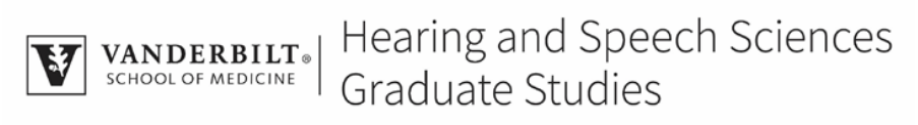

Examining the Complex Syntax of Second-Grade Teachers

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Abstract

Purpose: The purpose of this study was to describe the complex syntax in second-grade teachers' classroom talk and explore the relation of teachers' complex syntax to (1) vocabulary, (2) classroom socioeconomic status, and (3) academic subject area.

Methods: The transcripts from 15 second-grade teacher were analyzed from an extant database of teacher talk (Wanzek et al., 2021). For each teacher, two transcripts from the fall and the spring (n = 4) for English language arts (ELA) and one transcript from the fall and the spring (n = 2) for math were randomly selected. The transcripts were coded for complex syntax following Schuele (2009). Complex syntax was measured by the proportion of complex syntax in total utterances, complex syntax density, and proportion of complex syntax types. Vocabulary was measured by complex syntax specific word types and academic vocabulary. Classroom socioeconomic status (SES) was measured by the percent of children receiving free and reduced lunch.

Results: Teachers had similar proportion and density of complex syntax in ELA and math. The mean proportion of complex syntax in total utterances was 0.27. Neither teacher academic vocabulary nor classroom SES correlated with teachers' proportion of complex syntax in total utterances or complex syntax density. However, complex syntax specific word types significantly correlated with proportion of complex syntax in total utterances. Teachers had a higher proportion of infinitival clauses in math compared to ELA and a higher proportion of relative clauses in ELA compared to math.

Conclusion: Study findings provide a picture of second-grade teachers' complex syntax input that may be important to children's language development in early elementary school, particularly for children with linguistic vulnerabilities.

Keywords: complex syntax, socioeconomic status, academic vocabulary, academic language

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Examining the Complex Syntax of Second-Grade Teachers

Academic outcomes are inextricably linked to language abilities. For example, the best predictor of school achievement in fifth grade is kindergarten language (Durham et al., 2007; Pace et al., 2019). Academic language links language and academic outcomes because it is the language of the classroom and is associated with academic tasks such as providing explanations and definitions (Snow, 2010). Academic language includes three components: academic vocabulary, complex syntax, and decontextualized talk. Academic vocabulary includes the words used in academic discussions and texts that are not common in casual conversation. Complex syntax is a blanket term for spoken utterances or written sentences with one or more dependent clauses. Complex syntax allows speakers (and writers) to create more complex and abstract relations between entities in a sentence. Complex syntax is critical in using decontextualized language, the language that is used to convey ideas unrelated to the here-and-now.

Young children enter elementary school with varying exposure to academic language, with some variance attributable to family socioeconomic status (SES; Huttenlocher 2002, 2007, 2010) as well as participation in preschool education. Children who have greater experience with academic language at home in the preschool years may understand and use academic language more readily than children who have had less experience (Leseman et al., 2007). Elementary school experiences with academic language can facilitate children's academic language growth and potentially narrow or even close the student achievement gaps that relate to varying preschool language experiences. It is critical to understand the nature of language input that can facilitate academic language growth. The evidence-base is particularly lacking regarding complex syntax input. Thus, the purpose of this study was to describe the complex syntax in

second-grade teachers' classroom talk and explore factors, such as SES, that may relate to teacher complex syntax.

The following sections discuss the development of complex syntax, including vulnerable learners of complex syntax. Finally, we review the extant literature on possible influences on complex syntax: vocabulary, SES, and academic area.

Development of Complex Syntax

For typically-developing children, complex syntax emerges between 2 and 3 years old (Bloom et al., 1984; Limber, 1973). By age 4, children produce multiple types of dependent clauses. The verbal interactions that children use complex syntax within becomes increasingly decontextualized over the preschool years and into elementary school (Diesel, 2004). Thus, at the beginning of kindergarten, typical children use complex syntax to meet social and academic language expectations (Bloom et al., 1984; Diesel, 2004; Paul, 1981; Tyack & Gottsleben, 1986). The early elementary classroom appears to support continued complex syntax development. Huttenlocher and colleagues (1998) reported that across kindergarten and first grade, children increased their complex syntax skills more so in the months that they attended school as compared to months that included summer vacation.

There are multiple views on the theory of language development. Hoff (2008) summarized how input affects the rate of language acquisition but not the sequence of elements mastered (e.g., single words, combining words, subject-verb combinations). Regardless of the content of the input children hear, most children nevertheless progress in a similar order of acquisition. However, numerous factors, including the total quantity of talk, complex syntax used, and maternal responsiveness, impact children's rate of acquisition (Bradley & Caldwell,

1976; Clarke- Stewart, 1973; Huttenlocher et al., 2002; Mundy & Gomes, 1998; Tamis-LeMonda et al., 2001).

Children who have had more exposure to complex syntax likely will have more developed complex syntax in preschool than children who have less exposure (Huttenlocher et al., 2002). Hence, the children who are proficient users of complex syntax will have a greater propensity to meet classroom verbal expectations. In contrast, children who are still establishing their complex syntax skills may be less proficient in the understanding and production of academic language and may fail to adequately benefit from classroom instruction and discussion.

Vulnerable Complex Syntax Learners

Some children are at risk for not developing complex syntax comparable to their peers. If a child falls into multiple groups that are vulnerable complex syntax learners, that child may be even more at risk for not developing complex syntax and overall academic language comparable to their peers. Teacher talk in the elementary classroom is an important source of language learning for these children.

Children with specific language impairment (SLI) do not follow the same trajectory and timeline of complex syntax acquisition as normally developing peers (Barako Arndt & Schuele, 2012; Barako Arndt & Schuele, 2013; Leonard, 1995; Marinellie, 2004; Schuele & Tolbert, 2001; Owen & Leonard, 2006). Therefore, they may have not mastered the grammar of complex syntax by early elementary school, or they may struggle to use complex syntax in academic tasks. Additionally, given the high comorbidity of reading disorder with SLI (Catts et al., 2002), children with SLI are less likely to be exposed to complex syntax through reading.

Children who are English language learners (ELLs) may not have mastered English's complex syntax in early grade school. To fully understand and participate in classroom content,

they must acquire knowledge of English's complex syntax. One of the factors that affect second language learners' production of complex sentences is the number of months that they have been exposed to English at school (Paradis et al., 2017). Therefore, continued teacher's input of complex syntax is extremely important for ELLs continued development of complex syntax.

Children from lower SES households are also at risk for delayed proficiency with complex syntax. Huttenlocher and colleagues (2002, 2007, 2010) found a positive significant relation between SES and parents' use of multiclausal utterances in children's preschool years. On average, the higher the parent's SES, the more likely they were to produce more complex syntax. Of course, though, there was inter-group variability (Sperry et al., 2019). Additionally, the proportion of multiclausal utterances in parents' input accounted for nearly 40% of the variance in children's comprehension of complex syntax.

Vocabulary's Influence on Complex Syntax

Another component of academic language is the vocabulary a child must have to produce complex syntax to meet various spoken and written academic tasks. Thus, acquiring the vocabulary of complex syntax is critical for being more productive with particular complex syntax structures. The various subordinate conjunctions (e.g., *whenever, because, since*) used in subordinate conjunction clauses communicate specific relations between main and dependent clauses. Complement clause verbs include mental state verbs and verbs of communication. Barnes and Dickinson (2018) referred to mental state verbs that were defined as verbs that expressed cognition (i.e*.,* thoughts, memories, knowledge, feelings, or ideas). These verbs often are used in decontextualized language as well. Complement clause verbs can subcategorize for four different types of clauses: infinitival (e.g *I want* ***to read the next page***), WH finite complement (e.g. *I wonder* ***what is on the next page***), WH non-finite complement (e.g. *I don't*

know ***where to find the answer***), and full propositional complement clause (e.g., *I think* ***that the answer is on this page***). Each complement clause verb may not subcategorize every type of clausal complement, but they must subcategorize at least one type.

SES's Influence on Teacher Input

The literature is mixed about SES's influence on teachers' language in the classroom. Examining the impact of is critical because hypothetically, teachers should provide their students sufficient opportunities to develop academic language, especially the complex syntax portion. However, teachers may adapt their language based on their students' vocabulary or SES level, leading to classroom level variation. In preschool, Huttenlocher et al. (2002) did not find a significant correlation between SES and complexity of teachers' speech. However, they did find that children's syntactic growth was correlated positively with the proportion of teachers' language that had multiclausal utterances.

Wanzek et al. (2021) explored the relation between vocabulary and SES in second-grade classrooms. They recruited 38 second-grade general education teachers from schools that ranged in the number of students considered low-income (receiving free or reduced lunch [FRL]). There was a significant negative relation between teachers' academic words and the percent of students in the class receiving FRL. As the percent of students from low-income families in a class increased, the amount of academic vocabulary used by the teacher decreased.

Finally, Gámez and Lesauz (2012) analyzed how middle school students' vocabulary, teachers' talk, and classroom SES are related. They studied classrooms from low-performing, large urban districts with large numbers of bilingual students. The researchers found no correlation between teachers' use of sophisticated vocabulary and complex syntax, classroom SES, or percent of language minorities.

Overall, no consistent relation has been established between teachers' talk and classroom SES across the grade levels. Previous studies have not found an impact on teacher's complex syntax use by SES. However, the extant literature is limited in quantity.

Academic area's Influence on Complex Syntax

Another source of variance in teachers' complex syntax may be academic subject. Although classroom lessons are delivered to students via spoken (and written) language, every subject – English language arts (ELA), math, science, and social studies – has a unique language component. Traditionally, ELA has been known for its reliance on language competence. In Scarborough's (2001) rope model, language skills, such as background knowledge, vocabulary, language structures, verbal reasoning, and literacy knowledge, are all needed for a student to become a skilled reader.

However, math has its own unique demands. Although it is thought that math is associated with cognitive demands, math instruction involves language to explain and express mathematical objects, properties, and theoretical systems (Boero et al., 2008). Additionally, teachers must explicitly teach specific words associated with math, as well as explain that numerous words used in mathematics have a different meaning from their most common use (i.e., *mean, operation, significant*; Jourdain & Sharma, 2016).

Research Questions

The purpose of this project was to describe the complex syntax used by second-grade teachers during math and ELA instruction and to examine how multiple factors relate to teachers' production of complex syntax in the classroom. We focused on second-grade teachers as a plausible representation of elementary school teacher talk and because an extant database of

second-grade teacher talk was available (Wanzek et al., 2021). Four research questions about second-grade teacher talk were addressed:

1. What is the nature of complex syntax produced during classroom instruction?
2. Does teachers' complex syntax correlate with their vocabulary?
3. Does teachers' complex syntax correlate with classroom SES?
4. Does teachers' complex syntax differ by subject area (ELA, math)?

Methods

Study procedures were approved by the Vanderbilt Institutional Review Board.

Databases

The data for this study come from an extant database of second-grade teacher talk (Wanzek et al., 2021). Wanzek et al. analyzed second-grade teachers' classroom language focusing on vocabulary outcome measures; classrooms varied in SES, indexed by the proportion of students receiving FRL. The Wanzek et al. database includes transcripts from 38 general education second-grade teachers from 14 public elementary schools in four school districts that were in rural, suburban, near urban, and urban locations. The database includes teacher and student demographics.

To construct the database, teachers were audio-recorded twice a month across a single school year; teachers were recorded on randomly selected days that were stratified across teachers for the day of the week. Full-day recordings were collected by a language environment analysis digital language processor. Each recording was divided based on subject area, and then each subject area segment was segmented into 15-minute segments. Subject areas included ELA, math, science, social studies, and other (e.g., other instruction, transitions). Any 15-min segment in which the teacher said less than 20 words was excluded from the database (i.e., too small to

analyze). From each day of a teacher's recording, one 15-minute segment from each core content area and two 15-minute segments from other were selected randomly for transcription (n = 6 segments per day of recording). If a teacher did not engage in a particular area of instruction on the recording day, there would be no transcript for that subject for that day. Transcription was completed by the Systematic Analysis of Language Transcripts (SALT) software company (SALT Software, LLC). See Wanzek et al. (2021) for details on transcription and reliability.

Participants

For the present study, which involved secondary analysis of the Wanzek et al. database, 15 teachers were selected randomly as study participants. The proportion of consented student participants receiving FRL was a proxy for SES (Wanzek et al., 2021), and in the study sample, the proportion ranged from 0 to 0.58 across classrooms.

Teachers were eligible to be selected if they had the following data in the database: (a) two transcripts from ELA in the fall (September to November), (b) one transcript from math in the fall, (c) two transcripts from ELA in the spring (March to May), and (d) one transcript from math in the spring. The number of transcripts per teacher that were selected for analysis was based on the generalization statistic for each academic subject, calculated specifically for this study. Math had a high relative G-coefficient (G = 0.97), which means that proportion of complex syntax in total utterances was stable across transcripts. ELA had a lower relative G-coefficient (G = 0.19), which means that the complex syntax was less stable across transcripts. There are many reasons that stability could have been much less for ELA compared to math, but one reason appeared to be the greater variability in transcript length in ELA compared to math. Therefore, to increase stability, two transcripts were selected from ELA. All transcripts, regardless of subject, had to be at least 3 pages in length to be eligible for selection.

Coding Transcripts for Complex Syntax

The transcripts were aligned with transcription conventions developed in the Child Language and Literacy Lab (Schuele, 2009) to study child and adult complex syntax production in order to ensure consistency across studies. The written SALT transcripts from Wanzek et al. were transferred to Word documents to preserve track changes. See Appendix 1 for the type of convention changes completed. The first author completed all alignment, and where questions arose, sought input from the thesis advisor to reach mutual consensus.

All utterances in the transcripts were reviewed. First, any utterance that included one or more dependent clauses was coded as including complex syntax by appending [cs] at the end of the utterance line. Second, each dependent clause was coded for complex syntax type based on a classification system of 11 complex syntax types common in young children's spoken language outlined in Schuele (2009). The system classifies dependent clauses by grammatical structure and includes subordinate conjunction clauses, coordinate conjunction clauses, marked and unmarked infinitival clauses, WH finite and nonfinite complement clauses, full propositional complement clauses, subject relative clauses, other relative clauses, nominal or headless relative clauses, and participle clauses. Due to the unique linguistic challenges in classroom talk, an additional category was created, metalinguistic utterances. See Appendix 2 for definitions for each dependent clause type and codes. Third, the revised transcripts were copied back into a SALT document for analysis.

Reliability

The first author coded all transcripts for complex syntax. Where questions arose during the initial coding, the first author sought input from the thesis advisor to reach mutual consensus. Complex syntax coding reliability was completed by an undergraduate research assistant who

had five years of experience coding language samples for complex syntax. The research assistant randomly selected 20% of the transcripts (n = 18) for the reliability check. To establish reliability, the research assistant accessed the first author's coded written transcripts. For each utterance, she noted agreement or disagreement with the classification of an utterance as having complex syntax and agreement or disagreement with the assignment of codes for complex syntax type. For disagreements, the research assistant marked her decision for complex syntax type. In the case of dependent clauses that were missed by the first author, the research assistant identified and coded these clauses. The research assistant agreed with the first author that an utterance included complex syntax for an average of 99.3% of utterances across transcripts checked. The research assistant identified only 16 instances in which the first author failed to code a dependent clause. Of the dependent clauses that were coded for complex syntax (n = 1110), the first author and research assistant had 98.9% agreement on the complex syntax type codes. Given this high level of agreement, analysis proceeded with the first author's coded transcripts.

SALT Analysis and Variables Derived

Complex syntax Variables

Complex syntax was quantified by three variables. (a) *Proportion of complex syntax in total utterances* was total number of utterances with complex syntax divided by the total number of utterances. (b) *Complex syntax density* was the total number of all dependent clauses divided by the total number of utterances with at least 1 dependent clause. (c) *Proportion of complex syntax types* was the total number of dependent clauses for each of the following categories: infinitival (includes [si] and [uic]), complement clause (includes [fpc], [wfc], and [wnfc]) and

relative clause (includes [src], [rc], and [nrc]) divided by the total number of dependent clauses in the sample (tokens).

Complex syntax variables were derived from SALT analysis. For proportion of complex syntax in total utterances, total number of utterances were taken from the "C&I Verbal Utts" portion of Standard Measures Report in SALT which automatically calculated the number of utterances in the current analysis set. This set excluded utterances that were partially or fully unintelligible or only included interjections or mazes. The other SALT analysis used for calculating this variable was creating and running a SALT list that include [cs] and all of the dependent clause codes. A SALT list's function is to tally the frequency that each code or word on the list that occurs in the transcript as well as the total amount of times all the codes or words on the list were used (total frequency). Total number of utterances with complex syntax was determined based on the frequency [cs] appeared in a transcript.

For complex syntax density, total number of all dependent clauses was calculated through subtracting the total frequency derived from the SALT list (all of the dependent clauses and [cs] occurrences) by the total number of utterances with [cs]. This subtraction was chosen over adding each of the number of occurrences for each dependent clause because it required fewer steps. For each complex syntax type, proportion was also derived from the SALT list. For each category, the codes for each type (e.g., [si] and [uic] for infinitival clause) were summed on excel and then divided by total number of dependent clauses which was already calculated in the complex syntax density measurement.

When calculating the means across subject and time for each teacher, ELA and math were weighted equally. Because ELA had two transcripts, these transcripts were averaged into a single value before being averaged with math. Therefore, the averages were composed of one

ELA value (instead of two values) and one math value. This procedure was followed for each of the complex syntax and vocabulary measures.

Vocabulary Variables

Vocabulary was quantified by three variables. The first two variables are complex syntax specific vocabulary measurements. (a) *Unique subordinate conjunctions* was the mean number of unique subordinate conjunctions across all transcripts per teacher. (b) *Unique number of complement clause verbs* was the mean number of unique verbs that took a full propositional clause, WH finite clause, and a WH nonfinite clause. The last vocabulary measure reflected academic vocabulary which was determined by using the Coxhead Academic Word List (Coxhead, 2000). (c) *Academic vocabulary* was the number of words used from the Coxhead Academic Word List divided by the total number of words in the transcript.

Vocabulary measures were also derived from SALT analysis as well as by hand. For the complex syntax specific vocabulary measures, a new SALT list was used that included only [sc], [fpc], [wfc], and [wnfc]. For each transcript, the unique number of subordinate conjunctions that occurred in [sc] clauses were calculated by hand as well as the unique number of complement clause verbs that occurred in [fpc], [wfc], and [wnfc] clauses. These numbers were averaged across transcripts.

Academic vocabulary was calculated based off a third SALT list that included all of the words on the Coxhead Academic Word List. Total number of words in the transcript was "Total Number Words" portion of Standard Measures Report which automatically calculated the number of words in the current analysis set.

Data Analysis

Research Question 1

The nature of complex syntax used by teachers in the classroom was characterized with descriptive statistics. Mean, standard deviation, minimum, and maximum were calculated for each complex syntax measure.

Research Question 2

To determine if teachers' complex syntax was correlated with their vocabulary, we calculated Pearson correlation coefficients between (a) *proportion of complex syntax in total utterances, (b) complex syntax density, (c) academic vocabulary, (d) the unique number of subordinate conjunctions, and (e) the unique number of complement clause verbs.* Pearson correlation coefficients between .0 and 0.3 were considered "weak," between .4 and .6 will be considered "moderate," and between 0.7 and 1.0 were considered "strong" (Akoglu, 2018).

Research Question 3

To determine if teachers' complex syntax was correlated with classroom SES, we calculated Pearson correlation coefficients between (a) *Classroom SES* and *the proportion of complex syntax in total utterances* used by teachers, (b) *Classroom SES* and *complex syntax density* used by teachers, (c) *Classroom SES* and *Proportion of complex syntax types* for each type. Pearson correlation coefficients between .0 and 0.3 were considered "weak," between .4 and .6 will be considered "moderate," and between 0.7 and 1.0 were considered "strong" (Akoglu, 2018).

Research Question 4

To answer the last research question regarding how complex syntax differs by academic subject, we conducted an ANOVA test with the factors being time (fall and spring) and subject (ELA and math) for each of the complex syntax measures: (a) *proportion of complex syntax in*

total utterances, (b) *complex syntax density*, *and* (c) *Proportion of complex syntax types* for each type.

Results

Recall that the first purpose of this project was to describe the complex syntax used by second-grade teachers. Table 1 reports the descriptive statistics for each complex syntax variable averaged across subject (ELA, math) and time. Slightly more than one-quarter of teacher utterances included complex syntax. When teacher utterances included complex syntax, there was an average of about 1.5 tokens of complex syntax per utterance. There was substantial variation across teachers. In regard to what the teachers' complex syntax was composed of, teachers used a higher proportion of infinitival clauses compared to complement and relative clauses. See Figure 1 for the ratio of clauses by subject and time. The proportions of the three clause types do not add up to 1.00 because there were other dependent clause types that were coded (e.g. subordinate clauses, participle clauses, and other).

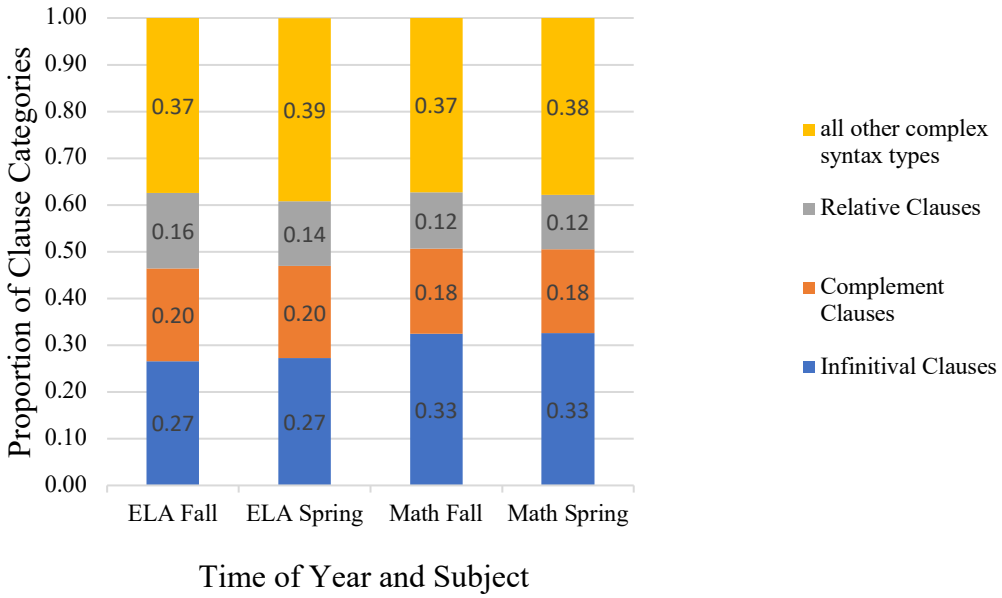
Table 1

Means, Standard Deviations, Minimum, and Maximum for Complex Syntax Variables Averaged Across Subject and Time

Variable	*M*	*SD*	Min	Max
Proportion of complex syntax in total utterances	0.27	0.08	0.11	0.47
Complex syntax density	1.42	0.15	1.11	1.85
Proportion of infinitive clauses	0.30	0.07	0.16	0.51
Proportion of complement clauses	0.19	0.07	0	0.40
Proportion of relative clauses	0.13	0.06	0	0.27

Figure 1

Ratio of Clause Type by Subject and Time of Year



The second purpose of this project was to examine the relation of vocabulary variables to teachers' complex syntax use. Teachers' vocabulary was measured as academic vocabulary and complex syntax specific vocabulary. There was no significant difference in academic vocabulary nor complex syntax specific vocabulary measures across subject or time. Refer to Table 2 for descriptive statistics of academic vocabulary and complex syntax specific vocabulary. The average proportion of academic words across teachers was about one academic vocabulary word in about every 100 words. Academic vocabulary only had a weak correlation with proportion of complex syntax in total utterances and complex syntax density. Refer to Table 3 for the correlation matrix.

Table 2

Means, Standard Deviations for Vocabulary Measures

Variable	*M*	*SD*	Min	Max
Academic vocabulary	0.01	0.01	0	0.05
# unique subordinate conjunctions	4.79	1.53	2	8
# unique complement clause verbs	5.63	2.14	0	11

Table 3

Correlation Matrix between Complex Syntax Measures, Vocabulary Measures, and Classroom SES

Variable	1	2	3	4	5	6
1. Proportion of complex syntax in total utterances	—					
2. Complex syntax density	0.74**	—				
3. Academic vocabulary	0.12	0.04	—			
4. # unique subordinate conjunctions	0.54*	0.39	0.04	—		
5. # unique complement clause verbs	0.54*	0.21	0.25	0.80**	—	
6. Classroom SES	0.21	0.21	0.25	-0.02	-0.08	—

Note: $^{*}p < .05$. $^{**}p < .01$

For complex syntax specific vocabulary, the average unique number of subordinate conjunctions across teachers' transcripts was slightly less than 5. The most common subordinate conjunctions were *if, when,* and *because*. The average number of unique complement clause verbs across teachers' transcripts was over 5 with a greater variance than for subordinate conjunctions. The most common complement clause verbs were *know*, *think*, and *say*. None of these variables differed by subject or time. Number of unique of subordinate conjunctions and number of unique complement clause verbs had a moderate correlation with proportion of

complex syntax in total utterances but not with complex syntax density. Academic vocabulary was not correlated with number of unique subordinate conjunctions nor with complement clause verbs. However, number of unique subordinate conjunctions and number of unique complement clause verbs had a strong correlation.

The third research question was about the relation between classroom SES and teachers' complex syntax. The mean percent of FRL was about 20%. The lowest percent classroom FRL in the sample was 0, and the highest was 58.3%. The distribution was skewed such that only four teachers taught in a classroom that had more than 25% of students receiving FRL. Classroom SES did not have a significant correlation with any of the complex syntax or vocabulary measures. Refer to Table 3 for the correlation matrix of the vocabulary variables to the complex syntax and SES variables.

The last variable examined was subject area. The mean proportion of complex syntax in total utterances for math was one-quarter and slightly higher for ELA. The mean complex syntax density for ELA was about 1.5 and slightly lower for math. Refer to Tables 4 and 5 for descriptive statistics of the complex syntax measures separated by subject and time. A two-way ANOVA was performed to analyze the effect of subject and time (fall and spring) on each complex syntax measure. Results can be found in Table 6. For proportion of complex syntax in total utterances and complex syntax density, time and subject had no effect. There was a main effect for academic subject but not time for proportion of complex syntax types. Teachers used a higher proportion of infinitival clauses in math than ELA ($p = 0.004$). Conversely, teachers used a higher proportion of relative clauses in ELA than math ($p = 0.03$).

Table 4

Means, Standard Deviations for Complex Syntax Variables for ELA

Variables	Fall				Spring			
	M	*SD*	Min	Max	*M*	SD	Min	Max
Proportion of Complex Syntax in Total Utterances	0.29	0.10	0.18	0.47	0.26	0.08	0.14	0.44
Complex Syntax Density	1.48	0.15	1.29	1.85	1.41	0.13	1.11	1.60
Proportion of Infinitive Clauses	0.27	0.04	0.21	0.36	0.27	0.06	0.16	0.37
Proportion of Complement Clause	0.20	0.06	0.08	0.28	0.20	0.08	0.00	0.31
Proportion of Relative Clauses	0.16	0.04	0.11	0.27	0.14	0.06	0.06	0.24

Note: ELA = English Language Arts; EL samples are averaged at each time point, e.g., two fall ELA samples are averaged for fall variables

Table 5

Means, Standard Deviations for Complex Syntax Variables for Math

Variables	Fall				Spring			
	M	*SD*	Min	Max	*M*	SD	Min	Max
Proportion of Complex Syntax in Total Utterances	0.25	0.08	0.15	1.16	0.26	0.08	0.11	0.41
Complex Syntax density	1.39	0.15	0.46	1.68	1.40	0.17	1.15	1.71
Proportion of Infinitive Clauses	0.33	0.08	0.23	0.51	0.33	0.05	0.24	0.43
Proportion of Complement Clause	0.18	0.06	0.04	0.27	0.18	0.08	0.08	0.40
Proportion of Relative Clauses	0.12	0.05	0.04	0.23	0.12	0.07	0.00	0.22

Table 6

Two-Way ANOVA for Complex Syntax Measures

Variable	SS	Df	MS	f	p-value
Proportion of Complex Syntax in Total Utterances					
Subject	0.003	1	0.003	0.48	0.49
Time	0.002	1	0.002	0.28	0.60
Complex syntax density					
Subject	0.04	1	0.04	1.70	0.20
Time	0.15	1	0.15	0.66	0.42
Proportion of Infinitive Clauses					
Subject	0.05	1	0.05	13.01	0.0007**
Time	0.0001	1	0.0002	0.048	0.83
Proportion of Complement Clause					
Subject	0.005	1	0.005	1.02	0.32
Time	0.000	1	0.00	0.005	0.95
Proportion of Relative Clauses					
Subject	0.15	1	0.015	4.81	0.03*
Time	0.003	1	0.003	0.947	0.33

Note: $^{*}p < .05$. $^{**}p < .01$

Discussion

Overall, this study found that teachers' complex syntax was correlated with complex syntax specific vocabulary but not academic vocabulary or classroom SES. In addition, the only differences in the use of complex syntax by academic subject was that teachers used a higher proportion of infinitival clauses in math as compared to ELA and a higher proportion of relative clauses in ELA compared to math.

The lack of correlation between complex syntax and academic vocabulary may be due to these constructs being influenced by different variables. The speaker and listener may not be the

only variables that influence complex syntax and academic vocabulary. If the teachers' language skills, the students' language skills, or even classroom SES were the only influences on these factors, the two constructs would be highly correlated because the teachers and classrooms they taught in were held constant. However, this is not the case. Because the two constructs are not correlated, there are likely different variables influencing both. A potential variable that influences complex syntax is the activity presented in class. For example, if a lesson talks about a character's perspectives in an ELA lesson, more cognitive state verbs may be used which could increase the number of full propositional clauses the teacher produces (e.g. *the character thinks* ***that he is right****).* If a lesson focuses on providing definitions for terms, then more relative clauses may be used (*e.g., a perspective is a thought* ***that a character has****).* If a math lesson focuses on teaching a skill and providing directions, for example, explaining how to regroup, more infinitival clauses may be used (e.g., *you have* ***to take from the next column***). Therefore, complex syntax may be more influenced by the activities happening in the classroom compared to the makeup of the students in the classroom. Because the activities in second-grade classrooms are somewhat consistent across classrooms, complex syntax input may be as well.

The proposed element that influences teachers' academic vocabulary is the academic language of the students. Teachers may try to bring their language level closer to their students' language level to improve the students' understanding, akin to how parents bring their language input closer to their young child's language level (Cameron-Faulkner et al., 2003). There are many ways to change one's language level, but one of the easiest ways is to change vocabulary because it takes the least amount of linguistic awareness. Hence, words are typically easier to adjust than sentence structure. For example, a teacher may use the word "inform" rather than "told" to explain a character's action for the students in more advanced groups rather than

changing a relative clause into two independent utterances. For students at a lower language level, teachers are more likely to adjust their vocabulary to their students' language level rather than their complex syntax.

Another finding of this project was that complex syntax specific vocabulary was correlated with proportion of complex syntax in total utterances, but academic vocabulary was not. This correlation is most likely because complex syntax specific vocabulary primarily occurs within utterances with complex syntax, whereas academic vocabulary can occur naturally in simple or complex sentences. For example, the word "because" almost always occurs in a subordinate clause (i.e., is biased for complex syntax), whereas the word "analysis" can occur in a simple or complex sentence (i.e., is not biased for complex syntax). Interestingly, complex syntax specific vocabulary was not significantly correlated with density, which may indicate that having a subordinate conjunction or complement clause verb does not make a sentence more or less likely to have additional clauses.

The findings in Wanzek et al. (2021) differed from the findings in this study. The previous study found a positive significant relation between academic vocabulary and classroom SES whereas this study did not. The difference in these findings is surprising because the data from this project comes from the Wanzek et al. database. The difference in findings may be explained by the lack of range of classroom SES of the current study. In the Wanzek et al. which used all teachers, there was a wide range of FRL which went from 0-100%, whereas the current sample was skewed towards lower FRL (higher SES), and the range was 0-58.3%. Therefore, the current study's findings that classroom SES and teachers' complex syntax can only be applied to classrooms with a higher SES, not to the whole range of classrooms.

The last element to correlate with teachers' complex syntax was academic subject. Along the same lines, this would determine if the event structure in the activities being presented in ELA and math are different enough to affect the complex syntax teachers used. Because there was no difference in the proportion of complex syntax in total utterances or complex syntax density between ELA and math, the amount of complex syntax was not different between the two subjects. However, the types of complex syntax differed by academic subject. Math had a higher proportion of infinitival clauses and ELA had a higher proportion of relative clauses. The nature of talk in each of these subjects may underlie this finding. Possibly, math includes a higher use of directives and procedural instruction, in which infinitival complement clauses would be more appropriate to use. In contrast, because relative clauses are used in defining terms and providing elaboration about nouns, they may be more prevalent in the descriptive language used in ELA.

Infinitival and relative clauses also differ in their acquisition by speakers. Infinitival clauses are typically the first complex syntax clausal type to be acquired, whereas relative clauses are a later acquired clausal type (Dissel, 2004; Schuele & Dykes, 2004). Vulnerable complex syntax learners in second grade will most likely not have difficulty producing and understanding infinitival clauses. However, they will be more likely to still be learning to comprehend and use relative clauses throughout elementary school. Because the proportion of relative clauses is higher in ELA, vulnerable learners may benefit more from the complex syntax input in ELA.

Time of year (fall and spring) was also analyzed. As the school year progresses, teachers may increase the complexity of their language as grade-level content becomes more complex. Additionally, the growth of language, particularly academic language, across second grade may

be accompanied by changes in teachers' language. However, because none of the complex syntax measures differed based on time of the year, it suggests that ELA and math activities in the fall and spring are not different enough to require changes in complex syntax. Also, teachers do not seem to increase their complex syntax input based on their students' increasing language levels, which supports the theory that complex syntax is influenced by factors other than the speaker's audience.

Limitations

A limitation to this study was that only a subset of the Wanzek et al. database was used for analysis. Not all of the teachers in the database were used nor were all transcripts for every selected teacher used. The decreased sample size restricted the range of classroom SES. Therefore, the correlation only took into account a partial range. Additionally, the original database was stratified so that each day of the week was represented in the sample. However, for this project, day of the week was not considered in transcript selection.

Another limitation was that the teachers' vocabulary outside of the classroom setting was not considered. Teachers' academic vocabulary and complex syntax specific vocabulary may have been influenced by their pre-existing vocabularies more than their complex syntax use or classroom SES. In addition, classroom vocabulary was not factored into the analysis. Therefore, we cannot rule out that classroom vocabulary could influence teachers' vocabulary even though this paper has hypothesized activities are the primary influence on complex syntax.

Future Directions

The current study also only focused on the complex syntax used by second-grade teachers; it would be very interesting to examine the complex syntax used by preschool teachers as well as middle school and high school teachers. Does the proportion of complex syntax in

total utterances, complex syntax density, and proportion of more advanced clausal types increase as students grow their academic language? Are there grades where a rapid change in complex syntax input occur and grades where there is a plateau? If so, then speech-language services in schools may want to focus more on complex syntax intervention in comparison to semantic interventions during the years of rapid increases in complex syntax demands in the classroom.

Additionally, a future study could examine the effectiveness of an intervention to increase teachers' complex syntax input. Two approaches might be taken. The first option is to require teachers to understand and be aware of their use of the various complex syntax types. However, this approach would require the teachers to gain a deep knowledge of syntax. The second option would be to prompt the teachers to use vocabulary that would naturally create opportunities to produce utterances with complex syntax. Vocabulary is more malleable and less linguistically complex than complex syntax. Van Horne et al. (2017) conducted a pilot study that found that teachers used more complex syntax when implementing a curriculum revolving around complement clause verbs compared to a curriculum revolving around verbs that did not take clauses as a complement. A continuation of that project as well as the current project could integrate complex syntax specific vocabulary into teachers' current curriculum instead of creating and implementing a new curriculum.

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Appendix 1

Transcription Convention Changes

Convention	**Change**	**Example of Change**
Utterance Boundaries	Independent clauses conjoined by a coordinating conjunction were broken into two utterances. Dependent clauses that were separated from their independent clauses were put into one utterance. **Rationale**: Utterance boundaries affect the total number of utterances.	Original: T It says [3irr] these invertebrate/s would eat a neighbor in a flash so separate tank/s are a must. Changed: T It says [3irr] these invertebrate/s would eat a neighbor in a flash. T so separate tank/s are a must [cs] [fpc]. Original: T Now if you got here late. T I want you to continue. Changed: T Now if you got here late, I want you to continue.
Parenthetical remark	A parenthetical remark is a word or clause, occurring within an utterance, which has been added by the speaker as an explanation, comment or question. These are put in double parentheses. **Rationale**: Parenthetical remarks are considered not dependent clauses in Schuele (2009). Separating these remarks with double paratheses increases clarity and reliability for coding complex syntax.	Original: T The perfect crime is something that you/'re able to do that/'s wrong, like eat another octopus, and get away with it. Changed: T The perfect crime is something that you/'re able to do that/'s wrong, ((like eat another octopus)) (um) and get away with it because nobody can trace back to see who did the crime
Paratheses addition	Utterances that contained only single words or rote phrases that are not answering a question are put in paratheses **Rationale**: Putting paratheses around an entire utterance will affect the total number of utterances.	Original: T awesome. Changed: T (awesome).
Curly bracket addition	All sound effects not being used in a sentence were put in paratheses	Original: T Mhm. Changed: T {Mhm}.

	Rationale: Putting curly brackets around an entire utterance will affect the total number of utterances.	
Attention getter code	[ag] word code was added after a verb that was used as an attention getter instead of part of the syntactic structure **Rationale:** attention getters are not acting as a full propositional verb. Putting [ag] increases clarity and reliability for coding complex syntax.	Original: T Remember we don't leave for RTI. Changed: T Remember[ag] we don't leave for RTI.
Error code	[err] code was added if part of an utterance was not grammatical and not revised by the speaker. A gloss line was added as a comment **Rationale**: To avoid different interpretations of an ungrammatical sentence, creating a gloss line increases clarity and reliability for coding complex syntax.	Original: T XX Tim feel/3s in the beginning he thought had happy. Changed: T XX Tim feel/3s in the beginning he thought had **[err]** happy. =g XX Tim feel/3s in the beginning he thought he was happy

Appendix 2

Complex Syntax Coding Scheme and Guidelines; Adapted from Schuele (2009)

Salt Code	Complex Type	Sentence examples and Isolated dependent clause examples	Definitions Notes
[cs]	Include the [cs] code with all utterances that have any type of complex syntax described below.		
Conjoined and Subordinate clauses			
[cc]	**coordinate clause**: *and, but, or*	I went to the store and bought a new dress. He'll drive to the mountains or take a plane. He'll climb the mountain but not camp overnight.	S: two clauses joined by and, but, or; the clauses share a subject DC: coordinate conjunction + clause but subject elided
		S1: We'll go to Ohio on vacation. S2: But not stay very long.	- But not*: I went to the store and I bought a new dress*; this string would be two utterances; *But I don't like that;* do not code if coordinating conjunction is utterance initial - code for conjoined verb phrases but not conjoined noun phrases (e.g., *I ran won the race*)
[sc]	**subordinate clause** with subordinating conjunctions including *before, after, until, although, if, when, because, since, so, though, while, like, as, where, in that, so that, such that, except that, as far as,* etc. (but NOT conjuncts or disjuncts, such as *however, then, thus,* etc.)	I went to the store because I needed a new dress. Before I went to the store, I called my sister.	S: 2 or more dependent clauses headed by a subordinate conjunction attached to a main clause DC: one or more dependent clauses headed by a subordinate conjunction without a main clause
		S1: Let's go to the movies today. S2: Yeah, after we finish our homework. S1: I bought three pairs of shoes. S2: because they were on sale?	- code if one clause and subordinating conjunction (e.g., *because he wanted to go*) - do not code single word utterances of subordinating conjunction alone (e.g., because)
Embedded Clauses			
[ri]	**reduced infinitive** (aka semiauxiliary or catenative) forms: gonna, wanna, hafta, gotta, etc. + VP	I wanna go home. They hafta take their dog with them.	S: verb phrase includes a phonologically reduced form of complement taking verb + TO complement verb. DC: clause does not include a subject.
		Hafta go home.	Most authors do not regard [ri] as true complex syntax; we code because reduced infinitives may developmentally precede marked infinitives.
[lc]	**let's, let me, lemme**	Let's go home. Let me have that.	S: Utterances beginning "let's" or "let me" where the complement verb (second verb) is nonfinite DC: n/a
		Not applicable	Most authors do not regard [lc] as true complex syntax; we code

			because [lc] may developmentally precede other true complex types.
[si]	**marked infinitive clause**	he wanted to go to the store (same subject) he wanted Mary to leave (different subject) it's time to go (non-complementing infinitive)	S: complement taking verb takes an non- finite complement that is obligatorily marked with TO; infinitival clause that does not have a complement taking verb. DC: TO + nonfinite verb (with no subject or tensed verb)
		Ready to finish my homework. S1: What do you want? S2: to go to the store.	The infinitival marker TO is obligatory in the adult grammar. The infinitival complement may or may not have an overt subject (i.e., different subject).
[uic]	**unmarked infinitive clause**	He made Mary leave.	S: complement taking verb takes an non- finite complement but TO does not mark complement. DC: main verb and nonfinite complement with no subject.
		S1: What did he do? S2: made Mary leave.	
[wnfc]	**wh non-finite clausal complement**	He doesn't know where to go I'll show you what to do	S: WH clause (headed by *who, what, when, where, why, how*) with a marked infinitive is complement (i.e., argument) of a cognitive state complement taking (e.g., *know, think*) DC: WH clause is produced without main clause, but the complement taking verb main clause is part of the dialogue.
		S1: You don't know what? S2: Where to put the Nile River on this map.	The non-finite embedded clause is an argument of a complement taking verb.
[fpc]	**full propositional complement clause** or **clausal complement**	Mary knew the boys would leave at 4:00. The old man wondered whether they were going.	S: Main clause includes a complement taking verb with a finite embedded clause that is the argument of the complement taking verb. Embedded clause may be headed by a complementizer (*that, whether, if*), dependent on the complement taking DC: only the embedded clause is produced, but the complement taking verb main clause is part of the dialogue.
		S1: I thought that your team one. S2: What did you say? S1: That your team won.	Clause may be headed by complementizer, *that, if, whether.* With some verbs, complementizer are obligatory whereas with other verbs complementizers are optional.
[wfc]	**wh finite clause or wh clausal complement**	I wondered where we were going on Saturday. I know who Jim was going to the dance with. I wanted to know who Jim was inviting.	Same as WH nonfinite complement clause but verb in embedded clause is finite.
		S1: What do you know? S2: Where are we going out tonight?	

[nrc]	**nominal or headless relative**	Whoever wants to leave needs to get in the car. This is where I put my shoes.	S: The nominal relative is an argument within the sentence (e.g., subject of sentence, object of preposition). DC: only the nominal relative is produced but the nominal relative completes previous dialogue.
		S1: Who is leaving now? S2: Whoever is ready to go.	Differs from WH -finite clause in that nominal relative is not a verb complement. In a nominal relative. There is no overt noun phrase in a nominal relative. Consider as alternative to example sentences: *The person who wants to leave needs to get in the car; This is the place where I put my shoes.*
[src]	**subject relative clause**	The man who/that crashed the car is in jail.	S: A dependent clause introduced by a relative pronoun (*which, that, who, whom, whose*) modifies a noun in the main clause; the gap in the relative clause is in the subject position. DC: Only the modified noun and the subject relative clause or the subject relative alone is produced (i.e., no main clause).
		The man who/that crashed the car.	The relative marker in a subject relative is obligatory in the adult grammar.
[rc]	**object relative clause**	The man who/that/null Mary invited is here.	S: A dependent clause introduced by a relative pronoun (*which, that, who*) modifies a noun in the main clause; the gap in the relative clause is in the object position. DC: Only the modified noun and the object relative clause or the object relative alone is produced (i.e., no main clause).
		The man that Mary invited.	The relative marker is optional in the adult grammar.
	oblique relative clause	The man that/whom/null I glanced at left the restaurant.	Same as previous, but the gap in the relative is the object of the preposition. The relative marker is optional; if the preposition is moved then the relative marker is obligatory. (e.g., *The man at whom I glanced left the restaurant* but not **The man at I glanced left the restaurant*).
		S1: What man? S2: The man I glanced at.	
	Indirect object relative	The person that/null the bike belongs to left.	Same as previous, but the gap is an indirecit object that would be marked in a to NP phrase in a simple

			sentence. (e.g., The bike belongs to Joe.)
		The person that/null the bike belongs to.	
	adjunct relative clause	I wrecked the car the time when/that I went to the store. The reason why/that you are leaving is not clear to me. The place where/that you lived burned down.	Same as previous. There is no gap; the relativized phrase is place, time, manner or cause adjunct.
		S1: What place is that? S2: Where I used to live.	
[pc]	**participle clause**	Meat cooked on the grill tastes good. He looked for her wandering around the store. The mom watched her children laughing at the clown.	S: an independent clause with a dependent past or present progressive participial phrase. DC: past or present progressive participial phrase.
		S1: What did you see? S2: The children laughing at the clown.	Includes past participles and present progressive participles.
[Other]	**complex utterance that does not fit into one of the above categories**		
[mu]	**Metalinguistic utterances**	Which one is “”I have””? Underline “”that’s because””. That goes back to “”why did the dog run away””.	Clauses that are embedded into a sentence that are uniquely found in learning environments. The clauses are usually being used as a noun and can be substituted for “this.” These are anomalies and do not contribute to the acquisition of complex syntax
			The clauses are put in double quotes. This code is not one of the original dependent clause types define in Schuele (2009) **These are not considered a complex syntax type**