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A mixed-methods investigation of third and sixth graders' academic sentence knowledge

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Abstract: This qualitative-dominant mixed methods study aimed to investigate how native English speaking third graders (n = 72) and sixth graders (n = 88) navigate cohesive ties in academic sentences. There are studies on supporting students with academic language at the word and text levels, but less research has been done on readers' knowledge of the dense and challenging sentences in academic texts. The current study examines both how students navigate cohesion in academic sentences as well as how their knowledge of cohesion relates to their performance on reading comprehension measures. With a multi-case study framework, we analyzed students' (n = 6) metalinguistic interviews with academic sentences. We then designed Maze tasks for a larger sample (n = 160) to identify patterns in students' knowledge of cohesion. We also conducted correlational analyses between students' sentence-level knowledge and performance on measures of reading comprehension. Qualitative findings suggest that students draw on both metalinguistic and epilinguistic knowledge to explain cohesion, and that students value explicit instruction with academic sentences. Quantitative findings show that knowledge of cohesive ties is significantly correlated with performance on reading comprehension measures. Implications and future research for both monolingual and multilingual learners are addressed.

Keywords: academic language; cohesion; metalinguistic awareness; mixed methods; elementary; secondary

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1 Introduction

The construct of academic language knowledge relates to many important individual factors, including language development (Nagy and Townsend 2012), reading comprehension (Uccelli et al. 2015), and a sense of belonging in schools (Flores and Rosa 2015). The focus of the current study emphasizes language knowledge; specifically, we explore how students navigate one dimension of academic language: cohesive ties. Cohesion, as defined by Halliday and Hasan (1976: 4), "relations of meaning that exist within the text, and that define it as text". In other words, when readers recognize that two or more sentences are meaningfully part of a text, rather than a disjointed set of ideas, it is because of the *cohesion* of that text. A cohesive tie is an individual occurrence of cohesion within a text – that is, a single reference whose meaning depends on another element within that text (Halliday and Hasan 1976). Identifying when and how the cohesion of academic language is challenging for students has important instructional implications. To this end, the purpose of this qualitative-dominant mixed methods study was to explore how third graders and sixth graders, primarily from English-speaking backgrounds, navigate cohesive ties in academic sentences. In addition, while the students in the current study were primarily monolingual English-speakers, we conclude by situating our findings in implications for both monolingual and multilingual learners.

2 Theoretical foundation

Within the framework of Systemic Functional Linguistics (hereafter SFL) (Halliday and Matthiessen 2004), this study uses the construct of metalinguistic awareness (Gombert 1992) to explore how students navigate cohesion in academic language. SFL provides pathways for exploring how language and context inform each other. Metalinguistic awareness, then, is an individual factor which can influence the language development and language choices of individuals within larger contexts. Figure 1 illustrates how an individual's metalinguistic awareness can interact with the language-context relationship explained by SFL.

2.1 Systemic functional linguistics

SFL is a social semiotic framework that provides a set of assumptions and tools to better understand how a given context guides and informs language use, and how language use reinforces the context (Fang and Schleppegrell 2010; Halliday and Matthiessen 2004; Schleppegrell 2004). An SFL-informed study recognizes the interaction of language and context in that specific structures and features of

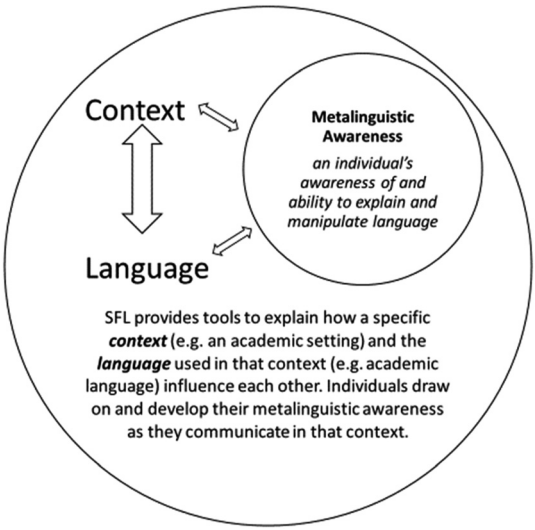

Figure 1: Graphic representation of SFL and metalinguistic awareness.

language are influenced by meaning from a given context. At the same time, using those language structures and features influences meaning in that context.

Within SFL is the concept of *register*, which is a "constellation of lexical and grammatical features that realizes a particular situational context" (Schleppegrell 2004: 18). Languages have many registers, or varieties; indeed, all language is contextualized and complex (Schleppegrell 2004). For example, Baker-Bell (2020) illuminates the contextualized and complex nature of Black English. Although academic language is no more or less complex than other registers of English, the features of academic language are not equally familiar to all students and can present challenges as students read at school.

2.2 Metalinguistic awareness

Navigating different registers of a language, including academic language, requires sociolinguistic skills and competence (Schleppegrell 2004; Snow and Uccelli 2009). Individuals use their sociolinguistic skills as they attend to a variety of semiotic cues in a given context to make language choices that will help them effectively communicate in that context. One component of sociolinguistic skills is metalinguistic awareness, which is defined as "thinking about language". Gombert (1992) explains that metalinguistic awareness allows for:

(1) activities of reflection on language and its use; and
(2) subjects' ability to intentionally monitor and plan their own methods of linguistic processing (in both comprehension and production).
(Gombert 1992: 13)

Metalinguistic awareness is key to supporting students in navigating academic language and recognizing the language choices that authors make to support text understanding (Myhill 2016). With well-developed metalinguistic awareness, language users can reflect on and manipulate sounds, spelling patterns, meanings, grammatical structures, contexts of language use, and features of text. Metalinguistic awareness also includes knowing language *about* language (Nagy 2007). For example, in science texts, readers may learn that authors can use a phrase like "This process […]" as an *anaphoric reference* (one type of cohesive tie) to refer back to a scientific process that was explained in the previous paragraph, and that this type of reference allows an author to continue elaborating on an explanation begun earlier in the text.

Metalinguistic awareness is most commonly explained as *explicit*, rather than *tacit*, language knowledge. When we have well-developed metalinguistic awareness, we can explain the functions of different components of language and our language choices, and we can manipulate language to serve our communicative goals. In contrast is more tacit language knowledge, also known as *epilinguistic* awareness, which means we can *use* language, but we are not be able to explain how and why we are using it. As Gombert (1992: 13) explains, epilinguistic awareness "is related to metalinguistic behaviour but is not […] consciously monitored by the subject". In other words, epilinguistic awareness generally facilitates language use, but on a functional level without the ability to explain or manipulate the many dimensions of language. For example, a young child might say, "I runned […] no, that's not right, I *ran* […] to the park." In this example, the child draws on their epilinguistic awareness, their sense of how to use language in a given context based on their prior experience with language. Young children would typically not be able to explain why *ran* is the correct past tense of *run*; they simply make language choices that "sound right" based on their experiences with language. However, when might epilinguistic awareness not be enough? When might it be necessary, even essential, to develop and draw on our metalinguistic awareness? There are two important answers to this question.

First, epilinguistic awareness develops over time with many, many meaningful exposures to language (i.e. via *statistical learning*) (Arciuli 2018). If a student's volume of reading is low, there are fewer opportunities to develop epilinguistic awareness. This is particularly pronounced when it comes to epilinguistic awareness of academic language, which is more commonly used in written rather than oral contexts (Biber 2006) and is reliant upon many opportunities to read and understand academic texts. It may be the case that supporting students' metalinguistic

awareness of academic language offers a "work-around" to underdeveloped epilinguistic awareness of academic language. For example, if a child reads many instances of the word *however* in texts they are able to comprehend, they will come to seamlessly recognize that *however* contrasts two ideas. This tacit, or epilinguistic, knowledge of the function of *however* supports them as they read and write in school. But, for students who have not had enough exposure to the word *however* to build epilinguistic awareness of its function, helping them build explicit knowledge of *however* may accelerate their ability to process that word when they do encounter it in text.

Second, relying primarily on epilinguistic awareness can privilege some registers of a language and devalue others. Haas Dyson and Smitherman (2009) demonstrate the complexities, and inequities, when epilinguistic awareness is overly-relied upon. In their article, Tionna, a first grader, speaks African American English (AAL). AAL is a rule-governed variety of English, just like any register (Lippi-Green 2012; Paris 2009). In a writing task, Tionna starts a sentence "But if you be bad […]", following the grammatical norms of AAL. Her teacher asks her if "be bad" sounds right, and Tionna does not answer. For Tionna, and within the rich language tradition that is AAL, of course it "sounds right"! In this example, both the teacher and Tionna are relying on their epilinguistic knowledge, and the result is that the teacher calls Tionna's language heritage into question. Fortunately, there are models for educators to approach these situations in ways that sustain Tionna's existing language resources and simultaneously develop new ones by examining forms and functions of all language practices (Baker-Bell 2020; Flores 2020).

Finally, there is a precedent in the literature for examining the roles of epilinguistic and metalinguistic awareness specifically with syntax. Syntax researchers distinguish between syntactic comprehension (or syntactic knowledge) and syntactic awareness (Brimo et al. 2017; MacKay et al. 2021). Syntactic comprehension aligns with epilinguistic awareness (Sorensen Duncan et al. 2021) and syntactic awareness aligns with metalinguistic awareness (Deacon and Kieffer 2018). Furthermore, there is likely a developmental aspect to these constructs, with syntactic comprehension (more epilinguistic) influencing younger readers' comprehension and syntactic awareness (more metalinguistic) playing a bigger role for older readers (MacKay et al. 2021). Further, syntactic knowledge influences a readers' ability to navigate cohesion in a text, the primary focus of the current study.

3 Literature review

Drawing on the SFL framework and metalinguistic awareness, we now share research on academic language and cohesion as it is relevant to the current

study. We begin by defining academic language and cohesion and continue by reviewing relevant research on relationships between cohesion and reading comprehension.

3.1 Academic language

In the current study, the register of interest is academic language in English. Academic language supports meaning making in academic contexts. As explained by an SFL framework, it influences and is influenced by the academic contexts in which it is used. Within the academic language register, there is a set of identifiable features that characterize the register. Uccelli and colleagues (2015) defined these features and the specific Core Academic Language Skills (CALS) (Uccelli et al. 2015) readers need to comprehend the academic language register. There are seven domains of CALS: unpacking dense information at the word and sentence level, connecting ideas logically, tracking participants and themes, organizing analytic texts, understanding metalinguistic vocabulary, understanding a writer's viewpoint, and recognizing academic language (Barr et al. 2019). While these domains are distinguishable from each other in their contributions to comprehension, readers draw on them collectively to construct meaning (Barr et al. 2019). Research has shown the efficacy of CALS in predicting reading comprehension across samples of linguistically diverse adolescents (Barr et al. 2019; Phillips Galloway et al. 2019, 2020; Uccelli et al. 2014, 2015) as well as correlational relationships between CALS and student writing outcomes (Phillips Galloway et al. 2020). In the next section, we will explore one linguistic feature of the register of academic settings, cohesion.

3.2 Cohesion

One component of language that weaves its way through many of the skills in the CALS construct is *cohesion* (how the sentences are related to each other in a text). Within academic language, cohesive ties are prominent, and their frequency and use can differ across the disciplines (Román et al. 2016). A reader's recognition of *cohesion* (which is housed in the text) supports their development of *coherence* (which is housed in the mind of the reader) as they read, and this is an essential part of reading comprehension (McNamara et al. 2014: 19). Being able to navigate cohesion requires interpretation of the language in a text to understand what the author is referencing in one sentence and how it connects to something they wrote in another sentence, or something that the author assumes that readers know and can

reference but is not in the text explicitly (Halliday and Hasan 1976). Other researchers have accurately referred to teaching cohesion as teaching children how to make an inference (e.g. Elleman 2017; Shanahan 2022).

A key feature of cohesion is that it is "expressed through the organization of language" (Halliday and Hasan 1976: 5). In particular, cohesion consists of different kinds of "ties" which connect language together (Halliday and Hasan 1976). Some ties are classified as grammatical, including reference ties, which refer to something in a previous sentence. Also classified as grammatical ties are "substitution", which involves replacing one item with another word; "ellipsis", what Halliday and Hasan (1976: 142) refer to as "what is left unsaid" that the reader must infer; and conjunctions, which are words used to connect clauses. In addition, there are lexical ties, in which authors refer to and build on the same idea across sentences using different vocabulary.

While word order and clause structure, components of syntax, are certainly related to the use of cohesive ties, syntax and cohesion are distinct components of language. Most simply, they are different because cohesion "has nothing to do with sentence boundaries" (Halliday and Hasan 1976: 5); instead, the references that readers need to connect often happen in two or more sentences that may not be adjacent to each other. McNamara et al. (2014: 20) explain that syntax is rule-bound and creates order around "the rules and relations of words". Cohesion, on the other hand, lives in the semantic domain of language more so than the syntactical one (Halliday and Hasan 1976). As McNamara and colleagues (2014: 20) explain, cohesion ties "together the clauses and sentences in text at a semantic level and thus helps the reader better understand the *ideas* of the text". This aligns with Martin's assertion that readers must go "beyond the clause", as he posits that relationships indicated by cohesive ties contribute to the overall semantic structure of a text.

3.2.1 How readers navigate cohesion

Related to these conceptions of cohesion as more semantic than syntactic (e.g. Halliday and Hasan 1976) is the research that explores *how* readers connect sentences and ideas across a text. Research has revealed that there are students for whom understanding or using cohesive ties to make inferences is difficult (Cox et al. 1990). One factor that influences readers' ability to comprehend cohesive ties in a text is readers' background knowledge, which is defined as the sum of what an individual or group knows (Lee 2007), and can include many different types of knowledge such as topic knowledge, linguistic knowledge, cultural knowledge, and experiential knowledge. An additional factor that influences readers' understanding of cohesive ties is their skill as readers (e.g. Fraser et al. 2021; Yuill and Oakhill 1988). For example, highly skilled readers are more likely to connect pronouns to the attributing word it

represents than less skilled readers. The amount and levels of cohesion in a text also influences how readers navigate relationships between ideas in texts (Gasparinatou and Grigoriadou 2013; Hall et al. 2015; Ozuru et al. 2009). Texts can be highly cohesive, meaning there are many cohesive ties cuing readers to connect ideas between and within sentences and across the text. Or, texts can be low cohesive, meaning the reader has to work harder to infer how ideas are connected. Dahl and colleagues (2021) found that students' produced more inferences when reading texts that were high in global cohesion. Relating to the interaction between levels of cohesion and readers' knowledge, Dahl and colleagues (2021) found that readers made more inferences from a low cohesive text when they had topic knowledge related to the text. This research suggests that attending to the degree of cohesion in texts matters for students, given that text cohesion can mediate differences in relevant topic knowledge for readers (e.g. Reed and Kershaw-Herrera 2016).

3.2.2 Two types of cohesive ties: connectives and anaphoric references

Exploring students' conceptions about semantic functions of different types of cohesive ties, specifically connectives and anaphoric references, was a goal of the current study. Connectives, also called conjunctions (Halliday and Hasan 1976), are words and phrases that show relationships between two ideas within or across sentences and paragraphs. For example, connectives can show how one idea elaborates on another (e.g. *specifically*), how one thing happened at the same time as another (e.g. *meanwhile*), and how one thing contrasts with another (e.g. *despite*). There are different ways to categorize connectives, but the most common categories are additive, temporal, causal, and adversative (Halliday and Hasan 1976).

Anaphora, or the use of anaphoric references, is commonly used to support cohesion in a text. An anaphoric reference is a word or group of words that are used in place of another word or group of words within the same sentence or in a different sentence. Morphologically, "ana" is from the root meaning "back" and "phora" is from the root meaning "carry". Anaphora literally carries meaning in the text, back and forth, from one idea to its referent. Anaphora can be a type of grammatical cohesion, in which pronouns are used to refer to a previous word, or a type of lexical cohesion, in which a synonym is used to refer to a previous word. Some scholars reserve the term anaphora just for pronoun replacements (e.g. Moats 2020), while others articulate different types of anaphora (e.g. concrete vs. Conceptual) (Uccelli et al. 2015).

There is some evidence of relationships between knowledge of connectives and anaphora with reading and writing. First, there is correlational evidence that knowledge of connectives relates to reading and writing (Crosson and Lesaux 2013; Duggleby et al. 2016; Taylor et al. 2019). Some early studies on the impacts of sentence-

combining instruction showed some positive effects on reading comprehension and writing (Hillocks 1986; Kanellas et al. 1998; Saddler and Graham 2005; Wilkinson and Patty 1993), suggesting that supporting students with connectives instruction and practice may be beneficial. However, notably absent from these studies are multilingual learners who navigate academic language with different language strengths than monolingual learners.

3.3 Rationale and research questions

While metalinguistic awareness has been studied in a variety of contexts, more research is needed to explore students' epilinguistic and metalinguistic awareness of cohesion to help them with the academic register so prevalent in school settings. In particular, research that explores how students navigate the dense and challenging sentences that are characteristic of academic texts is particularly needed (MacKay et al. 2021; Truckenmiller et al. 2019). The dense sentences of academic language are rich in cohesive ties, or specific words and phrases that connect and show relationships between ideas within and across sentences. The current study explores cohesive ties in academic sentences, specifically connectives and anaphoric references, and students' metalinguistic and epilinguistic understanding of these features. Specifically, this study seeks to answer the two questions:

(1) How do third and sixth grade students explain their knowledge of cohesive ties in academic sentences?
(2) How does third and sixth grade students' knowledge of cohesive ties in academic sentences relate to their performance on standardized measures of reading comprehension?

4 Methodology

For this mixed methods study, we used a qualitative-dominant approach (Johnson et al. 2007). Our overarching methodology was a collective case study design with two bound cases (Yin 2018) with one teacher and three students each. The multiple case study informed the design of the quantitative component of the study, which involved the participants in the two bound cases plus additional students and teachers at the same school. Correlational analyses were used to explore relationships between knowledge of cohesive ties and overall reading proficiency.

To negotiate the tensions between underlying assumptions of qualitative and quantitative research, we employed a pragmatic approach to mixed methods research. A pragmatic approach refutes the notion that qualitative and quantitative

research are incompatible (Teddlie and Tashakkori 2012). When designing mixed methods research, the purpose of integrating qualitative and quantitative assumptions and approaches can be to *triangulate*, *explain*, or *explore* (Bryman 2006). Our primary goal in the current study was to *explore* how students navigate cohesion in academic sentences, as well as how students' knowledge of cohesion related to their performance on measures of reading comprehension.

Other considerations for mixed methods research include attention to which methodology is dominant and whether different types of data will be collected simultaneously or sequentially (Bryman 2006). In the current study, a qualitative approach was dominant and drove the initial research questions, recruitment, and data collection protocols. Additionally, data were collected sequentially, with qualitative data collected first and quantitative data collected second. Preliminary analyses of qualitative data informed the design and collection of the quantitative data sources.

4.1 Context

This project took place at a K-8 public school (pseudonym: Carson Charter) in a metropolitan area in the western US. Total enrollment at the school was 925 students, 11 % of whom had specific learning needs and Individualized Educational Programs (IEPs), with an average student to teacher ratio of 31–1. The race/ethnicity breakdown of the student population was: 71 % White, 15 % Hispanic, 5 % Asian, 9 % two or more races, and less than a half percent each of Black, Pacific Islander, and American Indian/Alaskan Native. While the school does include multilingual students, the students designated as English Learners comprise less than 1 % of the school. On average, the school is very high performing: at the time of the study, more than 70 % of elementary and middle school students performed at the proficient level or higher on the state English/Language Arts assessment.

Teachers and administrators at Carson Charter recognized that academic language was challenging for many of their students. The first author was invited to share a professional learning workshop on reading and writing academic sentences with all interested teachers at Carson Charter, and the data for the current project emerged from a professional learning inquiry project with a smaller group of 3rd and 6th grade teachers. The goal of this inquiry project was to better understand how students navigate cohesion in academic sentences. While the participating teachers did share that they integrated varying degrees of cohesion instruction into their lessons, the focus of this inquiry was squarely on students' sense-making of cohesive ties, and instructional artifacts were not analyzed.

4.2 Participants

4.2.1 Qualitative participants

Three third grade students from Ms. Mason's class, and three sixth grade students from Ms. Libler's class were selected to participate in metalinguistic interviews (e.g. Myhill 2016) related to academic sentences (all names are pseudonyms). These interviews asked students to reflect on purposes and functions of specific cohesive ties in academic sentences. All six students were native English speakers and ranged in reading performance on standardized assessments of reading comprehension (i.e. i-Ready and MAP). Teachers selected students based on teachers' learning goals for the professional inquiry collaboration (e.g. selecting students with a variety of reading abilities in order to better understand how students at different reading levels navigated cohesion).

4.2.2 Quantitative participants

The quantitative component of the investigation was based on a convenience sample of teachers to extend our inquiry to a larger group of students at Carson Charter. This sample included the students from three third grade classrooms (n = 72), including Ms. Mason's class, and students from all of Ms. Libler's social studies classes (n = 88). Inclusion criteria for teachers included those who were interested in and able to administer an experimenter-designed Maze task, designed to measure knowledge of cohesive ties, to their students. No students in the aforementioned classrooms were excluded, although several were absent on the day the Maze tasks were administered and there was no time available for make-up testing.

4.3 Data sources and procedures

4.3.1 Qualitative data sources

For research questions (RQ) 1, data sources included audio recordings and transcripts from metalinguistic interviews with students, as well as researcher memos from each cycle of interviews. Interviews with the three students from Ms. Mason's and Ms. Libler's classes occurred four times, every two to three weeks, from February to May of the 2021–2022 school year.

4.3.1.1 Student metalinguistic interviews

Interviews were conducted by the researchers, and they started with rapport-building questions related to literacy activities and instruction in their classrooms. Then, complex sentences from texts students read recently with teacher support, as well as from grade-level texts that were novel to students, were shared? with students. We called these "taught" sentences and "cold" sentences. Students completed interviews in response to prompts that asked about cohesive ties in the sentences. For example, the interviewer would read aloud a sentence from either a taught or cold text and ask questions like, "What is the word *although* telling us in this sentence?" Researchers offered encouraging responses to students, regardless of the accuracy of the students' answers, in order to avoid the effects of researcher feedback on subsequent questions and interviews. Interviews lasted between 20 and 30 min, and all student interviews were audio-recorded and transcribed.

4.3.1.2 Metalinguistic interview memos

Following each round of interviews, we generated interview summaries based on interview transcripts and notes to capture in-the-moment observations and insights, and to share relevant themes with teachers as part of the professional learning inquiry project.

4.3.2 Quantitative data sources

Following the interview cycles, we supported teachers in learning more about their entire classes of students, including both their knowledge of cohesive ties and relationships between knowledge of cohesion and performance on measures of reading comprehension. The two quantitative data sources were experimenter-developed Maze tasks and reading scores from the i-Ready and MAP standardized assessments.

Maze task for knowledge of cohesive ties. We designed two Maze tasks (see Appendix A) which targeted comprehension of cohesive ties for third and sixth grade students. To design the Maze tasks, we first selected passages from popular websites with grade-level specific passages for students (e.g. NewsELA, Scholastic, Readworks). Because Maze tasks are typically completed independently and silently by students, our collaborating teachers provided feedback on the passages selected for the Maze tasks. Teachers shared their impressions of which passages would be accessible for most of their students, thereby allowing us to informally ensure that performance on the Maze items would not be overly impacted by independent, silent reading ability.

To create the items for the Maze task, our approach contrasted with a typical Maze measure which involves the removal of every seventh word from a text.

Instead, we removed words that served as cohesive devices. Items were developed to target knowledge of connective words (e.g. *however*, *despite*) and anaphoric references (e.g., pronouns or other references to earlier ideas or people). For each item, students had three words or phrases to choose from. The third grade Maze task had a total of eight items, with four each targeting connectives and anaphoric references. The sixth grade Maze task had a total of 16 items, with 11 targeting connectives and five targeting anaphoric references. Our teacher collaborators received training on the purpose and procedures of the Maze tasks and administered the Maze tasks with a standardized script and time parameters. An example from the sixth grade Maze tasks follows, with the first item targeting knowledge of connectives and the second targeting anaphora knowledge:

> Most of us are likely familiar with traditional printers, which use ink to create words and images on paper. _____ **(Similarly, Despite that, However)**, 3-D printers work differently. _____ **(It uses, They use, We use)** materials such as plastic, metal, or concrete to create solid three-dimensional objects – meaning they have length, width, and height.

Performance on reading comprehension measures: iReady and MAP. The second data source for the quantitative component of the study was reading comprehension performance, based on i-Ready and MAP reading comprehension scores. i-Ready Diagnostic is a computer-adaptive assessment of reading sub-skills (e.g. phonological awareness, phonics, comprehension in both informational text and literature) and growth in grade-level reading goals for grades K-12 (Curriculum Associates 2022). i-Ready Diagnostic provides normative and criterion-referenced data on student reading performance and strongly correlates with state summative assessments of English Language Arts (Curriculum Associates 2022). Reliability estimates ranged from 0.91 to 0.97 (Swain et al. 2020). i-Ready data were available for both third and sixth graders.

Measures of Academic Progress (MAP) (Northwest Evaluation Association 2008) is a computer-adaptive, untimed test of reading comprehension available for students in Grades 2–12 to assist teachers in determining students' reading ability. MAP is a norm-based assessment for measuring comprehension growth utilizing a Rasch Unit score, or RIT score, to determine students' reading comprehension ability. Marginal reliability for third grade is reported at 0.96 for third graders (Northwest Evaluation Association 2019). MAP data was available for third graders only.

Both the standardized reading measures were administered in the spring of the school year by school personnel as part of the school's assessment plan, and scores were made available to the research team. Importantly, these standardized reading measures operate from an assumption that there is such a thing as "normal reading"

(Huettig and Ferreira 2022: 727) that can be measured in a reliable way, which belies the many types of and purposes for reading.

4.4 Data analyses

4.4.1 Qualitative analyses

For qualitative data analysis, we adopted a theoretical thematic analysis stance (Braun and Clarke 2006: 84) drawing on our research questions and relevant literature to guide our analysis. Throughout data collection, we had already familiarized ourselves with the data through the creation of interview summaries. After data collection, we proceeded with initial coding (Saldaña 2016). We looked through the interview summaries, identifying ideas and patterns that aligned with our research questions; this process evolved into our creation of more formal codes that we used to code the entire data set of interview summaries (see Appendix B for coding scheme). Codes were then grouped together according to potential themes, and short narratives were written to further define each theme and ensure that all grouped data aligned with this potential theme. For example, "metalinguistic awareness" was frequently used to code both third and sixth grade students' explicit discussion or manipulation of cohesive ties. This broad code was broken down into three revised codes: metalinguistic awareness of cohesive ties and their functions, elaboration on relationships and ideas signaled by cohesion, and students' manipulation of cohesive ties (see Appendix B for definitions and examples of each code). Together, these codes constituted the theme, "Students leverage their developing metalinguistic awareness to comprehend and convey cohesion in disciplinary texts".

4.4.2 Quantitative analyses

We analyzed data separately for the third and sixth graders. We performed item analysis to assess how well individual items on the Maze Tasks worked for evaluating student knowledge of connective words and anaphoric references. Correlation analysis was performed to determine the association between Maze task total score and reading proficiency. An alpha of 0.05 was used as the cutoff for significance. Finally, to examine the features of the texts for the Maze tasks, the Coh-Metrix Text Easability Assessor was used to evaluate five features of the text (i.e. narrativity, syntactic simplicity, word concreteness, referential cohesion, and deep cohesion).

5 Results

Given the methodology for this study, qualitative-dominant mixed methods, we first present the qualitative results for the multi-case study. Next, the quantitative results are presented, first with the item difficulty and item discrimination findings on the Maze tasks and then with the correlational findings on the Maze tasks and performance on measures of reading comprehension are presented. Finally, the findings from the Coh-Metrix analyses of the two passages used in the Maze tasks are presented.

5.1 Qualitative results: within case themes

5.1.1 Case 1 themes

Theme 1: Third graders demonstrated developing metalinguistic awareness of cohesion via explanations of cohesive ties. Based on the taught and cold sentences, students typically demonstrated clear metalinguistic awareness of cohesion. This metalinguistic awareness was evidenced by their ability to explain the functions of cohesive ties in an explicit, decontextualized way. In other words, they used their metalanguage, or their language *about* language, to explain what specific cohesive ties were connecting. For example, Tamara explained that the word *then* meant that "something else was going to come", demonstrating that she understood the meaning of this word and the relationship it showed between the ideas in two sentences. Some students' responses demonstrated metalinguistic awareness that was still developing, which was evidenced by their self-corrections of their explanations. At times, they would rethink their responses and then offer different explanations or manipulations of cohesive ties. However, across multiple questions, all three students demonstrated metalinguistic awareness of cohesion in their explanations and manipulations of cohesive ties (see Table 1).

Theme 2: Third graders demonstrated developing epilinguistic knowledge of cohesion. Students also demonstrated their epilinguistic knowledge of cohesion throughout the interviews. Epilinguistic awareness is that tacit, implicit, unconscious use of language. With respect to cohesion, epilinguistic awareness would allow for overall comprehension of sentences without being able to explain the functions of the cohesive ties in an explicit or decontextualized way. When students were unable to explicitly explain the functions of cohesive ties, they were still able to make judgments about what "sounded right" or what "didn't sound right" throughout the interviews. For example, Ethan was able to paraphrase a sentence with the word

Table 1: Representative examples for the three themes of the third grade case.

Theme	Examples	Interpretation
Theme 1. Developing metalinguistic awareness of cohesion via explanations of cohesive ties	– In a review of the book *Peter Pan*, the author wrote: "As you read the book, your imagination goes wild". When asked about the temporal connective "As", Denise knew that "as" meant "during. When asked if she knew of other words that work instead of "as", she suggested "while" and "when". – In an informational text about seals, the author wrote: "With her teeth, she is scraping off bits of ice. Seals, like all mammals, need to breathe air, so Weddell seals use their teeth to make sure their breathing holes stay open". When asked what "so" meant in the sentence, Ethan said he thought it was to "tell about why [the seals] do it". – In the informational text about seals, the author wrote: "Into this brightly lit world, the large gray head of a Weddell seal appears through a crack in the ice. The seal takes several deep breaths, and then she opens her mouth and turns her head from side to side". When asked about the word "then", Tamara explained: "something else is going to come. You're adding more to it".	In each of these examples, students could explain the function of the connective in an explicit, decontextualized way.
Theme 2. Developing epilinguistic knowledge of cohesion	– When asked about the phrase "While I liked the book […]" from the *Peter Pan* book review, Ethan explained that he would expect to hear something about a "bad part" of the book because of the word "While".	In each of these examples, students had a sense of how cohesive ties were functioning, but could not explain them in explicit or decontextualized ways.

Table 1: (continued)

Theme	Examples	Interpretation
	– When asked whether the word "and" could be used in place of the word "but" in a sentence, Tamara explained that it wouldn't "have been as good of a sentence", but she wasn't sure how to explain why.	
Theme 3. Developing knowledge of cohesion is influenced by text-based, student-based, and instruction-based factors.	– All three third graders identified vocabulary as a challenge in reading, using descriptors including: "hard", "difficult", and "challenging". – Denise shared that circling connective words in drafts of their own writing was a big help. – Ethan said that Ms. Mason helped them start off the beginning of each paragraph and that was really helpful. He said he might have benefitted from even more examples. – Tamara found it really helpful for her writing when Ms. Mason gave a list of possible linking words to choose from.	These examples illustrate how students perceived the influence of their own knowledge about the topic and their experiences, the texts, and their teacher's support on their knowledge of cohesive ties.

while in it, but he could not explain the specific meaning of *while.* And, he had similar patterns of responses to questions that asked about both connectives and anaphoric references (see Table 1).

Theme 3: Third graders' developing knowledge of cohesion is influenced by text-based, student-based, and instruction-based factors. Multiple factors appeared to contribute to students' metalinguistic and epilinguistic knowledge of cohesion. Students typically relied on the ideas in the sentences as they explained or manipulated cohesive ties. In addition, they also drew on their knowledge about the topic and relevant experiences to explain the relationships that were represented by cohesive ties. For example, when explaining the function of the word "but" in the academic sentences, both Denise and Ethan gave examples that related to their own lives, such

as "I like pizza but not with peppers". With the sentence, "As you read the book, your imagination goes wild", students were asked about the meaning of the word *As*, and all three students talked through the metaphor of your imagination going "wild" as they explained what the word *As* meant. Finally, teachers played a clear role in students' knowledge of cohesion, both their developing epilinguistic and metalinguistic knowledge, as evidenced by the students' explanations of teacher's explicit instruction and scaffolding routines (see Table 1).

5.1.2 Case 2 themes

Theme 1: Sixth graders leverage their developing metalinguistic awareness to comprehend and explain cohesion in disciplinary texts. Students demonstrated accurate and explicit knowledge of cohesive devices, specifically connectives and anaphora, throughout the interviews. For example, Caroline used an analogy of a U-turn to describe the meaning of the word "although'. Most of the time, students were able to correctly identify the function of connectives and anaphoric references. Further, this metalinguistic awareness of connectives and anaphora enabled students to more deeply engage with and elaborate on relationships between ideas in disciplinary texts (both "taught" and "cold") and writing tasks. Additionally, when students demonstrated strong metalinguistic awareness of cohesive devices, they were more likely to manipulate cohesion through accurate substitution (e.g. replacing a connective with another connective that functioned similarly and maintained correct syntax) and paraphrasing sentences that utilized cohesive devices (see Table 2).

Theme 2: Sixth graders draw on epilinguistic awareness to comprehend challenging uses of cohesion, compensating for developing metalinguistic awareness. Throughout the interviews, all three students encountered cohesion that they found to be challenging or unfamiliar and attempted to make sense of these cohesive devices through various strategies, relying on both epilinguistic and metalinguistic awareness. For example, when unsure of the function of a connective, students discussed the different connective types to try to determine which one it might be, approximating its function through discussing the ideas and relationships in the text. Additionally, when students were unsure of an anaphoric reference, they often reread the excerpt to try to determine what idea was being referenced. However, when metalinguistic awareness was underdeveloped, students relied heavily on their epilinguistic awareness to make sense of cohesion. For example, Emily grappled with connective functions and the term "conjunction" (see Table 2) – sometimes inaccurately – demonstrating developing knowledge of both cohesion and academic

Table 2: Representative examples for the three themes of the sixth grade case.

Theme	Examples	Interpretation
Theme 1. Leverage developing metalinguistic awareness to comprehend and convey cohesion.	– In response to a question about what the word "although" means, Caroline explained, "It's like a U-turn. It introduces one idea, and then it introduces another. It kind of like turns the whole point around". – When asked about a sentence that began with the connectives, "Long ago, before the days of Islam", Andrew explained that both temporal connectives and phrases were used "so we can get closer to the timeline so we can understand what would actually be happening during that time if we did some research". He explained that "Long ago" alone would be too broad. – When discussing the sentence, "Women, children, enslaved people, and foreigners living in Athens were not citizens. Therefore, they could not vote in the Assembly or serve on juries", Caroline restated the sentence by saying "They weren't citizens, so they couldn't vote". When asked to explain why she replaced "therefore" with "so", Caroline said that they both mean "this is why".	In each of these examples, students explicitly define the function of the connective, expanding on the relationship it conveys.
Theme 2. Draw on epilinguistic awareness to compensate for developing metalinguistic awareness.	– When asked if "however" would work in place of "in addition" in "In addition to academic instruction, every young man was given two years of military instruction and many years of physical education", Andrew said, "That wouldn't make sense," and then reread the sentence,	In each of these examples, students grapple with the function of the connective, attempting to define it by discussing multiple possible functions and drawing on their existing knowledge of connectives.

Table 2: (continued)

Theme	Examples	Interpretation
	replacing "in addition" with "however". Then, he attempted to identify the function of each connective in his response. He said, "Isn't 'however' a compare and contrast word? And 'in addition' is to add on?" – In response to the question, "What do connectives do in a sentence?", Emily answered, "A few do cause and effect, and a handful of them do the opposite, like 'but' and conjunction, I think is the word – I wrote it down in my notebook as a vocabulary word to help me remember – but 'however' is more like a cause and effect".	
Theme 3. Sixth graders develop metalinguistic awareness through explicit instruction in cohesion, specifically in the context of disciplinary texts.	– When asked how Ms. Libler had been scaffolding cohesion, Emily responded "We've been practicing transition phrases a lot. She's been teaching us what their definitions are and what they can do in a sentence." When asked why she thought Ms. Libler asked them to include connectives in their own writing about a social studies topic they had been studying, Emily responded "I guess she wanted to see how we were doing and if we knew what they meant". – After discussing how Ms. Libler scaffolds students' understanding of cohesion through teaching them to annotate the text (e.g. circling words they don't know), Caroline thought it would be helpful if they discussed challenging sentences as a class.	In these examples, students describe scaffolds which they found helpful for comprehending cohesion as well as needs for additional scaffolding.

vocabulary in general. Overall, though, students were aware that metalinguistic awareness (e.g. explicitly knowing the function of a connective) would support them in their comprehension and attempted to leverage it where possible to make sense of the text.

Theme 3: Sixth graders develop metalinguistic awareness through explicit instruction in cohesion, specifically in the context of disciplinary texts. With prompting during the interviews and through spontaneous discussion about Ms. Libler's practice, students attributed their metalinguistic awareness of cohesion to her instruction. Students identified explicit instruction (e.g. teaching definitions of connectives) and repeated scaffolding (e.g. collaborative discussion) of connectives and anaphora as essential to their understanding of cohesion. Most often, students discussed explicit instruction and scaffolding of cohesion as taking place in the context of discipline-specific texts and tasks. When asked what scaffolding would be most helpful for their learning of cohesion, students emphasized the importance of repeated exposures to connectives and anaphora within disciplinary texts as well as repeated opportunities to discuss challenging or unfamiliar uses of cohesion.

5.2 Quantitative analyses

5.2.1 Item analysis

For the eight items on the third grade Maze Task, item difficulties ranged from 0.75 to 0.97. Seven of the eight items had item difficulties greater than 0.80. These results revealed that these items were too easy for these third graders. Point-biserial correlations between the response to each item and the total Maze score ranged from 0.20 to 0.69. Using 0.15 as a cutoff (Varma 2006), all the items performed well in terms of discriminating high-performing students from low-performing students.

For the 16 items on the sixth grade Maze Task, item difficulties ranged from 0.48 to 0.94 and seven of the 16 items had item difficulties greater than 0.80. These results revealed that some items were too easy for these sixth graders. Point-biserial correlations between the response to each item and the total Maze score ranged from 0.17 to 0.60. Using 0.15 as a cutoff (Varma 2006), all the items performed well in terms of discriminating high-performing students from low-performing students.

5.2.2 Correlation between maze task total score and performance on measures of reading comprehension

The mean and the standard deviation of the Maze task total score for the third graders were 7.24 and 1.18, respectively (Table 3). The mean and the standard

deviation of i-Ready score for the third graders were 562.82 and 38.85, respectively. The mean and the standard deviation of MAP score for the third graders were 208.38 and 12.94, respectively. The Pearson's *r* correlation between Maze task total score and i-Ready scale score was significant (r (64) = 0.38, p = 0.002). The Pearson's *r* correlation between Maze task total score and MAP score was also significant (r (45) = 0.40, p = 0.005).

The mean and the standard deviation of the Maze task total score for the sixth graders were 11.73 and 2.52, respectively (Table 4). The mean and the standard deviation of i-Ready score for the sixth graders were 620.31 and 39.81, respectively. There was a significant correlation between Maze task total score and i-Ready score (r (82) = 0.68, p < 0.001).

Following these results, to further explore item difficulty and relationships with performance on measures of reading comprehension, we conducted a subsequent analysis on both passages using Coh-Metrix Text Easability Assessor, which evaluates five features of the text: narrativity, syntactic simplicity, word concreteness, referential (local, or lexical) cohesion, and deep (global) cohesion to determine what aspects of the text make it complex.

These language features would not have impacted the selection of the passages, since the passages were chosen in collaboration with the teachers. However, as a follow-up analysis, identifying these language features allowed us to understand how they may have influenced students' responses and ability to understand the cohesive ties in the text. Table 5 presents these results and shows sharp contrasts between the third and sixth grade texts with respect to cohesion. Specifically, the third grade passage had much higher referential cohesion, which suggests more

Table 3: Descriptive statistics and correlations for test scores of the third graders.

Variable	*n*	*M*	*SD*	1	2
1. Maze task total score	72	7.24	1.18	–	
2. i-Ready score	66	562.82	38.85	0.38 (0.002)	
3. MAP score	47	208.38	12.94	0.40 (0.005)	0.82 (<0.001)

Note: *p*-Values are presented in parentheses.

Table 4: Descriptive statistics and correlation for test scores of the sixth graders.

Variable	*n*	*M*	*SD*	Person's *r*
Maze task total score	88	11.73	2.52	
i-Ready score	84	620.31	39.81	0.68 (<0.001)

Note: *p*-Value is presented in a parenthesis.

Table 5: Coh-metrix text easability assessment of maze task passages.

Language feature	Third grade passage	Sixth grade passage
Narrativity	95 %	26 %
Syntactic simplicity	98 %	81 %
Word concreteness	72 %	29 %
Referential cohesion	86 %	2 %
Deep cohesion	37 %	87 %

anaphoric references. In contrast, the sixth grade text was very low in referential cohesion, which likely required that students would have had to work harder to make inferences throughout the text.

6 Discussion

This qualitative dominant mixed methods study explored third and sixth graders' metalinguistic awareness with academic sentences, as well as relationships between knowledge of cohesive ties and performance on measures of reading comprehension. Results suggested that both the third and sixth grade students in this study drew on their metalinguistic awareness to explain and manipulate cohesive ties. And, when their metalinguistic awareness was not developed enough for some language tasks, students relied on their epilinguistic awareness and knowledge resources to make judgments about relationships between ideas. Students also indicated specific individual and instructional factors that they perceived as challenging and helpful to their ability to read and write academic sentences. Finally, the quantitative component of this study suggested that students' ability to choose semantically-appropriate cohesive ties in connected text correlates with their performance on measures of reading comprehension. Following are detailed discussions of the findings in response to each research question.

For RQ 1, our findings suggest that students were able to explain cohesive devices in academic sentences by leveraging their metalinguistic awareness. All students demonstrated metalinguistic awareness in their discussions of cohesive ties in academic texts (Schleppegrell 2001; Uccelli et al. 2015), their understanding of ideas and relationships connected by cohesion (McNamara et al. 2014), and their conscious manipulation of cohesive devices through oral and written means (Gombert 1992). However, the degree to which students successfully leveraged their metalinguistic awareness, and the ways in which they did so, depended on a variety of factors.

One of these factors is students' topic knowledge or experiences related to the texts in which these cohesive devices, and their corresponding sentences, were situated. Analyses of students' interviews revealed a reciprocal relationship between students' topic and experiential knowledge and their linguistic knowledge, including their understanding of cohesive devices, similar to findings of previous research (McNamara et al. 2014). For example, in the interviews when students demonstrated strong and accurate metalinguistic awareness of cohesive ties, they also were able to elaborate on relationships and ideas conveyed by these ties. Relatedly, when students lacked explicit knowledge of cohesive ties and their functions, they drew more heavily on their experiences and knowledge of topics related to the passage to support their explanations of cohesive ties.

An additional factor that may have related to the depth of metalinguistic explanations, as opposed to explanations relying on epilinguistic awareness, is language development at different grade levels. While both third graders and sixth graders demonstrated epilinguistic awareness when confronted with challenging and complex uses of cohesive devices in academic sentences during the interviews, sixth graders seemed to have more sophisticated strategies to do so. For example, third grade students seemed to make more judgments about what "sounded right" or what "didn't sound right" without employing additional strategies (Sorensen Duncan et al. 2021). However, sixth graders utilized a variety of strategies in the interviews, such as drawing on grammar and syntax knowledge, discussing the content of the passage around the cohesive device, and debating the possible functions of the connective. This variety of strategies demonstrated well-developed epilinguistic awareness along with developing metalinguistic awareness of challenging academic sentences (Deacon and Kieffer 2018; Gombert 1992). These findings align with previous literature about the developmental nature of awareness of syntax and cohesion (MacKay et al. 2021).

The role of scaffolding is another factor in learners' metalinguistic awareness of cohesion in texts. Though this study did not examine classroom practice, students discussed how their teachers shared definitions of connectives, taught them how to trace anaphoric references in a passage, and helped them break down complex sentences into manageable parts, affirming previous research that direct instruction in connectives and anaphora can support students' comprehension (Baumann 1986; Dommes et al. 1984). With complex sentences from taught texts, in particular, students even seemed to paraphrase their teacher's modeling of how to navigate cohesion, supporting previous research that demonstrates how inferencing instruction can improve readers' text understanding (Elleman 2017).

For RQ 2, analysis of the quantitative data revealed a significant relationship for both third and sixth graders between knowledge of cohesive ties and performance on reading comprehension measures. These relationships were not surprising given

research linking knowledge of cohesive ties with comprehension (Crosson and Lesaux 2013; Duggleby et al. 2016; Taylor et al. 2019; Uccelli et al. 2015). Even with ceiling effects on the third grade Maze task, which limits the inferences that can be made with the third graders' performance, there were still significant correlations between Maze performance and both MAP and i-Ready scores. However, the value of Pearson's *r* was small for the third graders (0.38 for i-Ready and 0.40 for MAP), which was likely related to the restricted ranges on both the third grade Maze task and standardized reading scores. A sample of students with a wider range of scores may have yielded even stronger correlations between knowledge of cohesive ties and performance on reading comprehension measures.

These results prompted a closer look at the features of the texts used in the Maze tasks. Text analyses using Coh-Metrix revealed that the third grade text had many features which may have supported students' text understanding, including high narrativity, syntactic simplicity, and many concrete (vs. abstract) words, whereas the sixth grade passage may have been more complex, as it had lower narrativity and contained more abstract words. These features could, in part, explain why the third graders had ceiling effects while the sixth graders did not. The Coh-Metrix analyses also showed that the texts varied in the type of cohesion, with the third grade text containing higher referential cohesion but lower deep (or global) cohesion, while the 6th grade had little referential cohesion, but higher amounts of global cohesion. These characteristics of the 6th grade passage may also have contributed to why the sixth graders were more challenged by the anaphora items on the Maze task.

7 Conclusion

The present study supports the notion that children bring a great deal of various types of knowledge, beyond academic knowledge, to reading experiences (Lee 2007, 2017). These types of knowledge include experiential knowledge, topic knowledge, cultural knowledge, and linguistic knowledge, and students can use all of that knowledge to make sense of dense academic texts (e.g. Cain et al. 2004). In the present study, students consistently showed high levels of metalinguistic and epi-linguistic awareness around making sense of dense academic sentences, and they also relied on their experiences to help them interpret those sentences. Thus, the present study affirms the notion that children of varying reading abilities can and should have high exposure to challenging, academic texts (e.g. Hiebert 2017) as they have a vast array of knowledge that they can draw from to help them understand academic texts.

In addition to students' array of knowledge resources, the present study also illuminated other factors that influence a reader's ability to comprehend academic

sentences. One factor is the degree of cohesion within the text (Gasparinatou and Grigoriadou 2013; Hall et al. 2015; Ozuru et al. 2009). For example, the third grade Maze passage may have supported readers who had lower comprehension with text features such as high narrativity, word concreteness, and high referential cohesion. A third factor was readers' general reading ability, although this may have been mediated in the third grade by passage ease (Dahl et al. 2021). Thus, readers' experiences, topic knowledge, cohesion knowledge, and typical reading performance, along with text features, should all be considered when designing cohesion instruction.

To move students from epilinguistic awareness to metalinguistic awareness, they need a deeper understanding of the language that ties together sentences, and much research has been conducted to support readers' development of these skills (e.g. Myhill 2016). Direct instruction of cohesive ties, using highly cohesive texts, has been shown to help readers understand how to use the relationships provided in the text to help them develop a situation model of the text (Baumann 1986; Dommes et al. 1984). There is also a place for cohesion instruction around low-cohesive texts. When focusing on helping children develop inferencing skills, lower cohesive texts are needed to provide opportunities for students to draw connections across ideas that are not explicitly connected. A meta-analysis on inferencing instruction for K-12 students has revealed that inferencing instruction improves readers' text understanding, particularly for students with prior low comprehension skills (Elleman 2017).

Researchers have identified many strategies to raise students' awareness of the language use of authors. For example, Myhill (2021) suggests providing students with a text but leaving a few words out, and allowing for students to discuss what words may go in the blanks. In another activity, students can compare two different words that could go in a blank and how that would change the overall meaning of the text. This research has promise for exploring how to support readers' metalinguistic understanding of cohesive ties. Additionally, researchers have suggested that the use of teacher think-alouds in texts that have high numbers of pronouns to model how to identify a pronoun antecedent may be beneficial for less skilled readers (Letchford and Rasinski 2021). Bridging is another suggested strategy, which includes supporting readers in using previously mentioned information to help them understand a later sentence or paragraph of a text (Best et al. 2005).

The mixed methods approach to this study allows an integration of qualitative and quantitative findings that yields a richer portrait of the sample than either methodology alone. This study was qualitative dominant, and expanding the sample at the project site allowed for quantitative inquiry. However, such an approach does not allow for research that is fully aligned with all quantitative assumptions. Traditional sampling techniques for quantitative studies were not used, and the

student sample was relatively small and lacked the types of language, cultural, and economic diversity that would allow for generalizations to be made to a broad population of students. Furthermore, the passages for the Maze tasks were not tightly controlled for a variety of text passages, features, or topics. Instead, our collaborating teachers helped us select passages based on their experiences with the kinds of texts their students could read independently. Again, the mixed methods approach afforded this collaboration and increased ecological validity, but it did limit the inferences that could be made from the analyses on the Maze tasks. These were acceptable limitations given our pragmatic approach to mixed methods research (Teddlie and Tashakkori 2012) and our goal of *exploring* (Bryman 2006) students' metalinguistic knowledge of cohesion and potential relationships between cohesion and general reading proficiency. The interviews allowed for specific and detailed demonstrations of both metalinguistic and epilinguistic awareness with connectives and anaphoric references. The Maze tasks, while not able to distinguish between students' metalinguistic and epilinguistic awareness on any given item, allowed for an exploration of relationships between knowledge of cohesive ties and comprehension.

The current study did not include a consideration of multiple registers of language, either those known by students or those that appear in texts that represent multiple ways of using English. These factors are not incompatible with an approach that is responsive to students' varied linguistic backgrounds and strengths (Hollie 2017; Phillips Galloway et al. 2019); on the contrary, we focused on building relationships with students, honoring their processes for sense-making, and celebrating their language choices and ideas. However, research that does not include considerations of other registers of language can serve to inadvertently reify dominant registers of language (Emdin and Lee 2012). In light of this, we wish to draw further attention to the value of supporting metalinguistic awareness development as a pathway for culturally and linguistically responsive instruction in features of academic language. SFL offers a framework for exploring this because of how it interrogates how language and context influence each other in academic settings (Fang and Schleppegrell 2010). Children who were raised in and thrive in language communities that differ from the language communities of K-12 schools in the U.S. have a wealth of language resources that are often not recognized or valued in K-12 schools. Indeed, numerous scholars (Baker-Bell 2020; Brown et al. 2010; García 2017; Lippi-Green 2012; Muhammad 2020; Tatum 2021) emphasize how multiple dialects and varieties of English offer nuanced and rich ways to comprehend and produce texts about the academic ideas often studied in school. Adulating academic language as the primary or most "appropriate" (Flores and Rosa 2015) way of using language can be an exclusionary component of schools (Valdés 2021). The present study highlights students' use of different types of knowledge to help make sense of

challenging, academic texts, thus demonstrating a pathway for supporting students of different backgrounds. In short, academic language should not have a monopoly on expressing academic ideas. With a SFL and metalinguistic approach, academic language can be aptly positioned as just one variety of language to be explored, one which is no more rich or complex than other registers of language (Baker-Bell 2020). This is a *linguistically sustaining* approach that recognizes all language resources as valuable both within school and without.

Appendices

Appendix A: Maze tasks

I. Maze task for third grade

The science of stripes
(Adapted from article by Erin Kelly, *Scholastic*)

A scientist named Tim loves zebras. He loves them so much he has his own zebra suit! Tim wanted to find out why zebras have stripes. What did he do? He used the steps that every scientist uses.

First, Tim asked a question. He asked, Why do zebras have stripes? He decided to investigate. That means he would try to find the answer.

_____ **(Second, Third, Fourth)**, Tim knew he would need to make some observations. He went to a farm that has horses and zebras, and he observed _____ **(them, it, her)**. He watched them carefully, and he saw that flies bit horses. _____ **(Then, But, And)** the flies did not bite zebras. Tim thought about how horses and zebras are different. He knew that zebras have stripes and horses do not. Tim thought maybe the zebras' stripes stopped the flies from biting.

Third, Tim set up a test to find out if _____ **(his, their, its)** idea was right. He put a striped coat on a horse to test his idea, and then he watched what happened. The flies flew up to the horse, but they did not land on it. _____ **(But, Until, And)** they did not bite it. Tim also watched the horses that weren't wearing striped coats. The flies kept landing on _____ **(it, him, them)** and biting them.

Fourth, Tim recorded what he saw in a notebook. He wrote that the flies didn't bite the horse with the striped coat. Tim was excited, _____ **(although, because, before)** he had answered his question. How do stripes help zebras? _____ **(It, She, They)** help keep flies away!

II. Maze task for sixth grade

How 3-D printing is changing the world

(Adapted from article by Mary Kate Frank, *Junior Scholastic Magazine*)

Imagine waking up one day and – poof! – there's a new school right across the street. It seems to have appeared overnight.

This may sound like magic, but it happened recently in the African country of Malawi. A small village there is now home to the world's first 3-D printed school. Its concrete walls were built in just 15 h.

_____ **(After, Before, When)** the school opened in June 2021, kids in the area had to walk miles to reach school. That's a common problem in Malawi, which the United Nations estimates needs about 36,000 more classrooms to meet demand. Building that many classrooms would ordinarily take 70 years. _____ **(Because, And, But)** with the help of 3-D printers, _____ **(the job, the problem, the village)** could be done in less than a decade.

Why stop with schools? Around the globe, 3-D printers are cranking out everything from a simulated Martian habitat to human body parts to toys, jewelry, and more.

How it works

Most of us are likely familiar with traditional printers, which use ink to create words and images on paper. _____ **(Similarly, Despite that, However)**, 3-D printers work differently. _____ **(It uses, They use, We use)** materials such as plastic, metal, or concrete to create solid three-dimensional objects – meaning they have length, width, and height.

Let's say you want to use a 3-D printer to make a plastic phone case. _____ **(Next, First, Now)**, a computer program lays out an image of the design. That image is sent to the 3-D printer, which has spools of plastic thread. _____ **(Lastly, Meanwhile, Then)**, the thread is pushed through heated nozzles. The melted plastic is deposited onto a platform to make the first layer. More layers are added on top of previous ones until the case is complete.

Just getting started

People are already doing amazing things with 3-D printers, _____ **(so, but, and)** it's easy to forget that _____ **(it has, they have, we have)** been around for only a few decades. The first patent for a 3-D printer was issued in 1986, to an American inventor.

Today's 3-D printers have many advantages. _____ **(Finally, For one thing, However)**, 3-D printing tends to be less wasteful than traditional manufacturing. In conventional manufacturing, some material is usually left over (think about how a

large piece of fabric is cut down to form a T-shirt, leaving scraps), _____ **(and, so, but)** 3-D printers use just enough material to make an object.

3-D printing can also generate complex shapes. In medicine, that's allowing people – and animals – to have prosthetic limbs custom-made for their bodies. Doctors are hoping to eventually 3-D print human organs for people who need transplants.

The future in 3-D

_____ **(Because, Yet, So)** if the technology is so useful, will we 3-D print everything one day? Probably not, in part because traditional manufacturing is still the most efficient way to mass-produce most items. 3-D printing can also be expensive. A high-end version of _____ **(the prosthetic limbs, the mass-produced items, the machine)** can cost more than $500,000.

Most likely, 3-D printing will be used to create certain components of products, while other parts will continue to be made traditionally. At the school in Malawi, _____ **(however, for example, specifically)**, the walls were 3-D printed, while the doors, windows, and roof were built the old-fashioned way.

_____ **(Eventually, At last, For now)**, scientists are working on other 3-D printed innovations that could transform our daily lives – including 3-D printed clothing and food. _____ **(They are, We are, It is)** also trying to speed up and improve the process.

Maybe even your outfit and your lunch will be 3-D printed one day!

Appendix B: Coding schemes

I. Coding scheme for third grade case

Code	Definition	Example
Metalinguistic (explicit) knowledge of cohesion	Student explained in a decontextualized way the function of a cohesive device. Student displays explicit, accurate knowledge and awareness of connectives/ anaphora.	We asked students about this sentence from an informational text about seals: Into this brightly lit world, the large gray head of a Weddell seal appears through a crack in the ice. The seal takes several deep breaths, and then she opens her mouth and turns her head from side to side. When asked about the word "then", Tamara explained that "something else is going to come. You're adding more to it".

(continued)

Code	Definition	Example
Epilinguistic (tacit) knowledge of cohesion	Student displays epilinguistic awareness, or developing, knowledge of connectives/anaphora. Tacit knowledge may be displayed through using experiential or topic knowledge to make sense of connectives/anaphora, monitoring their comprehension of connectives/anaphora, saying a cohesive device "sounds" right or wrong.	We asked students about the phrase "While I liked the book […]" from the Peter Pan book review. Ethan explained that he would expect to hear something about a "bad part" of the book because of the word "While".
Manipulation of cohesive cues	Student manipulates connectives/anaphora through writing, in speech, etc.	In a review of the book Peter Pan, the author wrote "As you read the book, your imagination goes wild". We asked students about the temporal connective "As". Denise knew that "as" meant "during" and, when asked if she knew of other words that work instead of "as", she suggested "while" and "when".
Explanations involving context from text	Student explained the relationship between specific words and ideas in the text that was signaled by the cohesive cue.	All three students shared detailed examples from the characters, plot, and setting of *Peter Pan* to explain the functions of different cohesive ties.
Stated teacher support within explanation	Student explained what the teacher did to support their understanding of cohesion.	Denise shared that circling connective words in drafts of their own writing was a big help. Tamara found it really helpful for her writing when Ms. Mason gave a list of possible linking words to choose from. Ethan said that Ms. Mason helped them start off the beginning of each paragraph and that was really helpful. He said he might have benefitted from even more examples.
Evaluation of confidence in explanation/response	Student demonstrated some degree of confidence (or lack thereof) in their explanation.	We asked students about this sentence from an informational text about seals: With her teeth, she is scraping off bits of ice. Seals, like all mammals, need to breathe air, so Weddell seals use their teeth to

(continued)

Code	Definition	Example
		make sure their breathing holes stay open. When asked what "so" meant in the sentence, Ethan said he thought it was to "tell about why [the seals] do it, but I don't really know how to explain it".
Academic vocabulary knowledge	Students knowledge of word meanings interacted with their explanation of cohesion. Student uses or is challenged by word reading/academic vocabulary knowledge in their understanding of connectives/anaphora.	All three third graders identified vocabulary as a challenge in reading, using descriptors including: "hard", "difficult", and "challenging".

II. Coding scheme for sixth grade case

Code	Definition	Example
Students' metalinguistic awareness of cohesion	Student displays explicit, accurate knowledge and awareness of connectives/anaphora.	In response to a question about what the word "although" means when she referred to it as a U-turn, Caroline responded: "It introduces one idea, and then it introduces another. It kind of like turns the whole point around".
Students' epilinguistic awareness of cohesion	Student displays epilinguistic awareness, or developing, knowledge of connectives/anaphora. Tacit knowledge may be displayed through using background knowledge to make sense of connectives/anaphora, monitoring their comprehension of connectives/anaphora, saying a cohesive device "sounds" right or wrong.	In response to the question "Would the word 'however' work in place of 'in addition'? Why or why not?", Andrew responded: "No, isn't that a compare and contrast word?"
Students' manipulation of cohesive devices	Student manipulates connectives/anaphora through writing, in speech, etc.	When discussing the sentence, "Women, children, enslaved people, and foreigners living in Athens were not citizens. Therefore, they could not vote in the Assembly or serve on juries", Caroline restated

(continued)

Code	Definition	Example
		the sentence by saying "They weren't citizens, so they couldn't vote". When asked to explain why she replaced "therefore" with "so". Caroline said that they both mean "this is why".
Elaboration on relationships and ideas signaled by cohesion	Student discusses connectives/anaphora in the context of the passage, elaborating on relationships and ideas signaled by cohesion, usually through metalinguistic awareness.	In response to the question, "What is the phrase 'in addition' telling us?", all three students expressed that the phrase was giving more information in addition to the information that came before; they further explained that the information that came before must have been talking about academic instruction.
Influence of word reading and academic vocabulary knowledge	Student uses or is challenged by word reading/academic vocabulary knowledge in their understanding of connectives/anaphora.	In response to the question, "What do connectives do in a sentence?", Emily answered, "A few do cause and effect, and a handful of them do the opposite, like 'but' and conjunction, I think is the word – I wrote it down in my notebook as a vocabulary word to help me remember – but 'however' is more like a cause and effect".
Intersection of disciplinary literacy and cohesion	Student discusses or understands connectives/anaphora in the context of disciplinary learning, both within the passage and/or beyond the passage.	Caroline explained that she wrote an essay about Alexander the Great to debate what kind of leader she thought he was; she argued that he was not a good leader based on the evidence from their readings. She explained how she used connectives in her writing: "I argued using 'however' a lot, so I can kind of show that I acknowledge the other side". She also explained that "however" can also mean "but then again […]" or "instead" to compare and contrast.

(continued)

Code	Definition	Example
Explicit instruction and scaffolding in cohesion	Student mentions Ms. Libler's explicit instruction in connectives/anaphora. Explicit instruction may include discussing definitions/functions of connectives, showing students how to trace anaphoric references, etc.	When asked how Ms. Libler had been scaffolding cohesion, Emily responded "We've been practicing transition phrases a lot. She's been teaching us what their definitions are and what they can do in a sentence". When asked why she thought Ms. Libler asked them to include connectives in their own writing about a social studies topic they had been studying, Emily responded "I guess she wanted to see how we were doing and if we knew what they meant".
Needed scaffolding in cohesion	Student mentions instructional routines/ scaffolding/strategies that Ms. Libler uses to scaffold learning and comprehension of connectives/anaphora.	After discussing how Ms. Libler scaffolds students' understanding of cohesion through teaching them to annotate the text (e.g. circling words they don't know), Caroline thought it would be helpful if they discussed challenging sentences as a class.

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