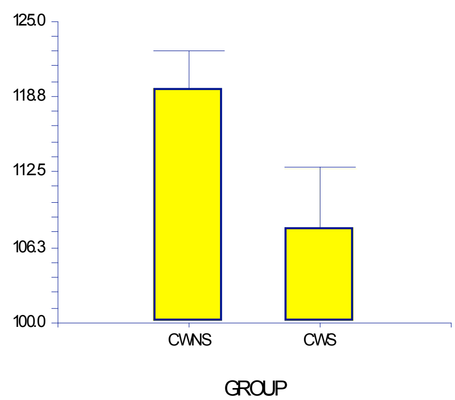


Figure 16: Error bars for SPELT-3



Finally, the findings of a significant correlation between test scores and a spontaneous language measure for CWS but not for CWNS confirms findings in at least one other study. Young CWS, but not age-matched CWNS, have also been shown to have a significant correlation between *TELD-2* scores and MLU (Anderson & Conture, 2000).

Also in keeping with the hypothesis presented here, standardized test scores reflecting lexical knowledge are more strongly correlated with the DSS of CWS than with the DSS of CWNS. This is suggestive of possible reliance on lexical knowledge to perform what resembles morphosyntactic operations (i.e., pulling a regular past-tense form like "kicked" from lexical memory rather than by applying a morphological rule). This finding suggests that using the declarative / procedural model to explain some subtle language differences between CWS and CWNS may be worth further exploration.

4.4 Irregular past-tense errors and frequency of use

Contrary to the hypothesis presented, CWS do not over-regularize past-tense verbs less frequently than CWNS; there is no statistically significant difference in frequency between the groups in this regard. However, although results did not reach statistical significance, it does appear possible that CWS use double-marked irregular past-tense forms more frequently than CWNS. It is suspected that the lack of significance results from the extremely low frequency of the behavior, which limited the power of the analysis. Theoretically, double-marking suggests competition between two systems (declarative, lexical memory and procedural, grammatical operations) in placing morphemes. If such competition truly is more prevalent among CWS than CWNS, it seems plausible that the increased cognitive activity involved in deciding whether to place a morpheme or use lexical memory to form an irregular past-tense form could reduce overall cognitive efficiency, leading to struggle in speech production. One might predict that on an experimental protocol, such as that of Ullman and Gopnik (1999), which collects data on individuals' performance with real and nonce irregular and regular past-tense verbs, CWS might stutter more frequently on irregular past-tense forms and/or double-marked error forms than on regular past-tense forms and/or correct forms.

In some ways, the relative prevalence of double-marking in the language of CWS compared to CWNS fits better into a potential overall language profile than a relative lack of over-regularization would. Lack of over-regularization is associated with SLI, and although there are reasons to wonder about a connection between the two disorders as discussed above, the language skills of CWS are clearly significantly above those of individuals with SLI. Double-marking, along with findings in PWS of simultaneous P600 and N400 activation for implausible utterances (Weber-Fox & Hampton, 2008), suggests that for CWS, the declarative and procedural memory systems are both functional, but improperly delegated to language tasks, as opposed to one system appearing less than fully functional, as is the case for procedural memory in SLI.

Another finding of note with regard to the irregular past-tense is that CWS appear to use these forms more frequently than CWNS. This may be in keeping with findings that the expressive language of CWS is characterized by lower lexical diversity than that of CWNS (Silverman & Bernstein Ratner, 2002), since irregular past-tense forms are generally high-frequency words, presumed to be more easily retrieved from the mental lexicon.

However, CWS' more frequent use of irregular past-tense verbs may also suggest a bias toward producing forms that can be pulled from lexical memory, rather than those that require morphological rule application. This is particularly intriguing since CWS have been noted to use another kind of verb with a different frequency than CWNS; namely, CWS have been shown to use copulas less frequently than CWS in Wagovich & Bernstein Ratner (2007) as well as in Pawlowska et al. (2008). This pattern is also true in a *post-hoc* analysis of the utterances from those studies, and from Wagovich and Hall (2007) and Hall et al. (2007), that were submitted to DSS analysis this study. A Fisher exact test with 292 copulas and 988 other verbs for CWS, and with 456 copulas and 1155 other verbs for CWNS shows this distribution to be significantly different at p=0.00085.

This is perhaps surprising because, in the declarative-procedural model, both copulas and the irregular past-tense are posited to be pulled from lexical memory systems. One potential explanation is that copulas (*is, am, are, was, were*) are more "purely" held in lexical memory; they bear so little resemblance to their root "be" that there is little role for procedural memory systems to play in their production. Irregular past-tense forms, however, generally bear a set of relationships to their root forms; it is conceivable that, if a linguistic system is biased toward competition between the two memory systems, irregular past-tense verbs would be uniquely prone to production. Previous findings of simultaneous N400 and P600 activation for PWS (Weber-Fox & Hampton, 2008), combined with findings in this study of more frequent double-marking of irregular past-tense forms and a strong association between performance on lexical standardized tests and syntactic complexity, suggest that the linguistic systems of CWS may in fact have such a bias.

4.5 Limitations

The potential limitations of this study include the diverse sources of participants and the hand-scoring methods used.

With regard to the first of these issues, efforts were made to assure rough comparability of participant backgrounds. For example, all participants were monolingual English speakers, and were roughly matched with regard to SES. Additionally, participants from three studies came from overlapping age ranges, and the oldest participants from these studies were very close in age to the youngest participants from Pawlowska et al. (2008). However, since the older participants from Pawlowska et al. (2008) were also older than all other participants, effects of age in this study need to be treated with some caution, as other variables other than age could have influenced results.

With regard to hand-scoring, efforts were made to assure the validity and reliability of DSS and past-tense verb counts. These included double-checking of data and inter-rater reliability scoring of 25% of the transcripts. Additionally, pairs were always scored at the same time, thus assuring that any learning or fatigue effects would not differentially affect the CWS or CWNS. However, there is inherent risk of some error in any hand-scored procedure. This method was chosen over automated methods because at the time of the writing of this project, automated DSS scoring procedures available in *CLAN* (MacWhinney, 2000) were prone to errors for complex utterances; the routine omitted many scorable utterances and frequently failed to score more than one example of a particular structure in a given utterance. Additionally, automated searches to count irregular past tense verbs would fail to catch some of the double-marked forms noted and would fail to distinguish between some forms with non past-tense meanings (i.e. "got" to mean "have", "did" as an auxiliary verb). Given these factors, the limitations of hand-scoring were felt to be less than the limitations of automated scoring.

4.6 Directions for future research

With regard to the development of syntactic complexity, this study augments the results of others suggesting that cross-sectional comparisons of the syntax of CWS and CWNS do not reveal significant differences between the two groups, while studies of syntactic development that are longitudinal in design may be more likely to do so.

The findings of more frequent use of double-marked forms among CWS relative to CWNS suggests the value of experimental work exploring past-tense marking in a more controlled fashion than language sampling allows. For example, sentence completion tasks eliciting irregular past-tense forms would allow differences in double-marking to be further explored. Additionally, verb-naming tasks that could elicit either an irregular past-tense or regular past-tense form might provide additional insight into the differences in frequency of use of the two forms between CWS and CWNS. Analyses in both cases would need to control for the overall greater frequency of irregular past-tense forms as opposed to most of their regular past-tense synonyms. Ullman and Gopnik (1999) provide a protocol controlling for this factor. Ullman and Gopnik's (1999) protocol also provides guidance in controlling for the potential interactions between irregular verbs and their regular verb neighbors (i.e., *fly* with irregular past-tense *flew* has neighbors *cry* and *die* with regular past tense forms).

Languages other than English might also be particularly valuable for exploring irregular verb-marking. German, for example, has many more verbs which take an irregular past-tense form than does English, and Romance languages have several verbs which take irregular forms in the present tense as well as the past tense.

Whether in English or another language, any grammatical rule that has exceptions creating an "irregular' cateogry can test the notion that CWS, like SLI, appear to be more likely to use lexical memory rather than morphological operations, or appear to apply both strategies to the same form more frequently than CWNS. One example in English is the case of irregular plurals (*one foot, many feet*, etc). An attempt was made to observe differences in use of the irregular plural in the transcripts discussed here; the number of instances, however, was too low for analysis.

4.7 Summary

This study found no significant differences in syntactic complexity, as measured by DSS, between matched pairs of CWS and CWNS between the ages of 24 and 59 months. It also found no evidence that the youngest CWS (under age 3) are advanced compared to normative data to any greater degree than age-matched peers selected from their same communities.

This study did find, however, that the effects of age on syntactic complexity may be different for CWS than for CWNS. Specifically, between the ages of 4 and 5 years, age appears to correlate to DSS more strongly for CWS than for CWNS. This suggests the possibility that syntactic growth is relatively faster for CWS than for CWNS between the ages of 4 and 5, although this hypothesis must be stated with caution since non-longitudinal data were used.

This study also found that standardized test results assessing both morphosyntactic and semantic domains correlate more strongly with the DSS of CWS than with the DSS of CWNS. These findings are speculated to reflect the possibility that both methods of assessment, standardized testing and measurement of syntactic complexity, tap into a common, subtle difference in language performance. The finding with regard to semantic tasks may be suggestive of lexical and morphological operations being somehow more closely connected in CWS than in CWNS.

Finally, this study found subtle differences in the usage frequency and error patterns of the irregular past tense in CWS and CWNS. Specifically, there was a trend for CWS to use irregular past-tense forms more frequently than CWNS, and there was also a trend for CWS to double-mark these forms more frequently than CWNS. These findings, in turn, can also be seen as supporting the possibility of atypical simultaneous use of declarative and procedural memory systems for morphosyntactic operations in CWS.

Appendix A: Child and Transcript Information

CWS	Sex	Age (m)	Number of DSS-scoreable utterances	Words in scored utterances	Total number of child utterances in transcript	Total number of child words in transcript
SW_CWS_5	F	25	17	49	88	164
BR_CWS_8	M	27	50	112	304	540
BR_CWS_5	M	28	14	55	34	95
BR_CWS_12	M	29	50	208	181	576
SW_CWS_2	M	30	50	247	119	405
BR_CWS_4	F	30	15	63	75	170
BR_CWS_11	M	32	50	171	104	383
BR_CWS_2	M	34	50	214	174	403
BR_CWS_13	M	35	14	57	69	154
BR_CWS_9	M	37	15	52	90	250
BR_CWS_15	M	37	19	77	76	213
SW_CWS_11	F	38	50	221	100	331
SW_CWS_6	M	38	38	132	97	222
BR_CWS_14	M	41	24	86	112	304
BR_CWS_10	M	41	40	220	82	350
BR_CWS_3	M	41	9	33	83	172
BR_CWS_6	F	43	42	185	156	460
SW_CWS_9	F	43	35	160	100	294
BR_CWS_1	M	48	22	97	82	265
WF_CWS_15	F	48	50	217	151	511
WF_CWS_7	M	48	50	250	148	544
WF_CWS_8	F	49	50	112	159	452
WF_CWS_2	M	49	50	304	200	1198
WF_CWS_3	M	50	50	210	185	665
WF_CWS_4	M	50	50	243	170	612
WF_CWS_6	M	55	50	230	185	779
WF_CWS_13	M	55	50	265	211	1005
WF_CWS_10	M	58	50	240	140	598
WF_CWS_17	F	58	50	268	227	1088
WF_CWS_18	F	58	50	301	216	916
WF_CWS_19	F	59	50	274	150	807
Totals			**1204**	**5353**	**4268**	**14926**

CWNS	Sex	Age (m)	Number of DSS-scoreable utterances	Words in scored utterances	Total number of child utterances in transcript	Total number of child words in transcript
NH_CWNS_3	F	28	30	127	102	220
BR_CWNS_15	M	27	50	210	223	580
BR_CWNS_13	M	29	50	208	194	508
BR_CWNS_12	M	29	50	157	216	582
NH_CWNS_4	M	30	50	198	166	484
BR_CWNS_2	F	31	50	214	203	552
BR_CWNS_14	M	32	40	147	146	312
BR_CWNS_9	M	34	50	198	237	497
BR_CWNS_8	M	35	50	242	179	469
BR_CWNS_6	M	38	50	303	366	1621
BR_CWNS_10	M	38	50	211	161	420
NH_CWNS_6	F	41	50	200	99	346
NH_CWNS_5	M	35	50	221	101	367
BR_CWNS_1	M	39	50	204	80	270
BR_CWNS_3	M	40	48	223	226	550
BR_CWNS_4	M	40	24	154	121	405
BR_CWNS_5	F	40	50	279	172	553
NH_CWNS_11	F	44	50	298	103	502
BR_CWNS_11	M	47	47	205	49	229
WF_CWNS_28	F	48	50	275	146	650
WF_CWNS_30	M	48	50	209	127	442
WF_CWNS_23	F	49	50	255	152	707
WF_CWNS_25	M	49	50	269	129	534
WF_CWNS_33	M	50	50	281	210	991
WF_CWNS_32	M	49	50	230	151	520
WF_CWNS_34	M	56	50	272	194	902
WF_CWNS_27	M	54	50	223	179	681
WF_CWNS_31	M	58	50	278	167	871
WF_CWNS_29	F	59	50	275	276	1222
WF_CWNS_26	F	56	50	236	181	688
WF_CWNS_24	F	56	50	214	140	582
Totals			**1489**	**7016**	**5196**	**18257**

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